Lake Helen

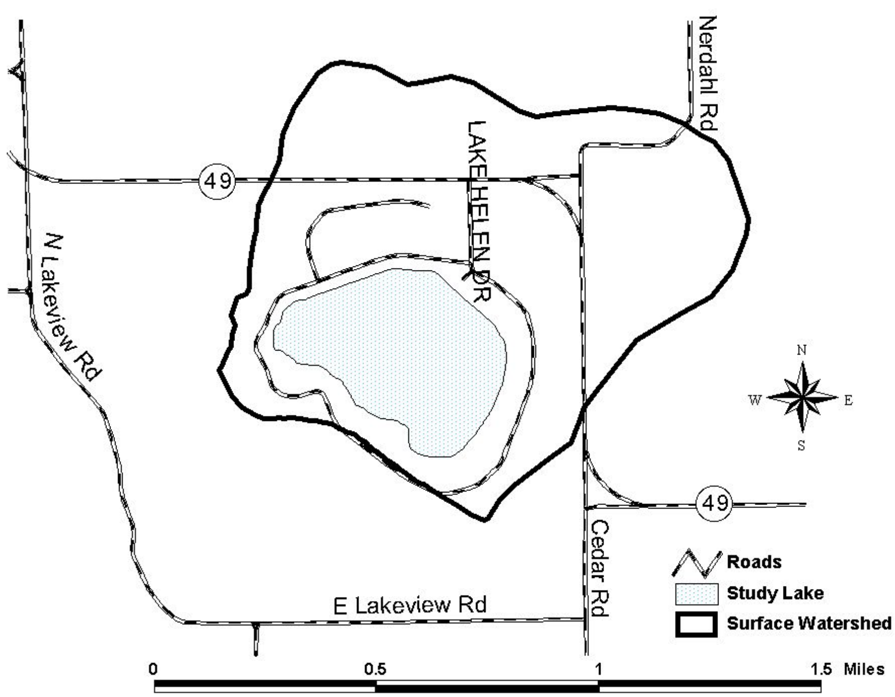
Introduction

Lake Helen is a **groundwater drainage lake** with moderately **hard water**, located two miles east of Rosholt in the Town of Alban. The **littoral** zone is extensive, covering approximately 80 percent of the lake. Sand provides good swimming around most of the lake. There are no inlets, but an intermittent outlet flows into Flume Creek. Lake Helen covers 87.4 acres, has an estimated volume of 599 acre-feet, and a maximum depth of 18 feet. The estimated **retention time** in Lake Helen is 2.3 years. The lake appears to have been very scenic at one time, however the shoreline is now completely developed several tiers deep. Population density is one of this lake's biggest problems. One small tavern on the northeast side of the lake comprises the commercial development. A small public access and picnic area are also present on the northeast shore, with a boat-launching site and small swimming beach available. Northern pike, large mouth bass, and panfish are the most common fish species. The lake is subject to winterkill of fish.

Land Use and Watershed

Lake Helen's surface **watershed** includes 500 acres (Figure 1). A large portion of the **watershed** is in non-irrigated agriculture (159 acres) or forest (89.6 acres). However, 79 acres (16%), of the **watershed** are residential. Residential development along the lakeshore boomed in the 1950s and 1960s increasing from 9 acres in 1948 to 70 acres by 1968. Forest and shrub land acreage has remained fairly constant since 1948. Non-irrigated cropland decreased by 67 acres between 1948 and 1968, presumably corresponding to the residential development (Figure 2 and Figure 3).

Figure 1. Lake Helen surface watershed boundary.



*Terms in bold, see glossary pp 17-21

Figure 2. Land Use in the Lake Helen surface watershed 2002.

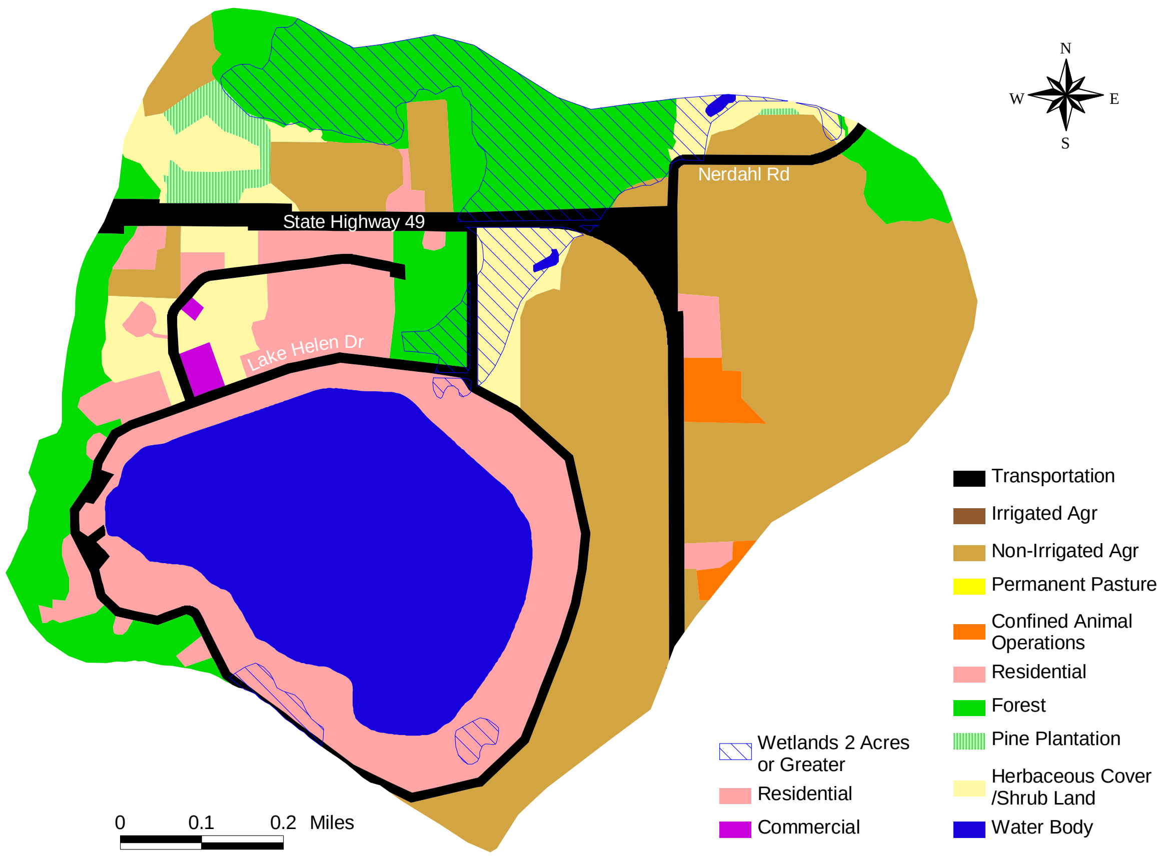
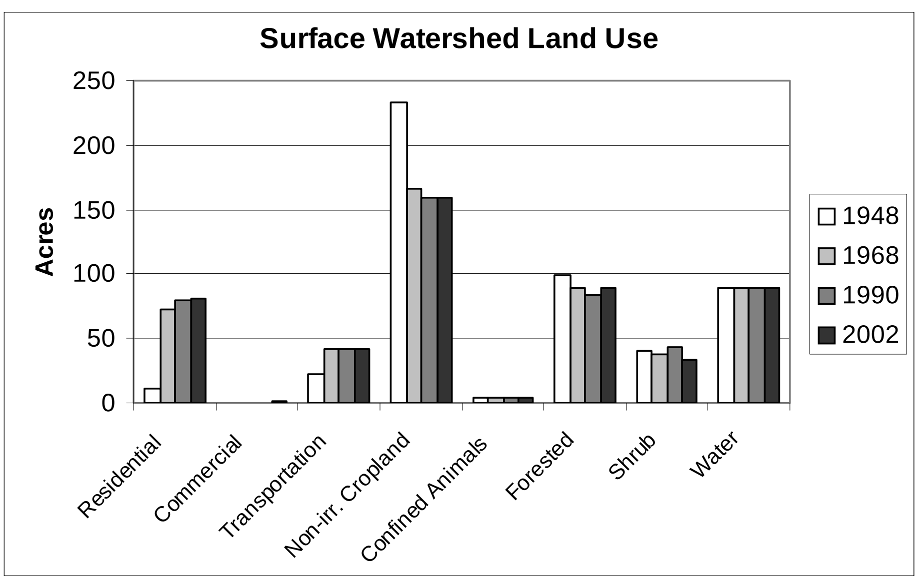


