DUCK LAKE

State of the Lake Report
&
Watershed Management Plan

December 2005

Cayuga County Department of Planning and Economic Development,
Cayuga County Soil &Water Conservation District
&
The Duck Lake Association

Acknowledgements

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Section 1: Watershed Characteristics

Geography of the Lake

Duck Lake is located in northern Cayuga County, New York, in the Town of Conquest. It is located in the central part of the Oswego River Basin, north of the Seneca River. Duck Lake was formed during the Pleistocene Era by the glaciers. It is located in an area with broad flat basins and classic drumlin formations resulting from glacial deposits.

Duck Lake's surface area is 213 acres (0.86 km^2) in size and the lake has a mean elevation of 396 feet above sea level. Duck Lake has a length of 1.5 miles (2.4 km), a mean depth of 4.9 feet (1.5 m) and a maximum depth of 20.0 feet (6.1 m) (Effler et al., 1988). For more information, see Table 1.

Both the north and south ends of Duck Lake contain wetlands and the lake bottom at both of these ends consists of muck (EcoResearch, 1976). There are homes and camps along the east and west shorelines and the lake bottom of these areas is firm near the middle area of the lake with areas of sand and small gravel (EcoResearch, 1976). The lake is relatively shallow, except for a small pocket of deeper water along the eastern shore (See Figure 1).

Duck Lake is a spring fed lake. There does not appear to be any tributaries to Duck Lake and it is believed that the water from the lake may flow out of both the north and south ends of the lake.

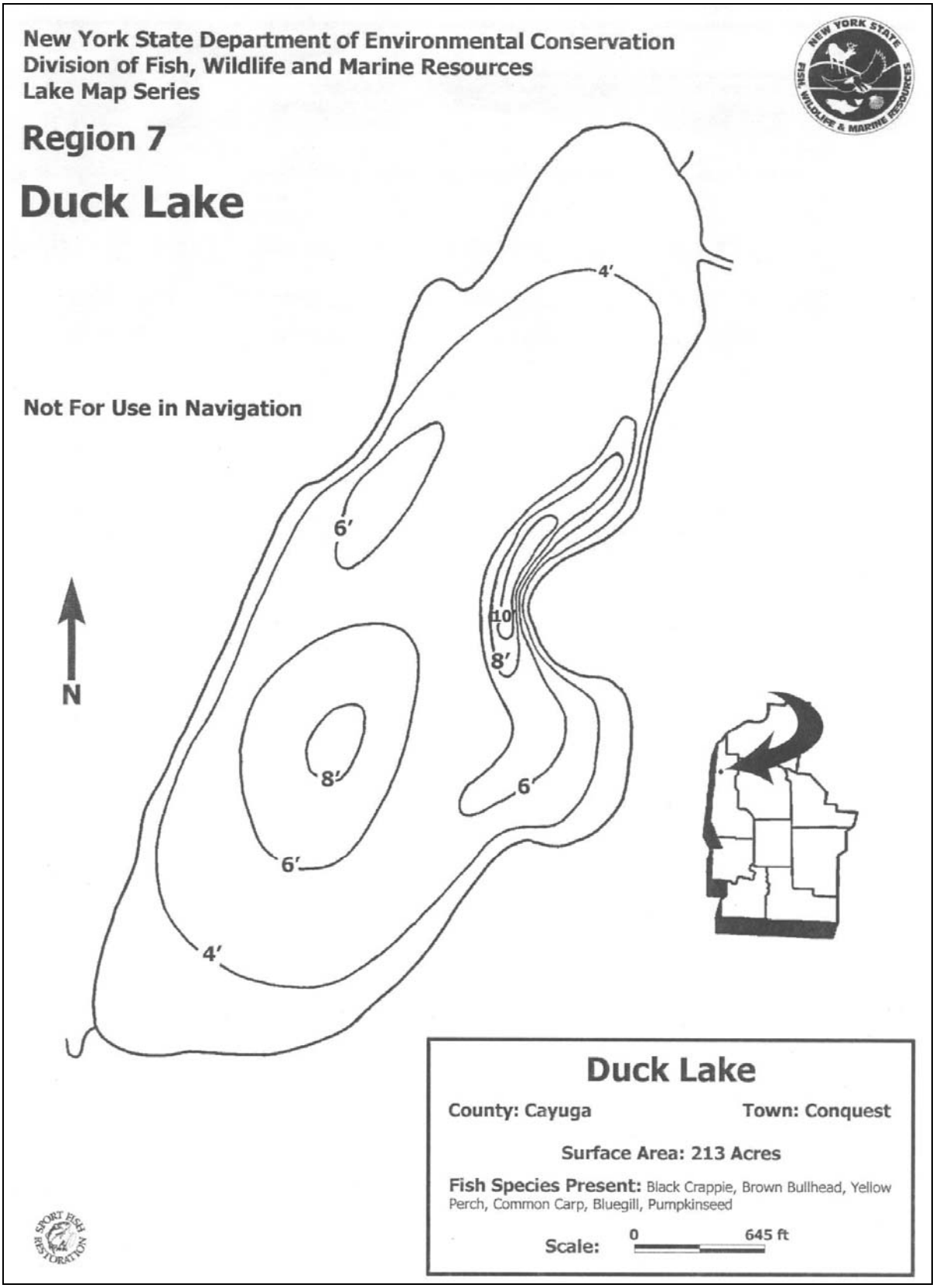
Table 1: Geographic and Morphometric Information on Duck Lake, NY.

		Source
Latitude	43.147ºN	Topozone
Longitude	76.690ºW	Topozone
Preliminary Watershed County	Cayuga	Cayuga County GIS
Surface Area	213 acres (0.86 km^2)	NYSDEC Lake Map
Length	1.5 miles (2.4 km)	Effler et al., 1988
Maximum Width	0.62 miles (1.0 km)	Hennigan, 1991
Mean Depth	4.9 feet (1.5 m)	Effler et al., 1988
Maximum Depth	20.0 feet (6.1 m)	Effler et al., 1988
Estimated Volume	450 million gallons	Hennigan, 1991
Preliminary Watershed Area	581.5 acres (2.4 km^2)	Cayuga County GIS
Elevation	396 ft.	Topozone
NYSDEC Water Quality Class	C	NYSDEC

Classification of the Lake

The New York State Department of Environmental Conservation (NYSDEC) classifies Duck Lake as a Class C waterbody. The best usage of Class C waters is fishing and waters shall be suitable for fish propagation and survival. The water quality shall also be suitable for primary (e.g. swimming) and secondary (e.g. boating) contact recreation.

Figure 1: Depth Contour Map of Duck Lake. New York State Department of Environmental Conservation. www.dec.state.ny.us.



Watershed Description

The Duck Lake Watershed is the area of land that drains into Duck Lake. The Cayuga County GIS staff developed a preliminary watershed for Duck Lake by utilizing digital elevation data for Cayuga County. The preliminary Duck Lake Watershed (hereafter referred to as the Watershed), or area of land that serves as the drainage basin for the Lake, is approximately 581.5 acres (see Figure 2). It is located entirely within the Town of Conquest in Cayuga County. The Watershed also is located within the Montezuma Wetlands Complex and the north and south ends of the Lake are within the Northern Montezuma Wetlands Project.

The ratio of land to lake surface area is 2.7 acres of watershed per acre of lake surface area. As is shown in the preliminary watershed map, there does not appear to be any major tributaries to the Lake. It is primarily a spring fed lake.

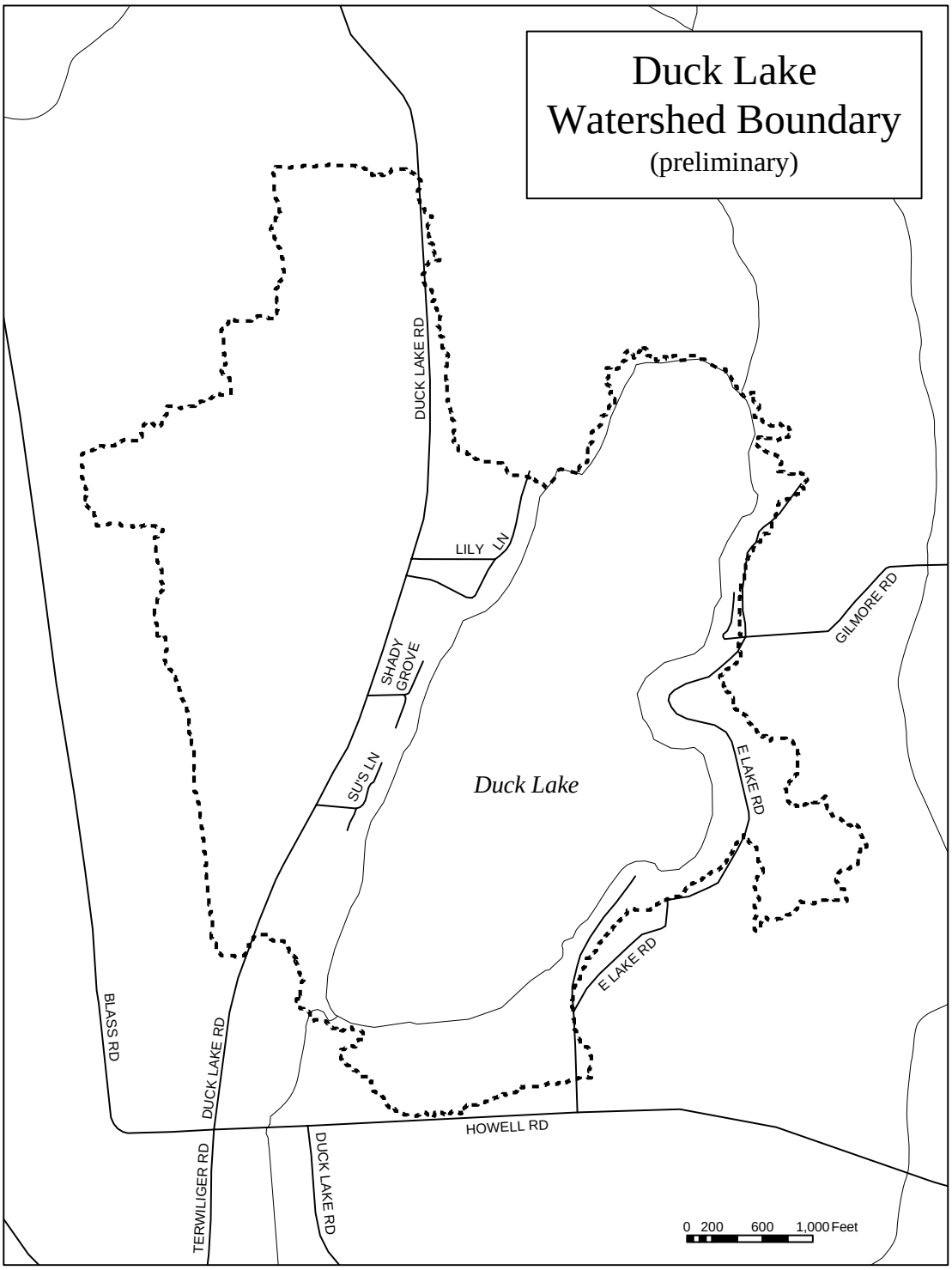
There is controversy regarding the flow into and out of Duck Lake, and in the size of its watershed. This may be due to the fact that Duck Lake is surrounded by wetlands, is a spring fed lake, and may flow differently depending on the level of the Lake. A NYSDEC study in 1984 stated that the major inlet to Duck Lake was located at the north end and its outlet at the south end, which was known as Spring Lake Outlet (at one time Duck Lake may have been known as Spring Lake). Hennigan (1991) stated that Duck Lake's watershed was 2803.2 acres in size and it had one major tributary draining a wetland area to the north. However, a letter from Ed Cook, the president of the Duck Lake Association, written in July of 1994 stated "There is no creek like outlet, the main drainage of Duck Lake flows to the North, not the South and the land elevation is higher at the South end than at the North end" and "The Duck Lake Association currently and has for years been treating this Lake with aquatic herbicide in compliance with DEC regulations. We are permitted to do this because there is no outlet from the lake." Residents on the lake currently believe that water drains out of the north and south ends of the lake and only flows into the lake from these ends during high water events.