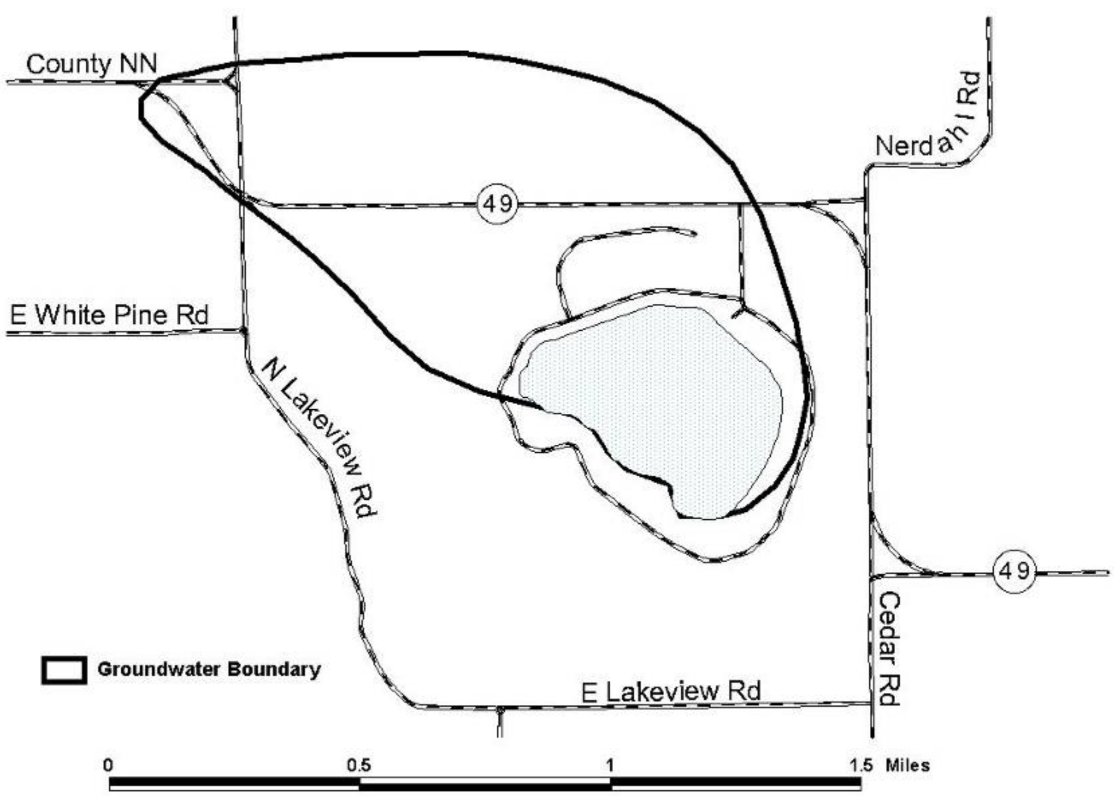
Figure 3. Land Use in the Lake Helen surface watershed 1948-2002.



*Terms in bold, see glossary pp 17-21

The **groundwater watershed** for Lake Helen encompasses 443 acres of land to the northwest of the lake (Figure 4). Non-irrigated cropland and forested areas were almost equal in 2002 with 98 acres (22 %), and 92 acres (21 %), respectively. Fifty-seven acres (12%) of the **groundwater watershed** were residential acres in 2002. Most of this development occurred sometime between 1948 and 1968. Non-irrigated cropland shows a corresponding decrease over the same time period. Both forested and shrub cover acres have fluctuated since 1948, but in 2002 overall forest acreage had increased while shrub acreage had decreased (Figure 5 and Figure 6). According to Portage County records based on age in 2002 there were three potentially failing septic systems in the surface **watershed**, two in the **groundwater watershed**, and three that fall in the boundaries of both **watersheds** for a total of eight. There is also a former landfill site within the **groundwater watershed** to the northwest of the lake. Half of the landfill is also within the boundary of the surface **watershed**.

Figure 4. Lake Helen groundwater watershed boundary.



*Terms in bold, see glossary pp 17-21

Figure 5. Land use in the Lake Helen groundwater watershed 2002.

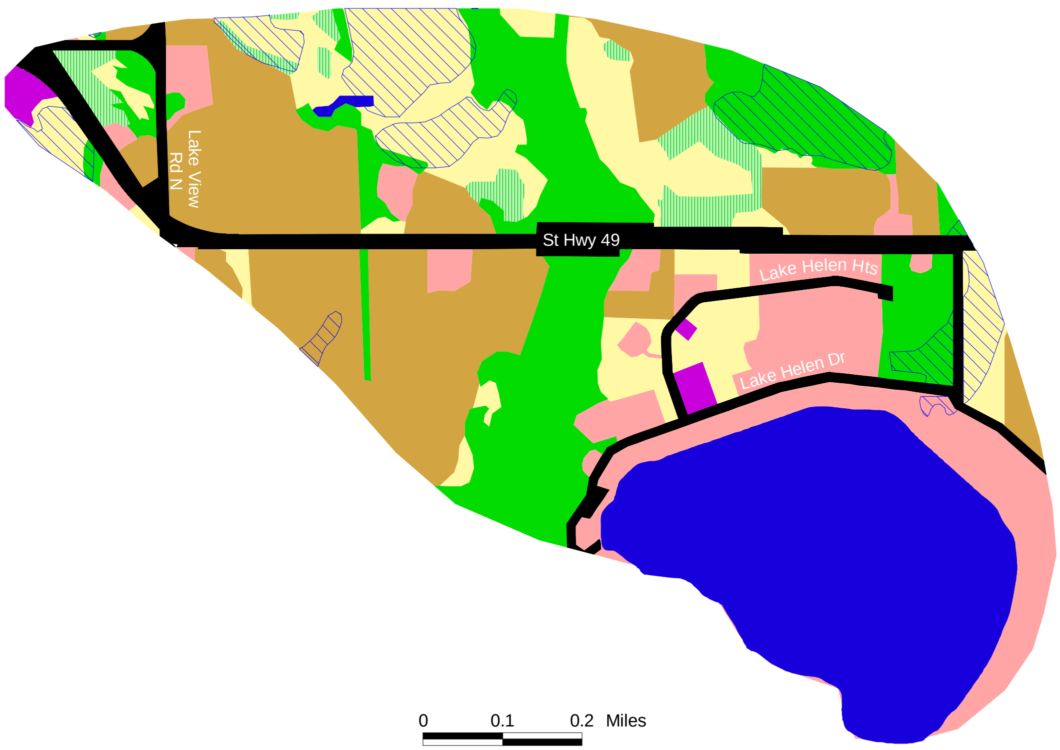
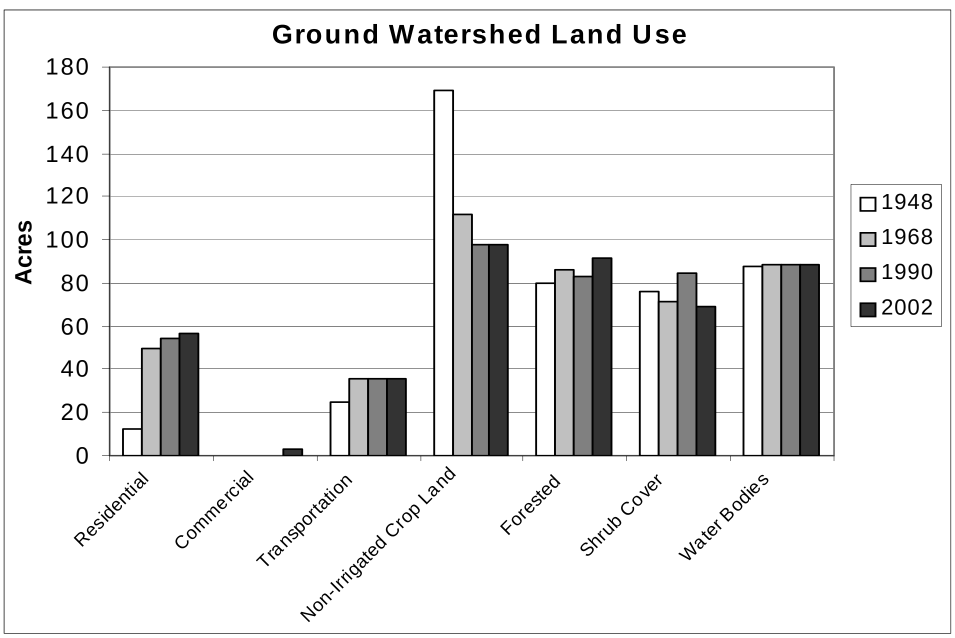


Figure 6. Land use in the Lake Helen groundwater watershed 1948-2002.