There have been some changes to the Duck Lake Watershed since these reports and studies were conducted. Potholes were excavated in the wetlands at the north end of Duck Lake to enhance wetland habitat. These potholes have no direct connection to Duck Lake. There is also a water control device as part of this wetland enhancement project that controls the flow of the creek north of Duck Lake to the wetlands northeast of Duck Lake and a tributary to the Spring Lake Outlet. It is unknown what effect, if any, this work has had on the flow into or out of Duck Lake. Additional field testing and hydrologic studies are needed to confirm Duck Lake's watershed.

Priority Waterbodies List

Duck Lake is listed in the NYSDEC publication "The 1996 Priority Waterbodies List for the Oswego-Seneca-Oneida River Basin" as a naturally eutrophic lake with a primary use impairment of bathing due to nutrients. Additional use impairments include fishing, aesthetics and boating; an additional type of pollutant is silt (sediment); and additional sources include on-site systems, streambank erosion, agriculture, and roadbank erosion.

Figure 2: Preliminary Duck Lake Watershed. Cayuga County GIS.



Geology

Duck Lake was formed during the Pleistocene Era some 9,000-10,000 years ago during continental glaciation. This lake, which is considered a drumlin lake, was formed in a depression between drumlins formed from glacial deposits (Hennigan, 1991). The bedrock in this area is part of the Lockport formation, which consists of deeply buried hard dark gray dolomite (calcium magnesium carbonate) (Cayuga County Planning Board, 1969). The rock from this formation was mixed with shale and sandstone by glacial action and formed the calcareous material of the Ontario soils, which is the dominant soil on rolling upland till plains and the drumlins (Cayuga County Planning Board, 1969).

The lake bottom at the north and south ends of Duck Lake consists of muck while along the east and west shorelines the lake bottom is firm near the middle area of the lake with areas of sand and small gravel (EcoResearch, 1976).

Topography

The topography of the lake and the preliminary watershed area reflects its glacial origins. This area has broad flat basins with classic drumlin formations resulting from glacial deposits. The heights of the drumlins range from 50-110 feet high. The highest elevations occur on the west side of the watershed with the tops of the drumlins at approximately 510 feet above sea level. The lowest elevation is the lakeshore at 396 feet above sea level.

Climate and Precipitation

The weather station utilized for climatological data was a NOAA/NWS Cooperative Observer Network Active Station located in Sodus Center in Wayne County, NY. This station is located approximately 14 miles from Duck Lake. Records for temperature and precipitation are from records from 1961-1990; records for snow are from 1948-2004.

Temperature

The normal annual average temperature is 47.8ºF (8.8ºC), with July being the warmest month (70.9ºF/21.6ºC) and January being the coldest (23.9ºF/-4.5ºC). The average maximum temperature occurs in July (81.9ºF/27.7ºC) and the average minimum temperature is 16.2ºF (-8.8ºC) in January.

Precipitation

Precipitation is well distributed throughout the year with an average rainfall of 37.1 inches per year. Monthly averages (water equivalent) range from 2.0 inches in February to 4.2 inches in November. The late fall and winter have frequent snow squalls and the total snowfall is normally heavy with an average snowfall of 89.5 inches per year. The maximum monthly average for snowfall occurs in January with 28.4 inches.

Other data

Climate data from Sodus Center from 1951-1974 also had an average relative humidity of 60% in the mid afternoon; the percentage of available sun was 65% in the summer and 34% in the winter, and the prevailing wind was west-southwest (Melberg and Slingerland, 1991).

Hydrology

The hydrologic budget is not quantified but groundwater is believed to be significant to the annual water budget (Effler et al., 1988).

Runoff

As precipitation lands on a lake's watershed it can infiltrate the soil, percolate into groundwater, evaporate into the atmosphere, or runoff. Runoff occurs when precipitation flows over Earth's surface into streams or other surface waters. A runoff study has not been conducted for Duck Lake. Runoff can enter Duck Lake from the area west of the Lake via four or five highway culverts along Duck Lake Road. These culverts range in size from 12 to 42 inches in diameter.

Groundwater

The Duck Lake area was included in the Final Environmental Impact Statement for the Northern Montezuma Wetlands Project and the following groundwater information comes from that document (Melberg and Slingerland, 1991). Groundwater recharges this region in two basic water-bearing units: consolidated (bedrock) and unconsolidated glacial deposits. The bedrock is sedimentary in origin of Upper Silurian through Upper Devonian age and is overlain by unconsolidated deposits of glacial till. The unconsolidated deposits produce the best yield of groundwater. Most of the groundwater in this region comes from precipitation that was absorbed by the mantle of surficial deposits.

Groundwater Quality

Groundwater in this region tends to be hard, have a high mineral concentration and turbidity, but with little treatment can meet health department standards. (Melberg and Slingerland, 1991).

Lake Levels

There are no gauges on Duck Lake to measure lake level and no studies were found on its levels. There has been public concern about the lake levels based on visual observations. At a meeting of the Cayuga County Water Quality Management Agency (11/13/03), the Duck Lake Association reported that the lake level stayed up in 2003, because drainage problems were fixed. In 2004, the lake level was also reported as good (WQMA 9/9/04).

Soils

Soil associations are intended to broadly describe the soil characteristics that are most dominant in an area. The two soil associations that make up most of Duck Lake and its watershed

are the Ontario association and the Muck association. The majority of the watershed on the west side is Ontario association. Ontario soils are often found in the drumlins and rolling uplands and these are deep soils that are well drained with a medium to moderately course textured subsoil. They are a moderate to severe hazard to erode, and have moderate to severe limitations for use of septic systems. Septic system limits are based on a properly designed, ½ acre lot, and takes into account permeability, depth to seasonal or prolonged high water table, depth to bedrock, slope and flood hazard. Along the north and south ends of Duck Lake, the main soil association is Muck. Muck soils are deep very poorly drained organic soils unsuitable for development or construction.

Most residences in the Duck Lake watershed are found along the eastern and western shorelines of Duck Lake. Therefore, the type of soils along the shorelines can have an effect on these residences and their effect on the lake. The predominant soils found along the northeastern shoreline are mixed (Alton and Howard) soils with 15-25% slope and gravelly sandy loam (Alton) soils with 8-15% slope. These soils are deep well drained to excessively drained. Due to the slopes along the northeastern shoreline, the Alton and Howard soils have severe limits for septic systems and the Alton soils have moderate limitations. The major soils found on the mid-eastern shoreline of the lake are Colonie soils with 1-6% slope. Colonie soils are loamy fine sands derived from sandy deposits that are deep and well drained to excessively drained. Colonie soils are subject to high wind erosion, moderate water erosion, and have slight limitations as septic tank disposal areas. The southeastern shoreline consists of Alton gravelly sandy loam with a 3-8% slope. This soil is deep and well to excessively drained with slight limitations for septic systems.

Along the northwestern shoreline, the major soils are Galen fine sandy loam with a 2-6% slope. For this soil erosion is a moderate hazard and it has moderate limitations for septic systems due to seasonal wetness.

The southwestern shoreline consists mainly of Niagara and Canandaigua silt loam with a slope of 0-2%. These soils are poorly drained and often have prolonged wetness. It is this prolonged wetness and variable permeability that cause these soils to have severe limitations for septic systems.

Wetlands

The following wetlands are listed on the National Wetlands Inventory from the United States Fish and Wildlife Service (FWS). The wetlands directly at the ends of the Lake are classified as lacustrine (lake associated) and littoral (along the lake's edge). At the south end, there are also palustrine (marshy), forested, broadleafed deciduous, seasonal saturated wetlands along the shoreline. Also within the watershed there are some palustrine, forested and scrub/shrub broadleafed deciduous seasonally saturated wetlands located between the drumlins.

The wetlands on the north and south ends of Duck Lake are also classified as New York Department of Environmental Conservation freshwater wetlands.

Forestry Resources

According to the *Master Plan Background Study: Natural Resources* (1969), the principal forest type on the northern, eastern and southern sides of Duck Lake is dominantly ash, elm and red

maple. This type is found in swampy, poorly drained areas, often located between drumlins. There are U.S. Fish and Wildlife Service has classified forested broadleafed deciduous wetlands in these areas, as well as some located between the drumlins.

Wildlife

The ends of Duck Lake and its watershed are located in part of the Northern Montezuma Wetlands Complex. This area is a major staging area for tens of thousands of migratory birds. The wetland areas and the lake itself provide habitat for a number of species of duck and geese. Canada geese can be found on Duck Lake all winter if the lake does not freeze over.

Resident species most likely include white tailed deer, beaver, muskrat, raccoon, mink, fox and other mammals (Melberg, C. and D. Slingerland, 1991). There were numerous complaints in 2004 by residents to the Duck Lake Association that there were too many deer in this area (WQMA 9/9/04).

Chemical, Physical and Biological Data

Overview

The levels of phosphorus and chlorophyll *a* as well as the water clarity in Duck Lake indicate that Duck Lake is best classified as a eutrophic or highly productive lake. Phosphorus levels in the hypolimnion generally exceed 0.020 mg/L, which is the state guidance value for total phosphorus (not a standard) for class B or higher waters. The Secchi disk transparency reading generally falls to below the minimum recommended water transparency for siting new swimming beaches. Also, fecal coliform samples taken around the lake have at times exceeded the NYSDOH Standard for swimming.

Duck Lake has a small volume of water and is a relatively shallow lake, therefore it responds readily to meteorological conditions and may not develop continuous thermal stratification in the summer every year. This can allow continuous cycling of material released from the sediments, including nutrients, into the upper productive waters (Effler et al., 1988). Productivity is also shown by the overabundance of macrobethic vegetation that exists around the lake.

Duck Lake's water is alkaline with pH readings that often exceed the upper limits of the NYS water quality standards about 30-40% of the Citizens Statewide Lake Assessment Program (CSLAP) sampling sessions. However, this is common to waterbodies in the Oswego River Basin and there is no evidence that this affects the ecological health of the lake. Nitrate and ammonia levels do not appear to threaten the health of humans or the water quality. A small portion of Duck Lake may become anoxic when thermal stratification develops in the summer. Fish kills have also occurred during the winter in Duck Lake due to oxygen depletion, which is assumed to be caused by the shallowness of the lake combined with ice cover.

Water Quality Sampling Efforts

Water quality sampling has been conducted on Duck Lake by the Duck Lake Association through the CSLAP in 1988, 1990-1992, 1994, 1998 and 2003. Finger Lakes Lake Ontario

Watershed Protection Alliance (FLLOWPA) funds have been dedicated to continue this sampling program in 2004 and 2005. Coliform bacteria sampling has also been conducted by the Duck Lake Association and Cayuga County Health Department.