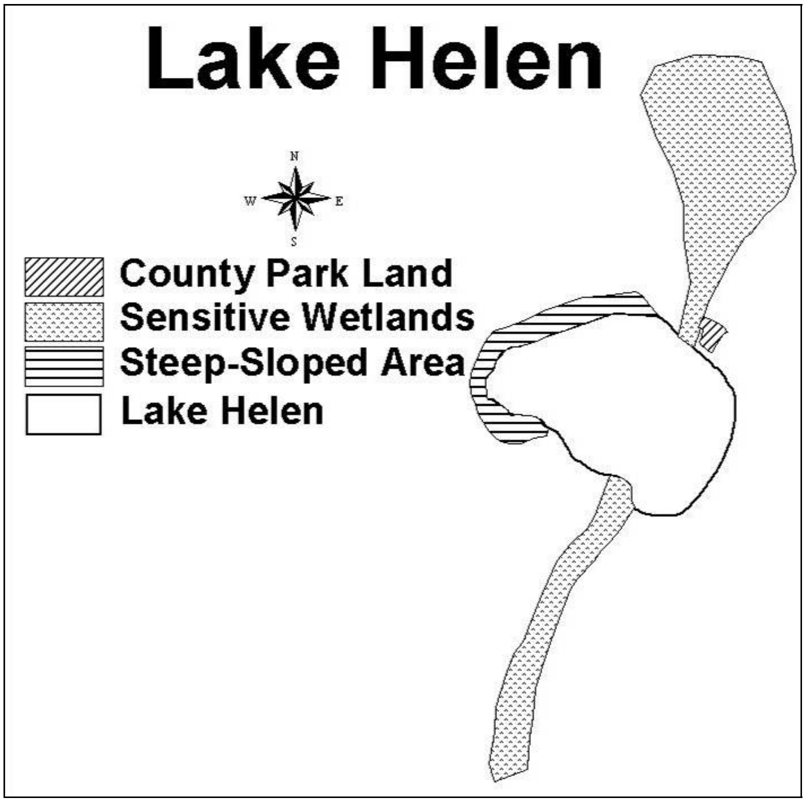


*Terms in bold, see glossary pp 17-21

Upland Sensitive Areas

The survey of upland sensitive areas was conducted to note areas immediately around the lakeshore that are particularly valuable or sensitive to disruption. There are two wetlands adjacent to the banks of Lake Helen, one extending from the northeast side and the other from the southwest side at the point of the intermittent outflow. A steeply sloped area is present along the western lakeshore, and a small county park is located to the northeast shore (Figure 7).

Figure 7. Upland sensitive areas near Lake Helen.



Birds

Lakeshore development can negatively or positively affect habitat quality for 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).

*Terms in bold, see glossary pp 17-21

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 Lake Helen.

Common Name	Number Observed	Food	Foraging	Nest Type	Nest Location
American Goldfinch	5	seeds	foliage gleaner	cup	shrub
American Robin	5	insects	ground gleaner	cup	deciduous
Black-capped Chickadee	2	insects	foliage gleaner	cavity	deciduous
Catbird	1	insects	ground gleaner	cup	shrub
Chipping Sparrow	2	insects	ground gleaner	cup	coniferous
Downy Woodpecker	2	insects	bark gleaner	cavity	snag
European Starling	1	insects	ground gleaner	cavity	deciduous
House Sparrow	3	seeds	ground gleaner	cavity	building
House Wren	2	insects	ground gleaner	cavity	deciduous
Least Flycatcher	1	insects	hover gleaner	cup	deciduous
Mourning Dove	2	seeds	ground gleaner	saucer	deciduous
Red-eyed Vireo	1	insects	hover gleaner	cup	shrub
Ruby-throated Hummingbird	1	nectar	hover gleaner	cup	deciduous
Song Sparrow	3	insects	ground gleaner	cup	ground
Tree Swallow	1	insects	aerial foliager	cavity	snag
White-breasted Nuthatch	1	insects	bark gleaner	cavity	deciduous
Total	**33**				

Shoreline Vegetation, Reptiles, and Amphibians

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

Large sections of continuous natural shoreline on lakes are ideal habitats for many frog species. Natural areas with large amounts of submergent, emergent, and floating-leaf vegetation provide protection and a place for attachment of eggs during the breeding season. The upland areas surrounding these lakes also provide important habitat as many frog species migrate to lakes and other bodies of water in the spring or fall to breed and spend the summer months foraging in the uplands. Several species also use the surrounding uplands for overwintering. The turtle species found associated with lakes are predominantly aquatic, usually departing from the water only to deposit eggs in a nest. Nests are usually on south facing slopes above the shoreline where there is open vegetation and sandy soil. The newly hatched young then find their way to the water. Thus, both turtles and amphibian are intimately associated with lakes and the associated habitats of a **watershed**.

Six frog species were identified during the amphibian survey near Lake Helen (wood frog [*Rana sylvatica*], spring peeper [*Pseudacris crucifer*], chorus frog [*Pseudacris triseriata*], northern leopard frog [*Rana pipiens*], gray treefrog [*Hyla versicolor*], and green frog [*Rana clamitans*]). The primary amphibian habitat is located in some small sections on the south side of the lake and in the wetlands to the north of the lake (Figure 8). Some of the key features of this habitat include protected wetlands with submergent and emergent vegetation. However, high levels of developed shoreline are present. Reptile surveys were not conducted near Lake Helen.

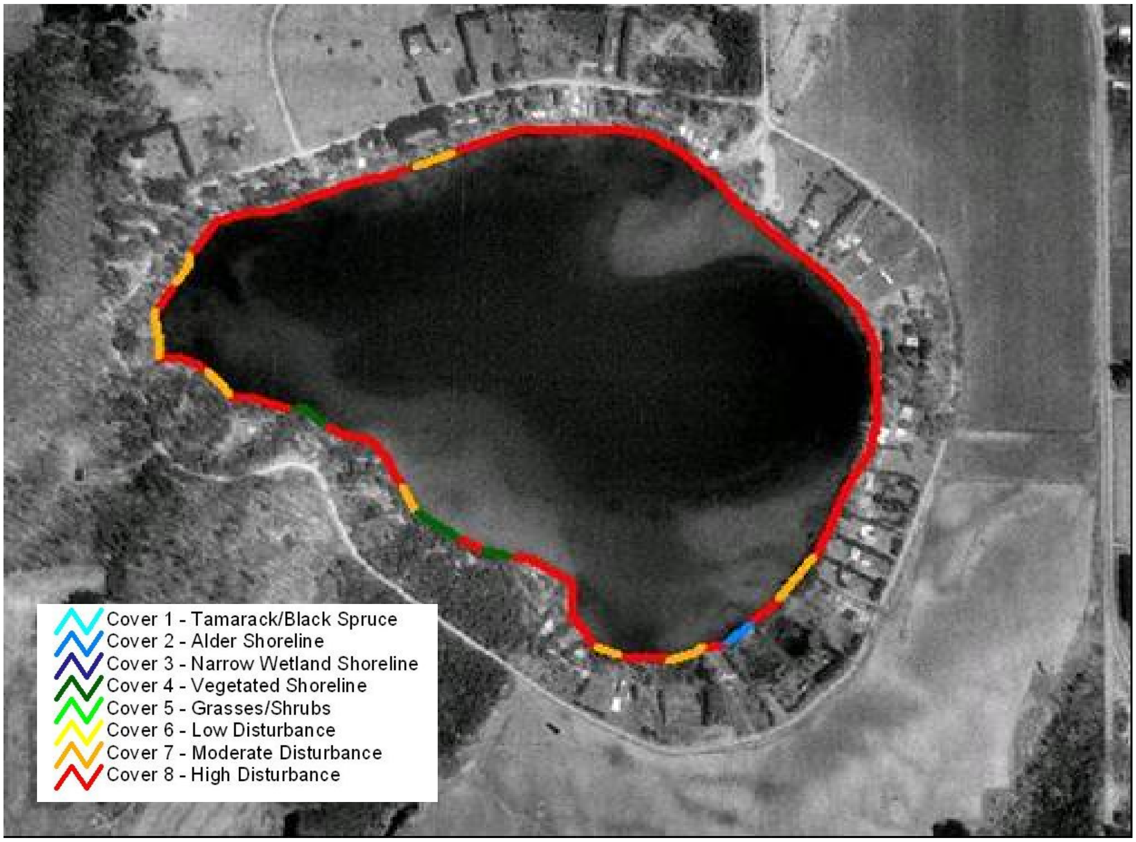
Figure 8. Regions of primary amphibian habitat around Helen Lake.

Only 5.5% of the shoreline around Lake Helen is considered vegetated shoreline. Vegetated shoreline is characterized as being upland areas with dense vegetation comprised of tall grasses or shrubs that lacks a rocky component. It is represented in dark green in Figure 9. Alder shoreline is characterized as areas where alder dominates the shore zone; 1.6% of the shoreline is classified as alder shoreline, which is represented by sky blue.

*Terms in bold, see glossary pp 17-21

Around Lake Helen, 93% of the shoreline vegetation is considered to be disturbed. Of that, 15.8% of the lake's shoreline vegetation is considered moderately disturbed and 77.1% is considered to be highly disturbed (shown in red). An area with moderate vegetation disturbance is an area of shore that may contain a mowed lawn but has an intact overstory. An area that exhibits high vegetation disturbance is defined as a beach, **rip rap**, sea wall or where the shore is mowed to the water line.

Figure 9. Shoreline vegetation around Lake Helen.



Aquatic Plants

There were **23** species of aquatic **macrophytes** (**22** species of **vascular plants** plus a macrophytic alga) that have been found in Lake Helen or wet areas of the adjacent shore. This is below average compared to the other Portage County lakes. The average **coefficient of conservatism (c-value)** of the 22 species of **vascular plants** is **4.8** which is slightly above average. The **floristic quality index** is **22.5** which is below average for the Portage County lakes.

Lake Helen is surrounded by homes and cottages, leaving very little wet shore and little native vegetation. Eurasian water-milfoil (*Myriophyllum spicatum*) and curlyleaf pondweed (*Potamogeton crispus*) have not been found in this study to date, but both species would likely become abundant quickly if they were to be established here in the future.

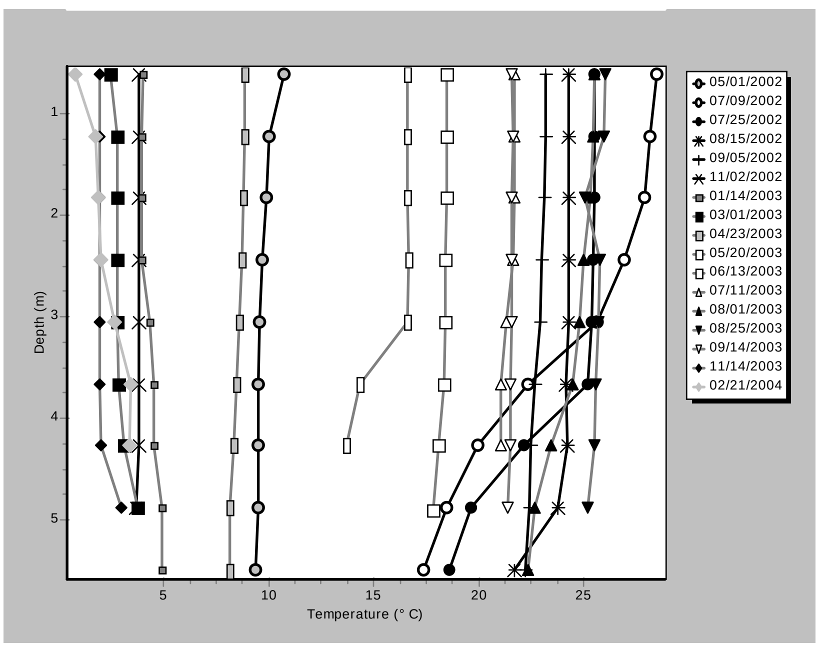
*Terms in bold, see glossary pp 17-21

Current Water Quality Conditions

Water quality assessment of a lake involves a number of measures including temperature, dissolved oxygen, water chemistry, **chlorophyll *a***, and **algae**. Each of the constituents discussed play a role in water quality. A more detailed discussion of those roles can be found at the beginning of the report and should be consulted for a more complete understanding of each lake.