Trophic State

Trophic state is a measure of the level of primary productivity. A measure of a lake's health depends to a large extent on the amount of nutrients that enters it. The nutrient level, or trophic state, of a lake is generally determined by its level of phytoplankton production (algae). This method of measurement is used because the growth of phytoplankton directly corresponds to the amount of nutrients present in the lake.

The three trophic states that describe the levels of nutrients and amount of phytoplankton in a lake are oligotrophic, mesotrophic, and eutrophic. Oligotrophic means nutrient levels, particularly phosphate or nitrogen compounds, are low. When lakes are young, they are oligotrophic. Eutrophic means nutrient levels are high and mesotrophic means nutrient levels are between oligotrophic and eutrophic.

Eutrophication is the natural aging process by which lakes move from being oligotrophic to being eutrophic. If this process is accelerated by human activity, it is called cultural eutrophication. As the water of an oligotrophic lake becomes enriched with nutrients and phytoplankton production increases, numerous changes take place. Like all green plants, phytoplankton produce oxygen, causing the surface of the water to become supersaturated with oxygen. However, oxygen generated by phytoplankton does not replenish the dissolved oxygen levels of deeper water. Phytoplankton have remarkable high growth and reproductive rates. Eventually, a maximum population is reached and a die off occurs. Dead phytoplankton settle, resulting in heavy deposits of detritus on the bottom of the lake. The accumulation of detritus then supports abundance of decomposers, mainly bacteria. Finally, the depletion of dissolved oxygen results in the suffocation of higher organisms, such as fish.

Although trophic levels are generally measured by phytoplankton populations, phytoplankton themselves can be assessed by measuring chlorophyll *a* concentrations, transparency, phosphorus concentrations, and surface oxygen depletion. Eutrophic lakes, for example, would have high concentrations of chlorophyll *a*, low transparency, high concentrations of phosphorus, and low concentrations of oxygen near the lake bottom.

In Duck Lake, Effler et al. (1988) found an intermediate level of production in the open waters with the water column conditions, chlorophyll *a* and total phosphorus concentrations indicative of mesotrophy. However, since the lake supported a large population of macrophytes, Effler et al. (1988) reported that it should be considered eutrophic. As shown in Table 2, the data from CSLAP shows levels of phosphorus, chlorophyll *a* and water clarity which indicate that the lake is eutrophic. Duck Lake appears to have a weak long-term trend toward increasing productivity based on lower clarity and higher nutrient concentrations, but this may not statistically significant (NYSFOLA and NYSDEC, 2004).

Table 2: Eutrophic Indicators and the Conditions in Duck Lake 1988-2003 (NYSFOLA and NYSDEC, 2004).

	Eutrophic Indicators	Average
Phosphorus (mg/L)	>0.020	0.034
Chlorophyll *a* (µg/L)	>8	29.4
Secchi Disk Clarity (m)	<2	1.06

Bacteria

***Indicator Microorganisms*:**

Water supplies and public bathing beaches are routinely monitored for the presence of fecal contamination by testing for the presence of indicator microorganisms. Indicator microorganisms are chosen because they are present in relatively high numbers in feces and are easily cultured in the laboratory. Their presence in the water indicates that there may be fecal matter in the water and therefore a potential for disease causing pathogens. When determining the quality of bathing beaches, the New York State Department of Health (NYSDOH) uses fecal coliform as an indicator organism. The NYSDOH Standard for fecal coliform levels for bathing beaches is an instantaneous count of 1000 or greater colonies/100 mL or a logarithmic average of 200 or greater colonies/100 mL.

Duck Lake Fecal Coliform

For the results of fecal coliform testing of Duck Lake, see Appendix 1. When sampling was conducted in 1997 and 1998, no samples had a count of more than 100 colonies/100 mL. In 1999, only one sample exceeded the NYSDOH Standard of 1000 colonies/100 mL for an instantaneous reading. However, as of 2000, over half of the sites sampled sites exceeded this limit at least once during the two sampling sessions conducted. The number of samples exceeding the NYSDOH Standard increased in 2001 and 2002. In 2002, all of the samples taken in April were below 200 colonies/100 mL, but by June 2002 60% of those same sites exceeded the NYSDOH Standard. Note that in 2002 the lake was open all year because of lack of ice cover and there was a large population of geese. These increasing coliform counts in Duck Lake stopped in 2003, when all the samples taken that year were below the NYSDOH Standard. Only eight samples were taken in 2004 due to lack of funds and half of those were at or above the NYSDOH Standard. Wildlife has been discussed as a possible source of fecal coliform in Duck Lake.

Dissolved Oxygen

When determining overall water quality, the concentration of dissolved oxygen (DO) is an important chemical parameter to consider. Many forms of aquatic life, especially fish, require a certain concentration of DO to survive. Major sources of oxygen to Duck Lake include the air and photosynthesis by aquatic plants and phytoplankton. The major oxygen depleting processes are cell respiration (from all organisms that live in the lake) and the decomposition of dead organic matter.

DO concentrations can vary throughout the water column. DO sources tend to be near the surface of the lake where mixing can occur and where light can penetrate, while in the deeper waters of the lake where light cannot penetrate, only respiration will occur and no photosynthesis. Also, when organisms die, they fall to the bottom of the lake, where decomposition occurs.

Therefore, the deeper waters of the lake use oxygen without producing more. If the lake stratifies in early summer, the hypolimnion (lower depths) becomes largely isolated from sources of oxygen. This can lead in low or no DO in the hypolimnion. The aquatic life that requires a certain amount of DO, cannot survive in these conditions. Oxygen levels can also decline during the winter when the lake is covered with ice and snow, which does not allow oxygen to mix with the water or light to penetrate for photosynthesis. If oxygen levels get low enough, it can lead to a fish kill. This is of a greater concern for Duck Lake because of the shallowness of the lake. Many largemouth bass died in a fish kill in Duck Lake in the winter of 1939-40, which was the first year that ice was not harvested from Duck Lake (NYSDEC, 1984).

The *Duck Lake Biological Survey* (EcoResearch, 1976) found that the deep area of Duck Lake became devoid of oxygen (anoxic) after summer stratification (see Figure 3). Similar results were seen in the Effler et al. in 1988 (see Figure 4). Due to the shallowness of Duck Lake, only the deep area of the lake stratified. In mid-August of 1988, elevated winds allowed the water layers in Duck Lake to mix so the top and bottom layers of the lake were essentially the same.

Figure 3: Spatial distribution of dissolved oxygen by depth on July 22, 1976 (EcoResearch, 1976)

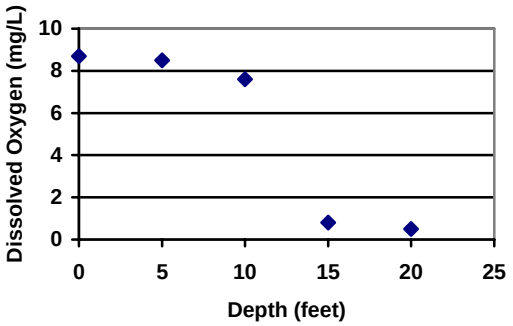
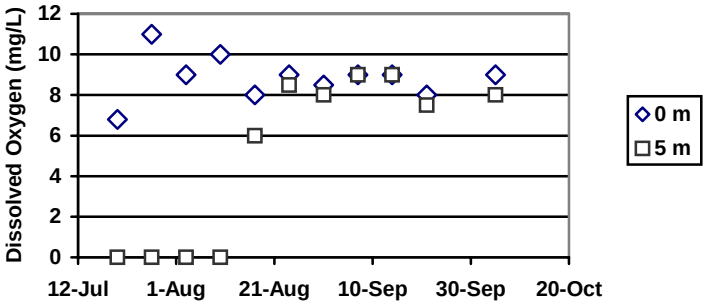


Figure 4: Temporal distribution of surface and near-bottom concentrations of dissolved oxygen in Duck Lake (Effler et al., 1988).



Ambient DO levels can be affected by the growth of aquatic plants and phytoplankton. These provide a source of oxygen during daylight hours due to photosynthesis. DO concentrations decline at night due to respiration. In lakes with moderate nutrient levels, photosynthesis and respiration tend to compensate for each other with small overall impact. In lakes with higher enrichment levels, such as Duck Lake, supersaturated conditions can occur due to elevated levels of

photosynthesis and incomplete air-water surface exchange. The study by Effler et al. in 1988 showed that Duck Lake had oversaturated conditions from late July to September; getting as high as approximately 140% in late July. They presumed that the rather strong saturation dynamics were due to rooted macrophytes as the chlorophyll *a*, and thus phytoplankton population, remained comparatively low.

Nutrients

In lakes, plant production increases as the supply of nutrients increases. The most important nutrients in regards to plant production are phosphorus and nitrogen.

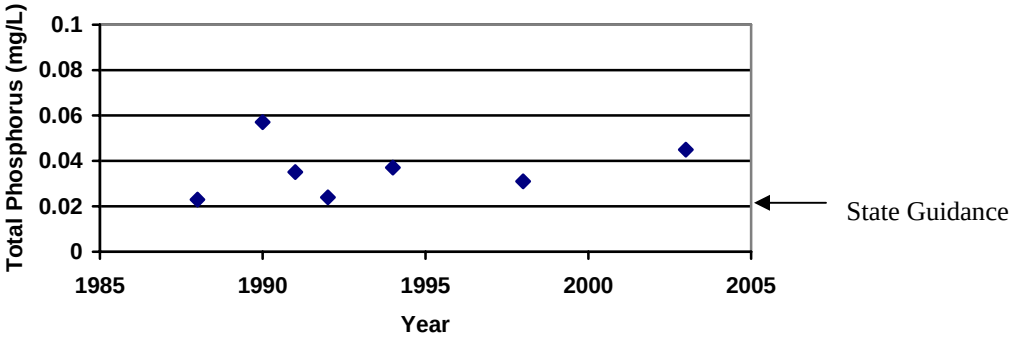
Phosphorus:

Phosphorus is a major nutrient needed for plant growth. It is often considered the limiting nutrient in lakes, which means that the amount of phosphorus controls the amount of plants that can grow. This is the case in Duck Lake where the CSLAP data from 1988 to 2003 shows that the nitrogen to phosphorus ratio routinely exceeds 15-25, which indicates phosphorus is the limiting nutrient (NYSFOLA and NYSDEC, 2004). Phosphorus can enter the lake from external loading sources, such as agricultural run-off, lawn fertilizers, animal waste, or faulty septic systems. Sources of phosphorus can also come from internal loads such as lake sediments. Lake sediments that are overlain with anoxic water can release phosphorus to the water column.

In a lake, phosphorus can be found in many different forms. The forms of phosphorus are technically defined according to laboratory extraction procedures rather than their functional role in the environment. Total phosphorus includes all forms of phosphorous (soluble, insoluble, organic, and inorganic). Soluble reactive phosphorous (SRP) is inorganic and soluble and it is this form of phosphorus that is most readily available for aquatic plant and phytoplankton use.

As shown in Figure 5, the average total phosphorus levels in the hypolimnion of Duck Lake generally exceed 0.020 mg/L, which is the state guidance level for total phosphorus (not a standard) for Class B or higher waters. The average level of total phosphorus in Duck Lake from 1988-2003 is 0.034 mg/L, which ranks it as a highly productive (eutrophic) lake. This data shows a weak, but not statistically significant, trend toward increasing productivity (NYSFOLA and NYSDEC, 2004).