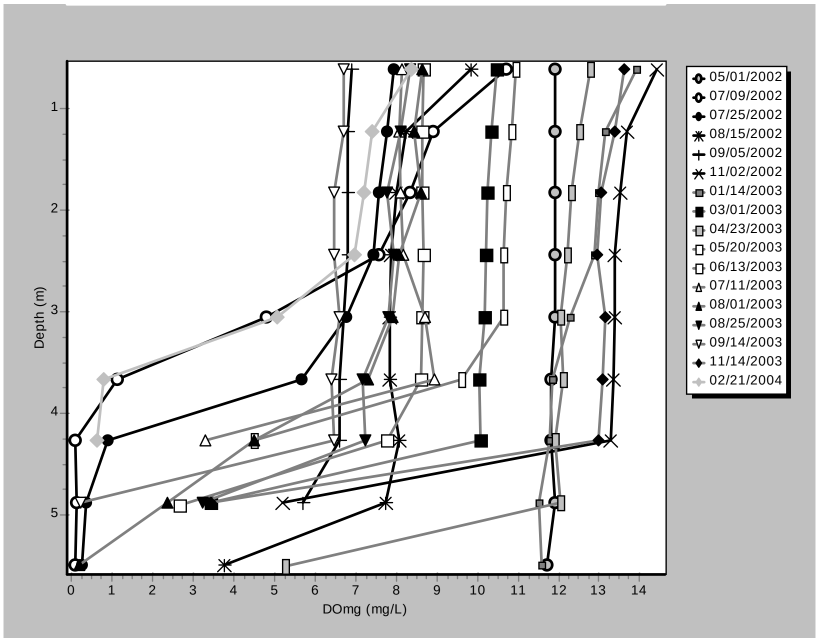
Temperature and oxygen were measured top to bottom when samples were collected. The temperature in Lake Helen was mixed from top to bottom throughout much of the study period. It was slightly **stratified** in July 2002. Despite the lack of temperature **stratification**, dissolved oxygen concentrations fell below 5 **mg/L** (needed to support many aquatic species) at depths below 10 feet during the summer and late winter.

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



*Terms in bold, see glossary pp 17-21

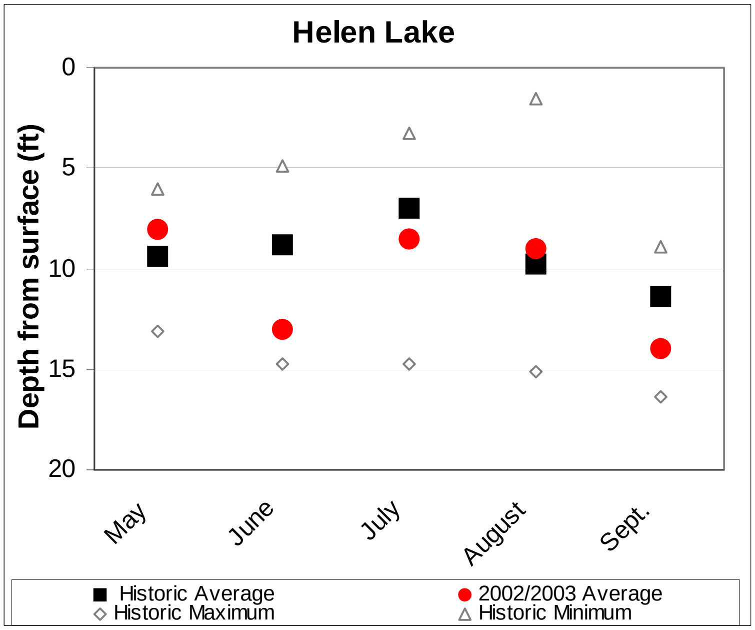
Figure 11. Profile of dissolved oxygen in Lake Helen 2002-2004.



Water **clarity** is a measure of how deep light can penetrate the water. It is an aesthetic measure and is related to the depth that **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***). Although the **turbidity** and **color** were low throughout the summer, **chlorophyll *a*** was high in July (ranging between 7.1 and 12 **mg/L**) (Table 2). The water **clarity** in Lake Helen is considered fair. The average **Secchi disc** depth reading for similar lakes in the region is 11 feet. The water **clarity** in Lake Helen during the 2002-03 growing seasons was better than this average during June and September, but was less than 11 feet during May, July, and August (Figure 12). These fluctuations throughout the summer are normal as **algae** and aquatic plant populations and **sedimentation** increase and decrease. Wind disturbance of sediment can also influence the water **clarity** in shallow lakes.

*Terms in bold, see glossary pp 17-21

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



A variety of water chemistry measurements were used to characterize the water quality in Lake Helen (Table 3). Nutrients (**phosphorus** and **nitrogen**) are important measures of water quality in lakes because they are used for growth by **algae** and aquatic plants (similar to houseplants and crops). Lake Helen is considered a **hard water** lake due to inputs of calcium from **groundwater**. For the most part total **phosphorus** is below problem levels of 30 ug/L; however, concentrations in July were as high as 97 ug/L. At the same time **chlorophyll *a*** concentrations were elevated and **clarity** was significantly decreased. Inorganic **nitrogen** (NO_2+NO_3-N and NH_4-N) were above the 0.3 **mg/L** needed to fuel **algae** blooms throughout the summer.

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. Both **chloride** and **sodium** are elevated. 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 lake water (0.13 and 0.06 µg/L); however, some toxicity studies have indicated that **endocrine** disruption can occur in frogs at these levels. The presence of **atrazine** indicates that other agri-chemicals may also be entering Lake Helen.

*Terms in bold, see glossary pp 17-21

Table 2. 2002-2003 Seasonal water quality averages in Lake Helen.

Lake Helen	RP (ug/L)	TP (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	3.5	24.7	1.22	0.35	0.09	131.3	157.5	81.0	9	1.0	6.0
Summer Averages	2.8	20.8	1.14	0.03	0.10	115.0	129.5	55.9	12	1.8	5.3
Fall Averages	8.0	17.5	1.31	0.18	0.16	118.0	146.0	64.0	12	1.2	
Winter Averages	3.8	2.0	1.58	0.40	0.44						
2002-2004 Averages	4.3	18.9	1.29	0.22	0.18	121.4	144.3	67.0	11	1.3	5.4

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

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

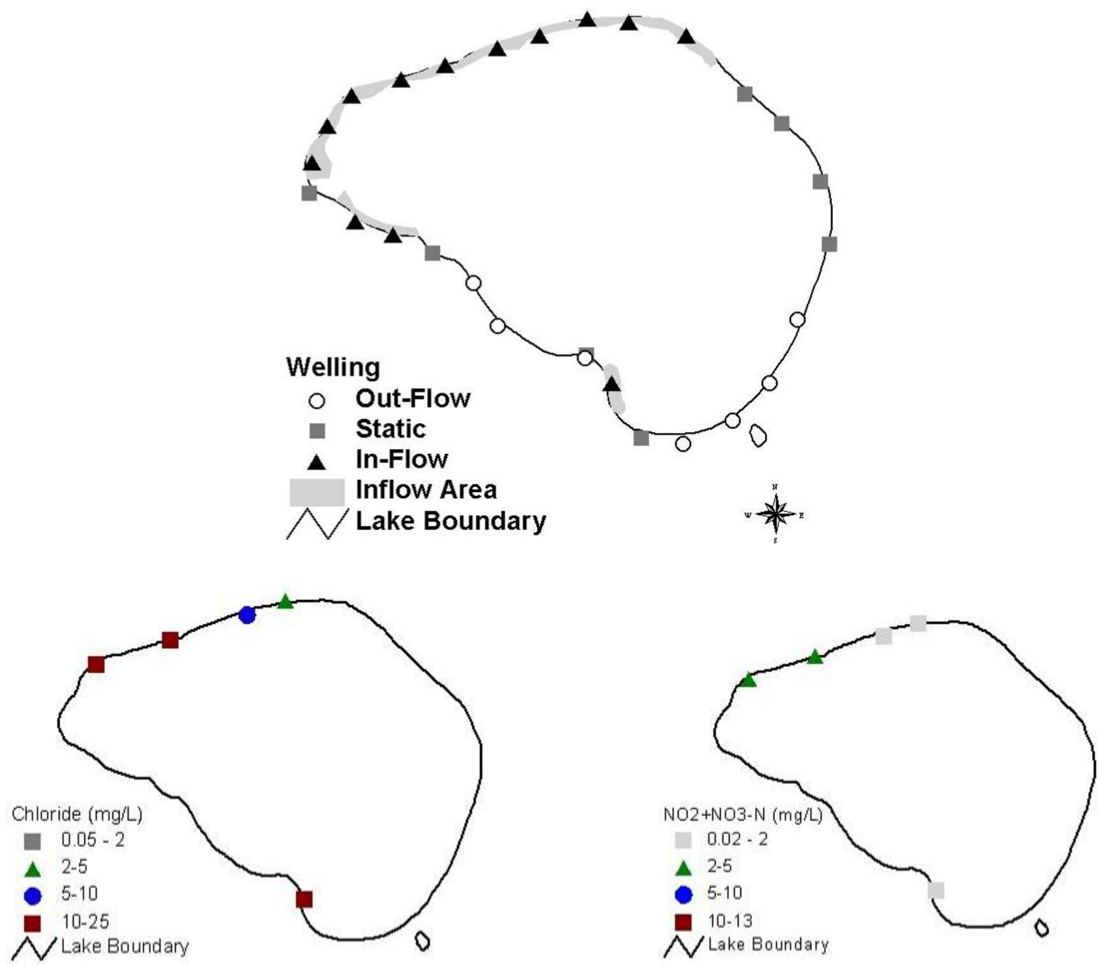
Lake Helen	Low	Medium	High	Reference Values	Low	Medium	High
Sulfate	9.83			Sulfate	<10	10-20	>20
Chloride			20.75	Chloride	<3	3-10	>10
Potassium	1.53			Potassium*	<2.16	2.16-4.30	>4.30
Sodium			6.95	Sodium*	<2.28	2.28-5.09	>5.09

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

Groundwater can enter lakes from water originating in the **groundwater watershed**, but it can also enter from local sources all around the lake, especially where there are steep slopes. Twenty-eight mini-wells were used to estimate where **groundwater** is entering and leaving Lake Helen. In addition, observations of open water during late winter were made by residents which enhanced the results from the mini-wells. Forty-six percent of the sites showed **groundwater** inflow with most entering Lake Helen on the northwest side of the lake (Figure 13). Five of the inflow sites were analyzed for the **groundwater** chemistry. Two of the sites on the northwest side had elevated **nitrate** (approx. 4 **mg/L**) and **chloride** (22.5 and 24 **mg/L**). One of these samples was also analyzed for **atrazine** with concentrations of 0.05 ug/L. **Chloride** concentrations in other wells were 4, 9, and 25 **mg/L**, with the latter sample collected at the inflow site on the southwest side of the lake.

*Terms in bold, see glossary pp 17-21

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



Algal Community

The algal community in Lake Helen was somewhat diverse. The dominant groups were the green **algae** (Chlorophyta, 27% of all cells counted) and the **blue-green algae** (Cyanobacteria, 25% of all cells counted) (Table 4). The yellow-green **algae** and **diatoms** (Ochrophyta) and cryptophytes (Cryptophyta) were subdominant phyla (18% and 16% of all cells counted respectively). These four phyla represented 86% of all cells counted during the 2003 sampling season. In the 2267 cells counted during this period there were 5 genera of Cyanobacteria, 10 genera of Chlorophyta, 10 genera of Ochrophyta (including 8 diatom genera), 2 genera of Euglenophyta, 2 genera of Dinophyta, and 1 genus of Cryptophyta identified. All four dominant phyla were of nearly equal abundance in May (20-26%/phylum) and again in June (17-27%/phylum). In the remaining sampling periods (August, September, November) the green **algae** (Chlorophyta) and **blue-green algae** (Cyanobacteria) become more dominant (22-35% of all cells counted/phylum) while the ochrophytes (Ochrophyta) and cryptophytes (Cryptophyta) become subdominants (9-20% of all cells counted/phylum. The euglenoids (Euglenophyta) and dinoflagellates (Dinophyta)

*Terms in bold, see glossary pp 17-21

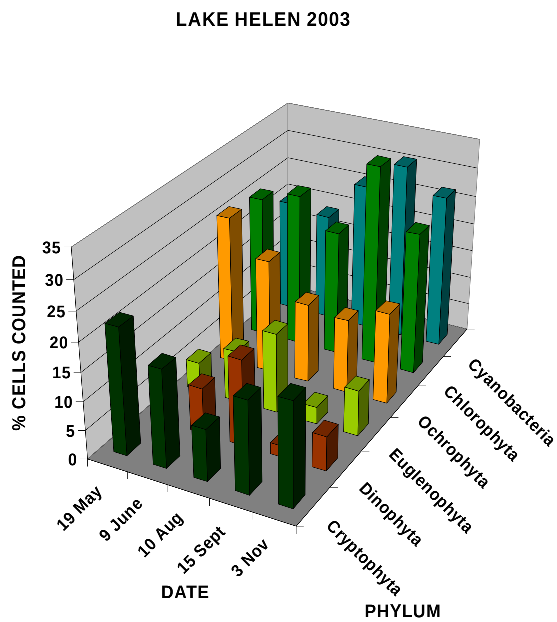
represented only 15% of all cells counted (ranging from 2-15% of cells counted in any particular sample period) (Figure 14).