Figure 5: Average Total Phosphorus in mg/L by year (NYSFOLA and NYSDEC, 2004)



Effler et al. (1988) sampled total phosphorus and SRP at both the surface and near the bottom in 1988 (4.5 m). Figure 6 shows that total phosphorus was enriched near the bottom of the

lake until the end of August. The bottom of Duck Lake was anoxic from mid July to mid August, and therefore the sediments could release nutrients such as phosphorus to the overlying waters. The higher phosphorus concentrations near the bottom appear to be particulate because as shown in Figure 7, the SRP concentrations did not differ greatly from the surface and bottom waters. This is important because SRP is the form of phosphorus most easily utilized by plants and phytoplankton. After overturn, the total phosphorus concentration was similar for the surface and the bottom of the lake. Also after overturn, there were secondary peaks in total phosphorus and SRP.

Figure 6: Total Phosphorus in µg/L by depth from Effler et al., 1988

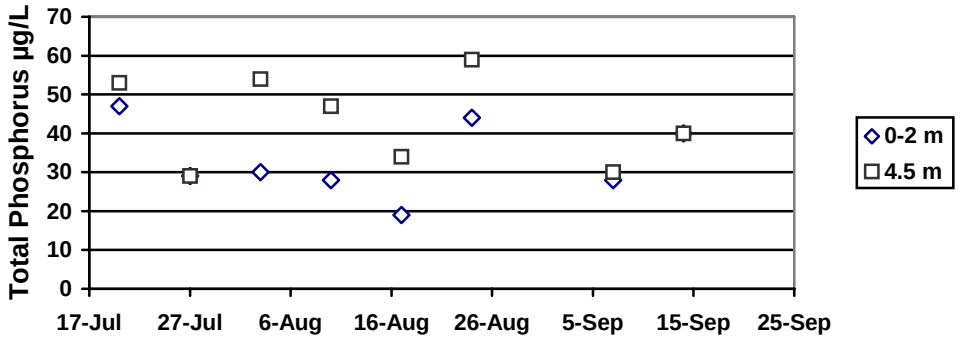
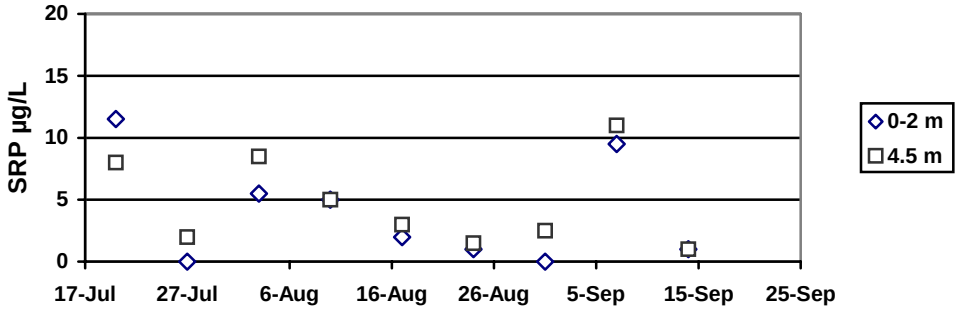


Figure 7: Soluble Reactive Phosphorus (SRP) in µg/L by depth from Effler et al., 1988



***Nitrogen**:*

Nitrogen is an essential plant macronutrient that exists in many forms. Fixed nitrogen (N_2), ammonia nitrogen (NH_4^+), nitrite nitrogen (NO_2^-), and nitrate nitrogen (NO_3^-) are all forms of nitrogen that exist in the environment. Nitrate is the form of nitrogen that plants most readily utilize and is the most common form entering most lakes. The state ambient water quality standard for nitrate/nitrite nitrogen is 10 mg/L to protect human health. The average level found in Duck Lake from 1988-2003 was 0.01 mg/L, which is far below this level (NYSFOLA and NYSDEC, 2004). This low level can mean that there is either a high rate of nitrate/nitrite nitrogen utilization and/or possibly low loading rates.

Ammonia levels were slightly higher than the nitrate levels (Table 3), but still below the human health standard (2 mg/L) and the aquatic toxicity standard (2.5-0.08 mg/L depending on temperature and pH). The data from Effler et al. (1988) showed strong temporal variations starting with a peak in late July gradually decreasing to a low in September then rising again to peak in

October. This showed that ammonia was utilized by the plants in Duck Lake during the period of highest plant growth.

Figure 8: Mean Nitrate + Nitrite Nitrogen as N (nitrogen) in Duck Lake from 1988-2003 (NYSFOLA and NYSDEC, 2004)

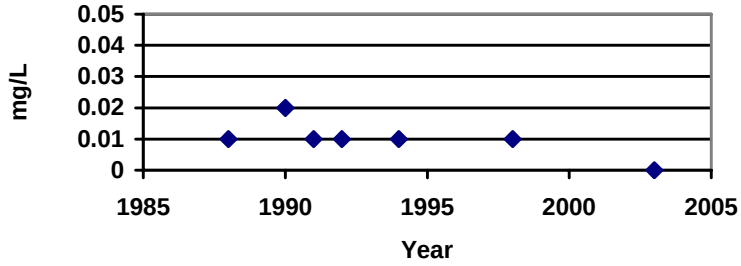


Figure 9: Range of Ammonia in mg N/L in the Surface Water of Duck Lake in 1988 (Effler et al., 1988).

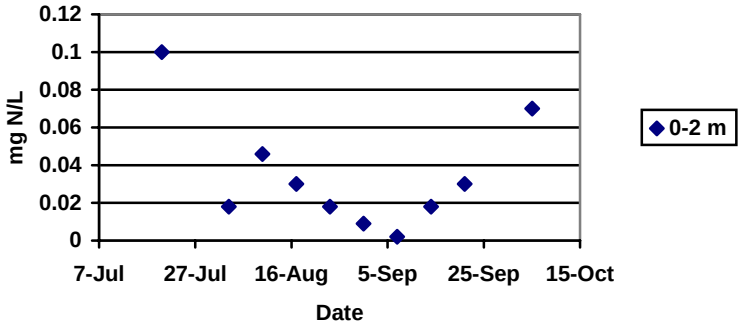


Table 3: Range of Ammonia in mg N/L in Duck Lake

Period	Reference	Number of Samples	Mean Ammonia as N (mg/L)
2003	NYSFOLA and NYSDEC 2004	8	0.02
1988	Effler et al. 1988	10	0.03

Major Ions

Ions are grouped into positively charged cations and negatively charged anions. Positively charged ions include calcium (Ca^{2+}), sodium (Na^{+}), and magnesium (Mg^{2+}). Negatively charged ions include carbonate (CO_3^{2-}), biocarbonate (HCO_3^{-}), sulfate (SO_4^{2-}), and chloride (Cl^{-}). The major sources of ions are from salts that have leached from mineral soils and rocks. Ions can also originate from anthropogenic sources, such as road salt, septic tanks, and agriculture run-off.

Calcium is a required nutrient for most aquatic organisms. Calcium is naturally contributed to lakes from limestone deposits and often strongly correlated with lake buffering capacity (NYSFOLA and NYSDEC, 2004). Zebra mussels require at least 8-10 mg/L for shell growth and

the data from the 2003 CSLAP program shows an average level of 37.5 mg/L in 2003(NYSFOLA and NYSDEC, 2004). Therefore calcium levels are high enough to support zebra mussels.

Conductivity, which measures the electrical current passing through water, can be used to estimate the number of ions in the water. This is somewhat related to hardness and alkalinity, and may influence the degree to which nutrients remain in the water (NYSFOLA and NYSDEC, 2004). Duck Lake had an average conductivity of 282 µmho/cm from 1988 to 2003 and is considered hard water (NYSFOLA and NYSDEC, 2004).

pH and Alkalinity

The pH of a lake is a measure of its acidity or alkalinity. Natural waters exhibit wide variations in relative acidity and alkalinity, not only in actual pH values, but also in the amount of dissolved materials that impact pH. Alkalinity of waters refers to the quantity and kinds of compounds present, which collectively shift the pH to the alkaline side of the pH scale (above 7). The concentrations of these compounds and their ratio to one another determine the actual pH and buffering capacity of a lake.

In general, pH values for Duck Lake have changed little from 1988 to 2003 (see Table 4). The pH has remained at approximately 8.40, which indicates alkaline conditions. This is typical of a hard water lake. The New York State water quality standards for pH to protect aquatic life is a pH higher than 6.5 but less than 8.5. For Duck Lake, pH readings have exceeded the upper limits for about 30-40% of the CSLAP sampling sessions, although there is no evidence it affects ecological health and these levels are common to Oswego River Basin Lakes (NYSFOLA and NYSDEC, 2004).

Table 4: Average pH values for Duck Lake.

Year	Source	Average	Number of Samples
1988-2003	NYSFOLA and NYSDEC, 2004	8.40	47
2003	NYSFOLA and NYSDEC 2004	8.36	8
1998	NYSFOLA and NYSDEC 2004	8.43	2
1994	NYSFOLA and NYSDEC 2004	8.41	8
1992	NYSFOLA and NYSDEC 2004	8.46	8
1991	NYSFOLA and NYSDEC 2004	8.41	6
1990	NYSFOLA and NYSDEC 2004	8.36	2
1988	NYSFOLA and NYSDEC 2004	8.39	13
1988	Effler et al. 1988	8.59	11
1984	NYSDEC 1984	7.3	1

Data from Effler et al. (1988) shows that the pH values peak in late July and early August (Figure 10). As aquatic plants and phytoplankton grow and reproduce, they consume carbon dioxide, which becomes acidic when dissolved in water. Consequently, as carbon dioxide levels decrease, pH levels increase. Therefore, there are slightly higher basic pH values found in the summer, when phytoplankton growth peaks. Data from Effler et al. (1988) also shows a secondary peak in mid September.

Duck Lake can best be described as alkaline. Data from Effler et al. (1988) shows that the mean alkalinity in 1988 from late July to mid October was 109.6 mg/L. This alkalinity peaked at about 125 mg/L in late July and decreased over the next couple of months. Effler et al. (1988) stated that the initial decreases probably reflect losses associated with the precipitation and deposition of calcium carbonate ($CaCO_3$) from the upper productive layers and this is consistent with the peak calcite turbidity during this time. Alkaline lakes such as Duck Lake have good buffering capacity which means that it can readily neutralize acid rain inputs and maintain its high pH. This protects its ecosystem and fishery from acid rain.

Figure 10: Temporal distribution of pH in 0-2 m interval in Duck Lake (Effler et al., 1988).