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

LAKE HELEN

PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					MEAN
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	20	19	26	31	27	25
Chlorophyta	25	27	22	35	25	27
Ochrophyta	26	20	14	13	16	18
Euglenophyta	5	9	14	3	8	8
Dinophyta	2	8	15	2	6	7
Cryptophyta	22	17	9	16	18	16

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



The small, motile, unicellular cryptophyte *Chroomonas* was the most abundant genus in the May sample (Figure 15). It remained abundant but slipped to subdominant positions while being present in every sample period. Green algal genera were present in 5 of the top 15 abundance slots during the 2003 sampling period. Two small, nonmotile, unicellular/colonial aggregate genera (*Kirchneriella*, *Oocystis*) were each dominant in one sample period and subdominant in one or more other periods. The nuisance cyanobacterial genus *Microcystis* was a dominant or subdominant in all late season samples (August, September, November). This is an organism that can produce toxins and dramatically decrease aesthetic and recreational values of a lake if it becomes the dominant, blooming-forming genus. The chain-forming, beautifully helical diatom genus *Fragilaria* was an early season subdominant (May, June) (Table 5).

*Terms in bold, see glossary pp 17-21

The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Lake Helen presents a picture of a barely **oligotrophic** or more likely mildly **mesotrophic** lake. The 30 genera identified during the sample periods were relatively common and with the exception of the cyanobacterium *Microcystis*, none of those that reached numerical dominance in the sample counts are associated with toxins or health issues. While the lake may currently be tagged **oligotrophic,** the water **clarity** was only fair, and the large fraction of cyanobacteria in the community should be seen as indicative of a lake that might be accelerating towards **mesotrophic** status.

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

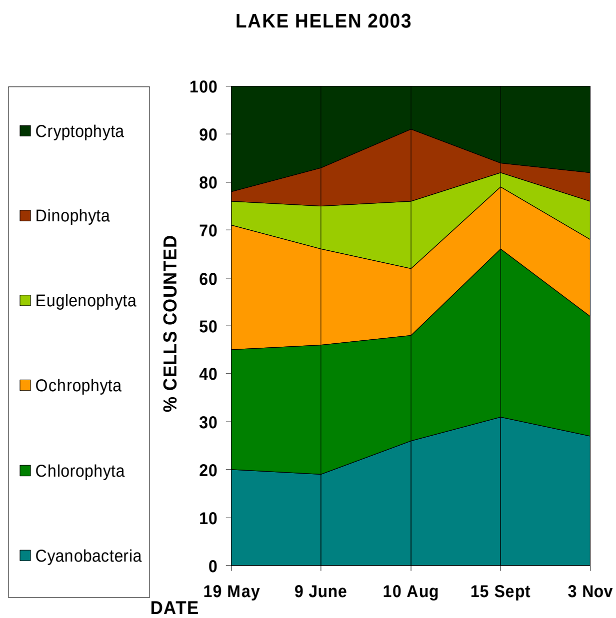


Table 5. Most common algal genera by date in Lake Helen from May to November 2003.

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Chroomonas*	*Fragilaria 2*	*Kirchneriella*
9 June	*Kirchneriella*	*Chroomonas*	*Fragilaria 2*
10 August	*Microcystis*	*Kirchneriella*	*Chroomonas*
15 September	*Oocystis*	*Microcystis*	*Chroomonas*
3 November	*Microcystis*	*Chroomonas*	*Oocystis*

*Terms in bold, see glossary pp 17-21

Helen Lake Study Highlights

- There are two wetlands adjacent to the banks of Lake Helen, one extending from the northeast side and the other from the southwest side at the point of the intermittent outflow. A steeply sloped area is present along the western lakeshore, and a small county park is located to the northeast shore.
- Six frog species were identified during the amphibian survey near Lake Helen (wood frog, spring peeper, chorus frog, northern leopard frog, gray treefrog, and green frog). The primary amphibian habitat is located in some small sections on the south side of the lake and in the wetlands to the north of the lake. Some of the key features of this habitat include protected wetlands with submergent and emergent vegetation; however, high levels of developed shoreline are present. Reptile surveys were not conducted near Lake Helen.
- Around Lake Helen, 93% of the shoreline vegetation is considered to be disturbed. Of that, 15.8% of the lake's shoreline vegetation is considered moderately disturbed and 77.1% is considered to be highly disturbed.
- The number of aquatic **macrophytes** species and **floristic quality index** is below average compared to the other Portage County lakes. The average **coefficient of conservatism** is slightly above average. Lake Helen is surrounded by homes and cottages, leaving very little wet shore and little native vegetation. Eurasian water-milfoil and curly-leaf pondweed have not been found in this study to date, but both species would likely become abundant quickly if they were to be established here in the future.
- Despite the lack of temperature **stratification**, dissolved oxygen concentrations fell below 5 **mg/L** (needed to support many aquatic species) at depths below 10 feet during the summer and late winter.
- On average total **phosphorus** is below problem levels of 30 ug/L, however concentrations in July were as high as 97 ug/L. At the same time **chlorophyll *a*** concentrations were elevated and **clarity** was significantly decreased. Inorganic **nitrogen** (NO_2+NO_3-N and NH_4-N) was above the 0.3 **mg/L** needed to fuel **algae** blooms throughout the summer. Both **chloride** and **sodium** were elevated. 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**.
- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Lake Helen presents a picture of a barely **oligotrophic** or more likely mildly **mesotrophic** lake. While the lake may currently be tagged **oligotrophic,** the water **clarity** was only fair, and the large fraction of cyanobacteria in the community should be seen as indicative of a lake that might be accelerating towards **mesotrophic** status. The cyanobacterium *Microcystis* was present; however, none of those that reached numerical dominance in the sample counts are associated with toxins or health issues.

*Terms in bold, see glossary pp 17-21

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 17-21

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.

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 17-21

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 $CaCO_3$.

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.

*Terms in bold, see glossary pp 17-21

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.

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 17-21