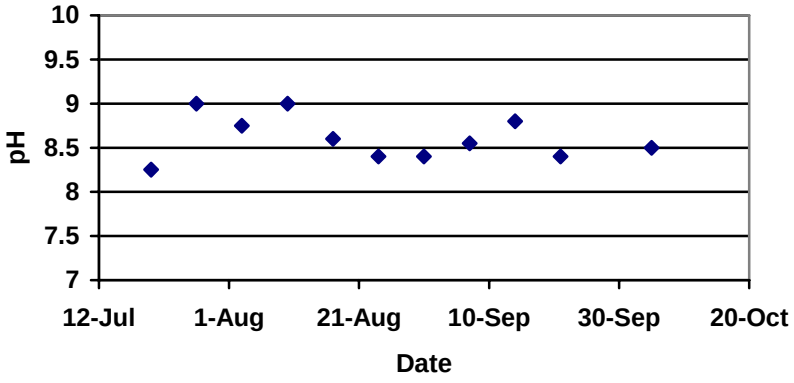
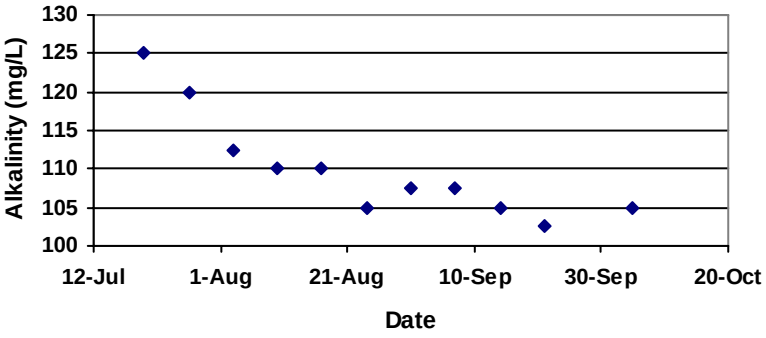


Figure 11: Alkalinity over the course of a summer. (Effler et al., 1988)



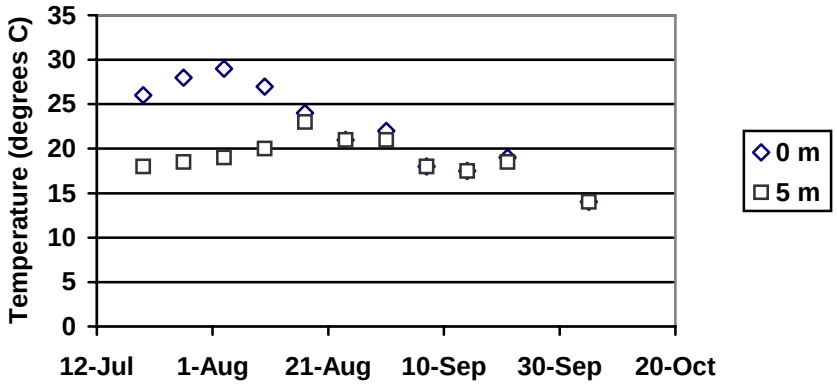
Pesticides

Duck Lake is not part of the Pesticide Monitoring Survey administered by the New York State Department of Health or the Statewide Pesticide Monitoring Program administered by the NYSDEC and assisted by the USGS. This lake has been treated with herbicides in the past to control growth of aquatic weeds. These herbicides have included Navigate and Diquat. The Duck Lake Association has a permit from the NYSDEC to treat Duck Lake with Navigate from 2002 to 2007.

Temperature

Effler et al (1988) examined the surface and near bottom temperatures of Duck Lake and the results are shown in Figure 12. The thermal stratification process and the importance of vertical mixing on the cycling of nutrients, oxygen concentrations, etc. will be discussed in respective sections of this report.

Figure 12: Temporal distributions of surface and near bottom temperatures of Duck Lake (Effler et al., 1988).



Thermal Stratification/Turnover

When the surface waters of a lake begin to warm up in the spring, the heat takes a long time to penetrate the bottom of a lake. Eventually there is a marked difference in temperature between the upper layer of a lake and the water at lower depths. This means that there is also a difference in the density of the water; lighter water floats on top of denser cooler water. When a lake divides into an upper, warmer layer and a lower, colder layer, the lake is said to be thermally stratified (summer stratification). The layers, or strata, are known as the epilimnion (top layer) and the hypolimnion (lower layer). There is a layer between the two known as a thermocline. Stratification reduces or eliminates exchange of nutrients, oxygen, etc. between the epilimnion and the hypolimnion. As the air temperature declines during the autumn, so does the surface water temperature. Eventually there is much less difference in density between the waters of the epilimnion and that of the hypolimnion. This situation allows strong wind to mix the layers of the water so that the temperature of the top and bottom of the lake are essentially the same. When this process occurs, the lake is said to have experienced turnover (fall overturn). This mixing also allows bottom nutrients to mix with the surface waters, and surface oxygen to mix with the bottom waters. Thermal stratification can also occur in the winter, with mixing occurring in the spring (spring overturn). A lake that experiences this spring and fall mixing is known as a dimictic lake (twice-turning). Duck Lake is considered a dimictic lake (Hennigan, 1991).

Duck Lake has a small volume of water and is a relatively shallow lake, therefore it responds readily to meteorological conditions and may not develop continuous thermal stratification in the summer every year. The absence of continuous thermal stratification allows cycling of material released from the sediments, including nutrients, to the upper productive waters and

oxygen to the lower waters. Also, only a small portion of the lake may stratify due to its shallow depth (NYSFOLA and NYSDEC, 2004). As is shown in Figure 12, the temperature of the surface water of Duck Lake peaked in early August in 1988 and then started to decline. In mid August, elevated winds prompted the rapid turnover of Duck Lake, which was early in comparison to the deeper, more strongly stratified lakes of the region (Effler et al., 1988).

Transparency (Clarity)

How well one can see an object in water is a measure of the water's transparency, or clarity. The ability of light to penetrate the water so that the object can be seen depends on the number and types of particles dissolved or suspended in the water. Sometimes we say that the water looks "murky" or "crystal clear." Examples of particles that can "cloud up" water include phytoplankton (algae), dissolved organic matter (detritus) and inorganic particulates (e.g. precipitants of minerals). Transparency is an aesthetic feature and controls plant growth by controlling how deep light can penetrate.

One method that measures transparency is the use of a Secchi disc. Typically, the Secchi disc is 20 cm in diameter, made of metal, and is attached to a rope to be lowered into the water. The depth at which the disc disappears from view is then recorded. The Secchi disc method is based on light penetration. Generally in the spring and autumn, when there is a lot of runoff or when mixing occurs after a storm, there are more particles that enter the water, resulting in lower transparency. On the other hand, in mid to late summer when there is less runoff, higher transparencies are often present.

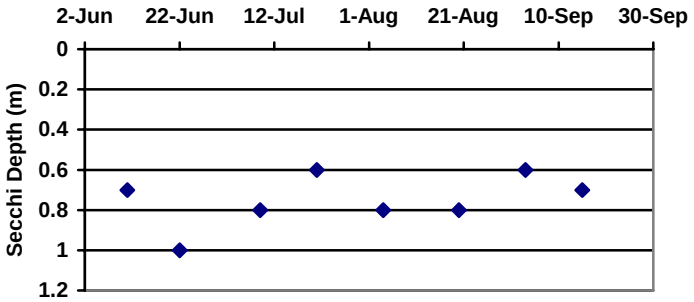
As shown in Table 5 there were great improvements in transparency from 1977 to 1988. This is most likely due to a shift from a system dominated by phytoplankton to one dominated by macrophytes (Effler et al., 1988). As the transparency improves, the depth and places that plants can grow increases. This system dominance can shift back to phytoplankton such as when herbicide treatments occur.

Table 5: Yearly mean Secchi disc transparency of Duck Lake in meters.

Year	Source	Average depth (m)	Number of samples
1988-2003	NYSFOLA and NYSDEC 2004	1.06	52
2003	NYSFOLA and NYSDEC 2004	0.75	8
1998	NYSFOLA and NYSDEC 2004	0.55	2
1994	NYSFOLA and NYSDEC 2004	1.17	8
1992	NYSFOLA and NYSDEC 2004	1.23	8
1991	NYSFOLA and NYSDEC 2004	0.74	6
1990	NYSFOLA and NYSDEC 2004	0.91	7
1988	NYSFOLA and NYSDEC 2004	1.38	13
1987	Effler et al. 1988	1.75	-
1977	Miller 1988	0.50	-
1976	EcoResearch 1976	0.30-0.46	-

The New York State guidance for Secchi disc transparency for swimming in a Class B or higher lake is greater than 1.2 m (4 feet) and this guidance is only applied to siting new bathing beaches. However, this guidance may be appropriate for all waterbodies used for contact recreation (e.g. swimming). The Secchi disc transparency for Duck Lake is generally less than this as shown in Table 5 and Figure 13.

Figure 13: Secchi disc transparency of Duck Lake in meters for 2003 (NYSFOLA and NYSDEC, 2004)



Duck Lake is moderately to highly colored by dissolved humic substances (Effler et al., 1988). The CSLAP report from 2003 states that the color readings probably do not exert any limits on water clarity, even when algae levels are low (NYSFOLA and NYSDEC, 2004).

Turbidity

Turbidity refers to the amount of suspended particles in water. As turbidity increases, transparency decreases. In a lake, turbidity is typically caused by a mixture of suspended particles that include clay, silt, finely divided organic and inorganic matter, phytoplankton, and other microscopic organisms. These particles can come from tributaries that feed into the lake, they can be resuspended from lake sediment that has been disturbed or agitated (natural or human caused), or produced in the water column. Another source of turbidity is known as "whiting," which is when calcite precipitates into the water. "Whiting" events occur in lakes with very high concentrations of calcium carbonate (hard water lakes) and they tend to occur as the temperature and plant productivity increases. The turbidity caused by the calcite is determined by subtracting the acidified turbidity from the total turbidity.

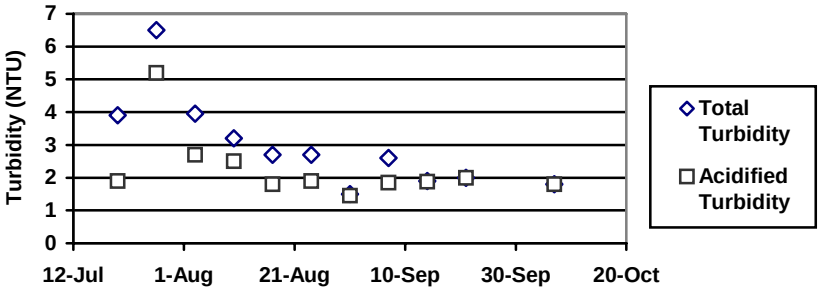
Table 6: Summary statistics for turbidity, acidified turbidity, and calcite turbidity in the 0 to 2 m interval of Duck Lake in 1988 (Effler et al., 1988).

Mean Turbidity (NTU)	Mean Turbidity Range (NTU)	Mean Acidified Turbidity (NTU)	Mean Acidified Turbidity Range (NTU)	Mean Calcite Turbidity (NTU)	Mean Calcite Turbidity Range (NTU)
2.9	1.4-6.4	2.2	1.3-5.3	0.7	0.0-1.9

Table 6 shows the summary statistics for turbidity in Duck Lake in 1988. As is shown in Figure 14, in 1988 total turbidity decreased in Duck Lake after peaking in late July. Calcite turbidity contributed to 24% of the turbidity in Duck Lake from late July to mid October, with the

highest occurring in late July. Therefore, calcite precipitation was apparently largely responsible for the elevated total turbidity at that time. As shown in Figure 14, significant amounts of "whiting" persisted in Duck Lake throughout the summer.

Figure 14: Temporal distributions of turbidity and acidified turbidity in the 0 to 2 meter interval of Duck Lake in 1988 (Effler et al., 1988).



Chlorophyll *a*

Chlorophyll *a* is a photosynthetic pigment common to all phytoplankton. Thus, researchers typically measure the level of chlorophyll *a* in water to quantify the amount of phytoplankton. For example, high concentrations of chlorophyll *a* indicate high concentrations of phytoplankton. In turn, high phytoplankton may indicate high nutrient loading and lower transparencies.

As shown in Table 7, chlorophyll *a* levels have varied over the past 15 years. When Duck Lake's chlorophyll *a* level is compared to neighboring lakes, lakes with the same water quality classification, and other CSLAP lakes (~4-6 µg/L), Duck Lake is more productive (NYSFOLA and NYSDEC, 2004). The readings for 1990 were higher than the others due to high algae levels all summer plus an extensive algal bloom in mid-September, which were probably caused by higher phosphorus and temperatures in August of that year.

Table 7: Average Yearly Chlorophyll *a* in µg/L

Year	Source	Average	Number of Samples
1988-2003	NYSFOLA and NYSDEC 2004	29.39	51
2003	NYSFOLA and NYSDEC 2004	17.47	8
1998	NYSFOLA and NYSDEC 2004	23.05	2
1994	NYSFOLA and NYSDEC 2004	20.72	8
1992	NYSFOLA and NYSDEC 2004	10.70	7
1991	NYSFOLA and NYSDEC 2004	18.00	6
1990	NYSFOLA and NYSDEC 2004	116.31	7
1988	NYSFOLA and NYSDEC 2004	11.53	13
1988	Effler et al. 1988	7.8	11

Plankton

Plankton are microscopic plants and animals composed of zooplankton (animal component) and phytoplankton (plant component).

Phytoplankton

Phytoplankton are microscopic plants that are common to most surface waters. Most often, phytoplankton consists of a large number of algal species, which need light, nutrients and warm temperatures to multiply. Like all green plants that photosynthesize, phytoplankton absorb light and carbon dioxide during the day, which results in the production of oxygen and glucose. During the night, they consume oxygen and use glucose in a process called cell respiration. When phytoplankton die, they fall to the bottom of the lake and decompose. This event also consumes oxygen.

Phytoplankton are the principle regulators of water transparency; they effect oxygen concentrations in lower depths, and are indicators of phosphorus levels. Many researchers quantify phytoplankton by measuring the amount of chlorophyll *a* pigment found in a cubic meter of water. However, identifying specific species of phytoplankton can also be used as a method to determine the trophic conditions of a lake.

Historical data regarding identification of phytoplankton species in Duck Lake is limited, but a plankton survey was conducted in August of 1992 (NYSFOLA and NYSDEC, 2004). The most abundant species found were unidentified bacteria (92%), *Aphanocapsa delicatissima* (blue-green algae, 3%), *Pediastrum duplex* (green algae, 2%), and unidentified diatoms (1%). The most abundant genera were *Cyanophyta* (blue-green algae, 4%) and *Chlorophyta* (green algae, 2%). In 1992 the sample was dominated by bacteria, which suggests that a large quantity of organic material is being broken down and the chlorophyll *a* levels suggest that it is at least partially algal (NYSFOLA and NYSDEC, 2004). This small amount of phytoplankton species is usually not associated with taste or odor problems.

Zooplankton

Zooplankton are largely made up of copepods, cladocera and rotifers and are generally less than 2 mm in length. Some zooplankton feed on plants (herbivores or planktivores), some feed on animals (carnivores) and some feed on plants and animals (omnivores). Zooplankton are considered a biologically important component of a "healthy" lake. They control algae and other phytoplankton, bacteria populations, and form an important food component for several fish species. As a result, zooplankton populations are valuable indicators of change in the conditions of the lake.

A 1984 survey by the NYSDEC found eight species of zooplankton with the most abundant being *Sida crystallina*, *Diaptamous minutus*, *Bosmina longirostris* and *Ceriodaphinia quadrilangulata*. The mean size of zooplankton in this survey was 0.57 mm, which is characteristic of lakes dominated by planktivores (NYSDEC 1984). Another survey in 1992 (NYSFOLA and NYSDEC, 2004) found the most abundant most abundant species to be *Copepod nauplii* (25%), *Conochilus spp*. (rotifers-16%), and *Chydoridae spp*. (cladocera-14%). The most abundant genera were rotifers (43%), copepods (34%) and cladocera (23%). The zooplankton assemblage in 1992 along with the Secchi disk transparencies suggests a mix of zooplankton engaging in an expected amount of algal predation (NYSFOLA and NYSDEC, 2004).

Macrobentic vegetation

Overabundance of aquatic vegetation has been a concern in Duck Lake since as far back as 1941 when a Conservation Department Study found that weed growth was excessive (NYSDEC, 1984). In 1972, aquatic plant growth, especially northern watermilfoil (*Myriophyllum sibiricum),* was so severe that motorboat use was restricted for the entire lake (CCSWCD et al., undated). An aquatic weed control program was started by local camp owners in 1973 to improve the lake for recreational purposes and the lake was treated with Diquat in 1973, 1974, 1975, and 1977 (CCSWCD et al., undated). The population of aquatic vegetation was significantly reduced, but residents felt that the treatment was affecting fishing. A study conducted by Cornell University in 1976 found that the reduction in fish population was most likely due to angler harvest and not the weed control program (CCSWCD et al., undated).

After Diquat treatment in the central portion of the lake in 1975, a survey of plant species conducted in 1976 found that that most abundant species in the treated areas was stonewort (*Chara sp.*) and watermilfoil (*Myriophyllum sp.*) in untreated areas (EcoResearch, 1976). Other common species were wild celery (*Vallisneria americana*), whitestem pondweed (*Potamogeton praelongus*), sago pondweed (*Potamogeton pectinatus*), water lily (*Nymphaea sp.*) and yellow water lily (*Nuphar sp.*)(EcoResearch, 1976). Also, by 1976, Eurasian watermilfoil (*Myriophyllum spicatum*), an invasive plant, had become a major concern.

Aquatic vegetation is limited to the littoral zone, which is the area between the high-water mark and the area where sunlight can no longer reach the bottom. A comparison of plant surveys conducted by Miller in 1977 and 1987 found that the total area of littoral plant growth increased from 64% to 95% and Eurasian watermilfoil (*Myriophyllum spicatum*) covered most of the expanded macrobenthic zone (Miller, 1988). This may be due to the increase in water clarity from 0.5 m in 1977 to 1.75 m in 1987, which allowed the depth plants could grow to increase from 1.8 m in 1977 to 3.5 m in 1987 (Miller, 1988). These surveys also found that the total area of nuisance weed infestation increased from 30% in 1977 to 71% in 1987 (Miller, 1988). Miller believed that the reason that this nuisance plant growth did not cover approximately 95% of the littoral zone was due to the use of aquatic plant controls in the 1980's (1988). Other plants that increased in abundance were water lily (*Nymphaea ordato* and *Nuphar variegatum*), and watershield (*Brasenia schreberi*); while there were decreases in stonewort (*Chara sp.*), coontail (*Ceratophyllum demersum*), and muskgrass. Northern watermilfoil (*Myriophyllum sibiricum*), water naiad (*Najas flexilis*) and marine naiad (*Najas marina*), which had extensive populations in the past, were no longer detected (Miller, 1988). The north end had the densest growth consisting of white water lily (*Nymphaea ordato*), watershield (*Brasenia schreberi*), and Eurasian Watermilfoil (*Myriophyllum spicatum*) (Miller, 1988), but this area lost coontail (*Ceratophyllum demersum*) (Miller, 1988).

The Cayuga County Aquatic Vegetation Control Program (AVC) determined that there were 64 acres of nuisance growth on Duck Lake in 1982, which consisted of *Myriophyllum spp*., water lily (*Nymphaea odoratoa*) and stonewort (*Chara vulgaris*). One acre of Duck Lake was treated in 1982 and 1.5 acres of the southeast channel and 2.3 acres of the northeast channel of the lake in 1983 were treated with AquaKleen (2,4-D ester) to target *Myriophyllum spp*. In 1988, the Cayuga County AVC program bought a smaller harvester and made a significant harvest on Duck Lake.

In 1992-1993, the Duck Lake Association attempted to get a permit from the New York State Department of Environmental Conservation to stock triploid grass carp in Duck Lake to

control aquatic vegetation. Grass carp had been used in ponds without outlets for weed control. Duck Lake Association's pulled this request.

In 2003, the Duck Lake Association purchased their own harvester and conducted chemical treatment using Navigate to control 40 acres of milfoil. Naiad (*Najas*), which was not detected in 1987, was found in Duck Lake after treatment, as well as American pondweed (*Potamogeton nodosus*). The Duck Lake Association has a permit to treat Duck Lake with Navigate until 2007.

Fish

In general, Duck Lake is a warm water fishery. Results from a 1984 survey by the NYSDEC were similar to surveys conducted 40 years before, with yellow perch, black crappies, pumpkinseeds, brown bullheads, and golden shiners being the most abundant species. There were rare sightings of Northern pike, and largemouth bass was the principal game fish and predator (NYSDEC, 1984). The largest black crappie caught on record in New York State was caught in Duck Lake in 1998.

A study conducted by Cornell University in 1976 found that the reduction in fish population in Duck Lake was most likely due to angler harvest and not the weed control program (CCSWCD et al., undated). In 1981, EcoResearch conducted a fish population survey of Duck Lake and recommended a stocking program of five 6 to 8 inch largemouth bass per acre to maximize the yield of legal size largemouth bass captured by fisherman. This 1984 survey found a stunted panfish population most likely caused by the dense aquatic vegetation, which provides unlimited escape cover for juvenile fish (NYSDEC, 1984). Black crappie and blue gill showed the slowest growth, while the large mouth bass growth was at or slightly below other New York State waters (NYSDEC, 1984). They determined that there was sufficient habitat and numbers of largemouth bass adults in 1984 to provide an adequate natural recruitment, so they recommended that stocking be discontinued (NYSDEC, 1984). The major limiting factor of the bass was competition for food with small panfish until the bass reached three years of age, so they recommended stocking 4 inch walleye to improve the balance of predators and increase fishing opportunities; as well as stocking fall fingerling muskies to increase predation (NYSDEC, 1984). They also recommended removing 1/3 of the aquatic vegetation yearly to remove cover (NYSDEC, 1984). Records show that the NYSDEC stocked tiger muskellunge from 1985 to 1988, and there was no stocking in 1990 (Hennigan, 1991). There may have been stocking conducted other years. In 2003, the NYSDEC stocked 700 fall fingerling tiger muskellunge into Duck Lake.

There is concern that the shallowness of Duck Lake may lead to oxygen depletion in the winter and lead to winter mortality of fish (EcoResearch, 1981). A severe winter kill was reported in 1939-1940, but this was the first year ice was not harvested on the lake (NYSDEC, 1984).

Tributaries

The preliminary watershed map shows no non-intermittent tributaries entering Duck Lake.

Section 2: Watershed Land Use, Economy and Cultural Resources

History

Within or adjacent to the Northern Montezuma Wetlands Project area, which includes Duck Lake, there have been found numerous important archeological sites (Melberg and Slingerland, 1991) and the entire Duck Lake area is located in an archeologically sensitive area as determined by the New York State Historic Preservation Office. A letter from the New York State Museum stated that recorded prehistoric archeological sites are located in or within one mile of the lake, and the physiographic characteristic of the location suggests a high probability of prehistoric use (1992).

Duck Lake is located within the Town of Conquest. Earliest settlers arrived around 1800 and Conquest was formed from Cato in March 1821.

Human Population

In the Duck Lake preliminary watershed, the majority of the housing units are located along the eastern and western shorelines. In 1991, 1.5 miles (56%) of the 2.7 miles of shoreline had dwellings (Hennigan, 1991). The Duck Lake preliminary watershed contains parts of four census blocks (1002, 1003, 1004 and 1998).

Census blocks are the smallest entities for which the Census Bureau collects and tabulates decennial census information. Census blocks are bounded on all sides by roads, streams, railroad tracks, or other features shown on Census Bureau maps. Census block data for census blocks 1002, 1003, 1004 and 1998 for the year 2000 is shown in Table #8. Within these four census blocks, over 60% of the homes are seasonal. There is a year round population of 134 for Duck Lake, but the population could increase greatly during the summer months when most seasonal residents would be present.

Table 8: 2000 Census Data (United States Census Bureau).

Census Block	# Housing Units	# Occupied	Population Occupied	# Vacant (Total)	# Vacant (Seasonal, recreational or occasional)
1002 (East shore)	97	33	83	64	62
1003 (West shore)	44	15	42	29	27
1004 (West upland)	9	9	9	0	0
1998 (Lake)	0	0	0	0	0

Existing Land Use

The preliminary Duck Lake Watershed covers approximately 581.5 acres of land area. All of the acreage in the Watershed lies within Cayuga County in the Town of Conquest. The largest portion of land use within the Watershed is open water (38%), followed by deciduous forest (21%), pasture/hay (19%), woody wetlands (10%), mixed forestlands (4%), row crops (4%) and residential use (0.9%) (see Figure 15). Agricultural land in the preliminary watershed is concentrated to the west of the lake. Many of the residential areas in the Watershed are low-density/rural; however, there is a higher concentration of homes along the lakeshore on the eastern and western sides of the lake. The northern and southern lakeshores are wetland areas that are not developed. Many of the lakeshore residences are seasonal and fully functional for only three months out of the year.

Agricultural Resources

Part of the preliminary watershed on the west side of the lake west of Duck Lake Road is located within Agriculture District #1. Most of this is in the northwestern portion of the Watershed. This area is a mixture of woodland and agricultural land.

Roads/Highways

There is one major road in the preliminary Duck Lake Watershed and this road is Duck Lake Road. This road is a county road and it is approximately 1.2 miles long in the preliminary watershed. There are also smaller roads such as East Lake Road and other miscellaneous lanes.

Recreation

Duck Lake offers a number of recreational activities to its residents, especially during the summer months. The majority of the residences surrounding Duck Lake are seasonal, so the highest concentrations of outdoor recreational use occur during the summer. The lake itself offers swimming for lakeshore residents and is a warmwater fishery.

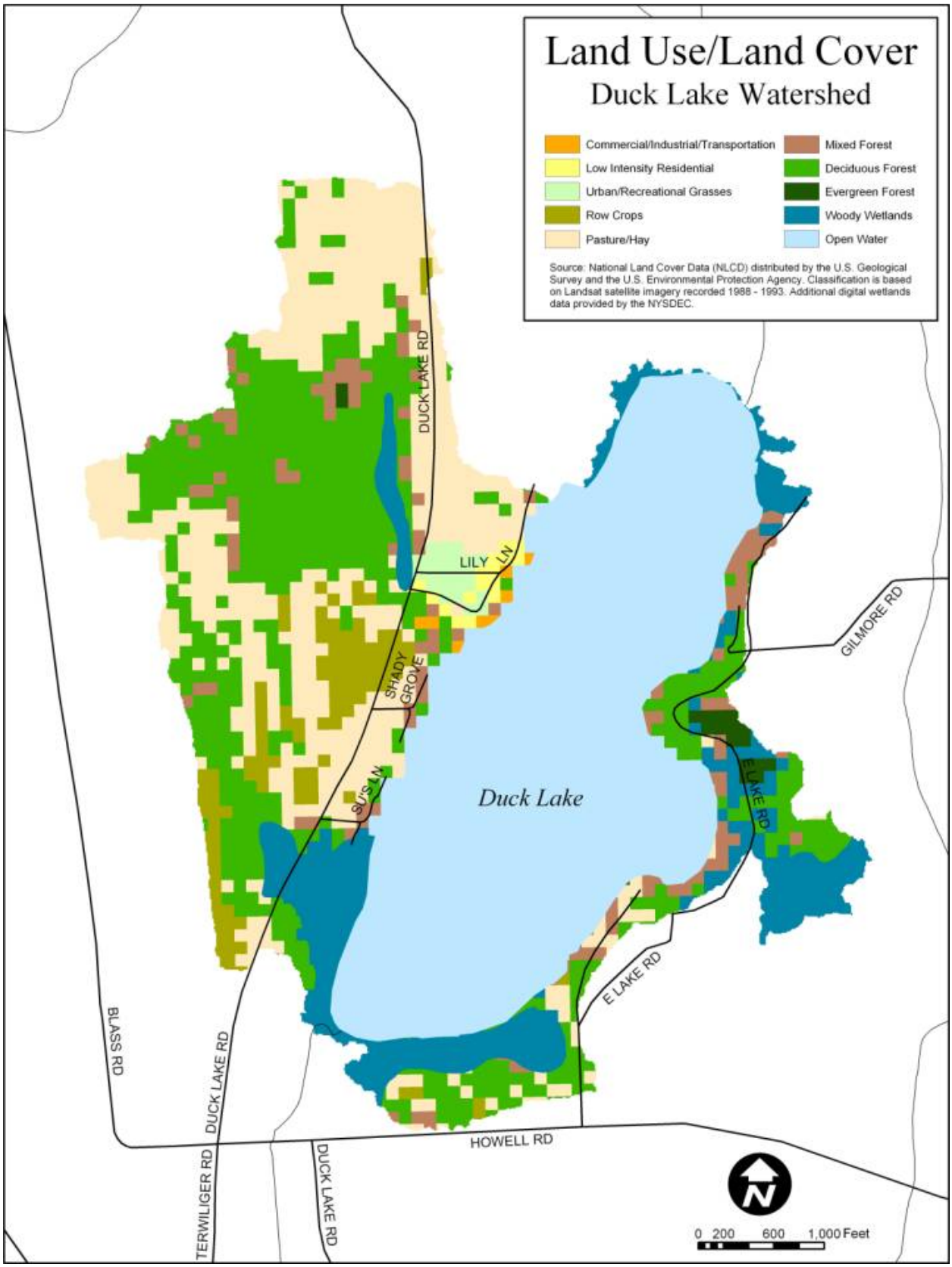
A recreational survey conducted during the 2003 CSLAP season found that the recreational suitability of Duck Lake was described most favorably by residents, with recreational conditions described as “excellent” for most uses (NYSFOLA and NYSDEC, 2004). Even though residents describe Duck Lake as having “definite algae greenness,” it ranked more favorable than expected based on clarity and assessments in previous years, and it is ranked more favorable than lakes with similar conditions (NYSFOLA and NYSDEC, 2004). This report stated that the ranking does not change as the season changes.

The Duck Lake Watershed is in the Montezuma Wetlands Complex and the north and south ends of the Lake are within the Northern Montezuma Wetlands Project. Recreation such as birding, hiking, canoeing, wildlife observation, etc. is important in the complex.

Tourism

Duck Lake is not conducive to tourism. At this time there is only one public access point to the lake. The campground on the western side of Duck Lake allows boats to launch for a fee.

Figure 15: Land Use Map of the Preliminary Duck Lake Watershed (Cayuga County GIS)



Real Estate

In general, lake front property has significantly increased in value in New York. The Town of Conquest underwent a re-evaluation in 2003, therefore it is difficult to compare assessed prices before that time to assessed prices today. The Town Assessor stated that the sales are coming in higher than the assessed value on lake and river front property, and from 2003-2004 these prices were about 6% greater than the assessed value.

The majority of the residences in the Duck Lake preliminary watershed were classified by the 2000 Census as being seasonal, recreational or occasional. The majority of homes sold on Duck Lake from 2000-2004 were classified as single family homes (13), with only one that was classified as a seasonal home during the same time period (Cayuga County Real Properties). Please note that the classification by the 2000 Census may differ from the classification by the town assessor. Over 75% of the single family homes sold at or above their assessed value. Other sales from 2000-2004 were five mobile homes and ten vacant properties.

Landfills

Currently there are no active landfills located in the preliminary watershed of Duck Lake. There is one landfill located just outside of the watershed on Howell Road, which is southeast of Duck Lake. This was a privately owned, municipally operated landfill that collected mostly household trash. It is unknown when this landfill opened and it was closed in 1967 according to standard methods at the time of its closure.

There are no reports of illegal roadside dumping sites in the watershed.

Section 3: Watershed Laws/Ordinances/Regulations

Land Use and Zoning Laws

The preliminary watershed is located entirely within the Town of Conquest. The Town of Conquest has no comprehensive or master plan, no zoning, no subdivision regulations or site plan review laws. It does have a setback and lot law, a junkyard and automobile junkyard law and a dwelling and structure law.

Agricultural District Law

Part of the western side of the preliminary watershed is located within Agricultural District #1. Agricultural districts were created to protect and preserve agricultural lands from loss to non-agricultural development. Article 25AA- Agricultural Districts of the Agriculture and Markets Law states that:

> *The socio-economic vitality of agriculture in this state is essential to the economic stability and growth of many local communities and the state as a whole. It is, therefore, the declared policy of the state to conserve, protect and encourage the development and improvement of its agricultural land for production of food and other agricultural products. It is also the declared policy of the state to conserve and protect agricultural lands as valued natural and ecological resources which provide needed open spaces for clean air sheds, as well as for aesthetic purposes.*

The law provides for the establishment of a county agricultural and farmland protection board and provides for placement of unique and irreplaceable agricultural lands in district by local owner proposal. Advantages include: agricultural tax assessment based on soil classification; limits on local regulation that might unreasonably restrict or regulate farms; limitation on exercise of eminent domain and other public acquisitions; coordination of local planning and comprehensive plans with the policy and goals of agricultural district law; and a "right to farm" clause, stating that a sound agricultural practice shall not constitute a private nuisance.

The Cayuga County Agricultural and Farmland Protection Board was formed in 1994. Included in the duties to be performed by this board was the creation of the Agriculture and Farmland Protection Plan for Cayuga County. This plan identifies and evaluates land use patterns, regulatory factors, and economic circumstances that encourage the conversion of agricultural land to non-farm purposes. Based on this evaluation, a program was developed to minimize, prevent or reverse the factors identified as contributing to conversion. The plan suggests ways to minimize the negative impacts of any unavoidable agricultural land use conversions.

Cayuga County Sanitary Code

In 1994, Article V of the Cayuga County Sanitary Code was revised as a result of increased public concern for water quality and an increased number of beach closings at Emerson Park on Owasco Lake during the early 1990's. The revisions called for individual residential wastewater treatment systems (septic systems) within the County to be periodically inspected and repaired if found to be failing. Development of the septic system inspection schedule was based on the

system's location relative to Owasco Lake or Little Sodus Bay as outlined in Table 9. Conquest was last inspected in 2000.

Table 9: Cayuga County Septic System Inspection Schedule

Septic System Location	**Routine Inspection (years)**
Bordering Owasco Lake or Little Sodus Bay	2
Within 500 feet of Owasco Lake or Little Sodus Bay	3
Within the watersheds of Owasco Lake or Little Sodus Bay and within Sterling, Fleming, Owasco, Niles, Scipio and Moravia	5
Outside the watersheds of Owasco Lake or Little Sodus Bay	7

Inspection Procedure

Through the County's privatized inspection program, homeowners must contract with a certified Cayuga County Wastewater Inspector for septic system assessments. Inspection includes a review of Division of Environmental Health records, an interview with the homeowner, inspection of plumbing and system components, and a dye test. Typically the dye test involves adding a florescent dye and a volume of water (depending on the number of bedrooms) to a wastewater receptacle and observing if the dye surfaces. Lastly, a sketch of system components, such as septic tank, distribution box, and leach field, is drawn in relationship to wells and waterbodies, such as lakes and streams.

Homeowners who are transferring property are required to have an inspector perform a property transfer inspection. A property transfer inspection is more stringent than a regular inspection. More water is added per bedroom and the septic tank must be pumped out by a certified waste hauler. All information relating to a homeowner's septic system is entered onto a six-page inspection form. The information is then logged into a database software package at the Environmental Health Division.

Section 4: Watershed Management Programs

Agricultural Environmental Management Program

Agricultural Environmental Management (AEM) is a voluntary, locally-led and implemented initiative that provides one-on-one help to farmers who want to identify environmental concerns on their farms and implement appropriate solutions. AEM provides a framework for existing agricultural agencies and private sector organizations to coordinate the delivery of their services to farmers. AEM utilizes a tiered approach to whole farm plan development.

Services provided through AEM include aid in identifying environmental concerns, planning and design of needed environmental practices, and the opportunity to apply for financial assistance. The farmer's business needs are a key consideration throughout the AEM process.

Cayuga County GRAZE NY Program

One of the goals of the Cayuga County Graze NY Program is to improve water quality by reducing the inflow of sediments, pathogens and nutrients into waterbodies via nonpoint source pollution, through the implementation of rotational grazing systems. The practice of intensive rotational grazing is an environmentally sound management practice that, where implemented, improves water quality. Unlike annual tillage crops that expose the soils, rotational grazing stabilizes the soil by providing permanent vegetative cover. As a result of this cover, rotational grazing provides reduced soil erosion and animal waste runoff. In addition to pasture establishment, maintenance practices also encouraged by this program (such as no-till and broadcast seedings, forage tests, soil tests, and proper fertilization techniques) greatly reduce soil erosion as well. Another component of rotational grazing is to physically exclude the animals from entering streams and/or other bodies of water. This practice further reduces erosion and improves water quality.

A second goal is to hold regular workshops, informational meetings, farm visits, and farm tours to educate farmers about the environmental benefits related to rotational grazing. Through the use of regular workshops, meetings, visits, and tours, agricultural producers will have an opportunity to share their experiences with, as well as gain information from, peers, grassland specialists, grazing technicians, and dairy nutritionists. Such grazing could be used in agricultural areas of the watershed, which are generally west of the lake.

Cayuga County Aquatic Vegetation Management Program

The principal objective of the Cayuga County Aquatic Vegetation Control Program, which was initiated in the early 1970's, is to sustain a balance of aquatic plants and algae in order to maintain the biological structure of our lakes. The program is not an attempt to eradicate or eliminate aquatic weeds, but rather to control them. The program seeks balance among recreational, economical, and ecological concerns, which includes integration of both short- and long-term goals. Partial funding for this program comes from the Finger Lakes Lake Ontario Watershed Protection Alliance (FLLOWPA).

Long term controls

Long term controls address the causes of nutrient and sediment loading to the lake. Since all aquatic plants require nutrients for growth, reducing and controlling their growth requires limiting the amounts of nutrients entering the lake from its watershed.

Short term Controls

Short-term controls address the immediate effects of nutrient and sediment loading which are excessive weed and algae growth. With the exception of harvesting, many of the methods do not significantly affect the nutrient levels and are therefore considered cosmetic or temporary. Short-term controls are, however, necessary to keep excessive plant growth at a manageable level, while long-term prevention methods are implemented. Duck Lake has such extensive weed growth that short-term controls are, at times, necessary to maintain the recreational and economic interest in the lake.

Mechanical Harvesting

Mechanical harvesting involves the use of mechanical equipment to cut and remove nuisance plant growth from the lake. This is strictly a temporary measure and must be repeated two or more times each year in an area for best control. The equipment is expensive and relatively slow. Cut and unharvested plants can float to “clean” areas and begin infestations. Maintenance of the equipment is expensive. The Duck Lake Association owns a small Jenson weed cutter, which is generally used around docks and to keep channels open.

Chemical treatment

Involves the application of herbicides or algaecides to retard or kill aquatic plants and algae. Although these chemicals are relatively easy to apply and provide relatively fast results, permits are required, monitoring costs are high, and environmental effects are not always known or easily monitored. Also, the chemicals can be hazardous to the applicator if not handled properly. Repeated applications are required annually. For the reasons stated above, chemical treatments by County agencies ended in the 1970's for lakes within the County. The Duck Lake Association has a permit to treat Duck Lake with a herbicide known as Navigate until 2007.

Finger Lakes Lake Ontario Watershed Protection Alliance (FLLOWPA)

Cayuga County is a member of the Finger Lakes Lake Ontario Watershed Protection Alliance (FLLOWPA) and this group receives an annual appropriation from the New York State. Cayuga County receives funds from FLLOWPA annually. In recent years funds have been allocated to the Cayuga County Soil and Water Conservation District to conduct aquatic vegetation management and streambank stabilization, to the Cayuga County Department of Environmental Health to conduct septic system inspections, to the Cayuga County Planning Department to conduct inflow monitoring of tributaries to Owasco Lake, roadside erosion surveys for Owasco Lake, and stormwater education, and to the Duck Lake Association and Cayuga Lake Watershed Network to fund their CSLAP (Citizen Statewide Lake Assessment Program).

Section 5: Issues of Concern

Duck Lake State of the Lake Report Preliminary Meeting

The following issues of concern for Duck Lake were identified at the public informational meeting held October 28, 2004 at the Conquest Municipal Building. Nine participants listed all the issues of concern they had for Duck Lake. Participants were then given 4 stickers to place on the issue or issues they felt were of the most importance. The number in parentheses next to the issue is the number of stickers the issue received.

The following is the results of this exercise:

- Septic Systems (10)
- Public Access (5)
- Bacteria (4)
- Weed control (4)
- Liquid Manure use (3)
- Lake level (3)
- Springs (3)
- Invasive species (2)

Other issues expressed at the meeting included (order is random):

- Closed dump and dumping occurring on Howell Road
- Dredging of the lake at each end
- Nutrients
- Geese and Wildlife
- Boating/Jet Skis/Wave Runners
- Chemicals
- Lake Shore Erosion
- Fish and Stocking
- Using lake water for irrigation

Watershed Resident Survey

A copy of the survey was sent to all Duck Lake Association members in the 2005 Duck Lake Association newsletter. An additional 100 copies were printed for distribution at the Duck Lake Association Annual Picnic. Below are the results of that survey based on the responses of 23 individuals.

1. Does your property have lake frontage?
   a. Yes 87%
   b. No 13%

2. Average length of residence?
   a. Seasonal 87%
   b. Year Round 13%

3. Average number of people?
   a. 2.43

4. How do you use your property?
   a. Recreational 78%
   b. Residential 22%

5. Source of drinking water?
   a. Private well 83%
   b. Other 17%
      Includes campground, bring own water (4).

6. How do you rate the quality of your drinking water?

		Very Good	Good	Poor	Very Poor	Unsure	No Response
a.	Taste	43%	35%	0%	4%	0%	17%
b.	Looks	48%	26%	0%	4%	0%	22%
c.	Smell	39%	30%	4%	4%	0%	22%
d.	Purity	39%	30%	4%	4%	0%	22%
e.	Other: sulfury, iron						

7. Do you use Duck Lake for the following activities?

		Once a Week	Once a Month	Every 3 Months	Once a Yr	Never	No Response
a.	Fishing	48%	22%	4%	9%	9%	9%
b.	Swimming	61%	17%	0%	4%	4%	13%
c.	Boating	57%	22%	0%	0%	4%	17%
d.	Scenic	74%	9%	0%	0%	4%	13%
e.	Ice Skating	0%	0%	0%	17%	43%	39%
f.	Ice Fishing	0%	0%	0%	17%	43%	39%

		Once a Week	Once a Month	Every 3 Months	Once a Yr	Never	No Response
g.	Jet Skiing	13%	0%	0%	17%	39%	30%
h.	Canoeing	17%	17%	0%	4%	39%	22%
i.	Hunting	4%	0%	0%	9%	57%	30%
j.	Farming	0%	0%	0%	0%	61%	39%
k.	Gardening	26%	9%	0%	9%	30%	26%
l.	Forestry	0%	0%	0%	4%	61%	35%
m.	Camping	0%	0%	0%	0%	65%	35%
n.	Hiking	13%	26%	0%	4%	26%	30%

8. How would you rate the water quality of Duck Lake for:

		Very Good	Good	Poor	Very Poor	Unsure	No Response
a.	Swimming	22%	70%	4%	0%	0%	4%
b.	Boating	26%	70%	4%	0%	0%	0%
c.	Fishing	48%	52%	0%	0%	0%	0%
d.	Lawn/Garden Water Source	26%	43%	0%	0%	13%	17%
e.	Drinking	0%	9%	26%	17%	35%	13%

Please describe any recent changes in lake water quality that has affected your use of the lake:

Lake level up and down.
Have seasonal weeds.
Weed control.
Weed control has made boating much improved.
Low water levels.

9. In the past five years:

	Strongly Agree	Agree	Disagree	Strongly Disagree	Unsure	No Response
a. My use and enjoyment of the lake has increased	35%	52%	9%	0%	0%	4%
b. The value of my property/ business has benefited from proximity to lake	26%	57%	4%	4%	4%	4%

10. These are some of the concerns expressed by people around the watershed. Do you have concerns about:

    The concerns were weighted and ranked according to the number of responses; "strong concerns" (weight of 4); "concern" (weight of 3); "little concern" (weight of 2); "no concern" (weight of 1); or "unsure" (weight of 0).

Concern	Value
1. Invasive species such as zebra mussels and Eurasian milfoil	73
2. Septic systems and other wastewater treatment systems around the lake	70
3. Aquatic vegetation (weeds)	70
4. Boating speed/safety/noise	69
5. Using lake as irrigation water	67
6. Fuel spills or hazardous waste	65
7. Waterborne pathogens such as coliform	64
8. Agricultural runoff	64
9. Herbicide and pesticide use in business/agriculture	62
10. Changes in lake level	61
11. Sedimentation	61
12. Public access to the lake	60
13. Chemicals	60
14. Quality of springs feeding the lake	60
15. Shoreline erosion/siltation	59
16. Nutrients	58
17. Geese and wildlife	57
18. Herbicide and pesticide use around the house	54
19. Fisheries development	52
20. Private water supply	50
21. Stormwater runoff	49
22. Use of chemical weed control	44

11. Have you had any of the following problems on your property last year:

	Yes	No	Unsure	No Response
a. Drinking water contamination	0%	87%	4%	9%
b. Flooding	9%	83%	0%	9%
c. Shoreline erosion	35%	57%	0%	9%
d. Access for swimming	4%	87%	0%	9%
e. Access for boating	4%	87%	0%	9%
f. Other (list)				

12. Are you aware of any problems associated with water quality or recreation in the Duck Lake Watershed? If so, how did you become aware of the problem?

    - None (3)
    - People boating to close to dock/float.
    - Weeds-used weed control.

- Algae blooms made us aware of excess nitrogen/nutrients in the water-geese? Agriculture?
- Water level concerns- low level made it tough to get the boat off the hoist.
- I do not like the high bacteria count in my area. There should be some way to make year round people pump their septic tanks especially the small tanks.

13. What would your positions be on the following, if you were in charge of managing Duck Lake:

		Strongly Support	Support	Against	Strongly Against	Unsure	No Response
a.	A watershed inspection program	35%	48%	0%	0%	0%	17%
b.	Limiting adverse effects of septic tanks systems	65%	26%	0%	0%	0%	9%
c.	A mechanical aquatic weed harvesting program	22%	35%	30%	4%	0%	9%
d.	A chemical aquatic weed harvesting program	43%	39%	0%	4%	4%	9%
e.	A hazardous spill response program	43%	43%	0%	0%	0%	13%
f.	A dredging program to deepen particular areas of the lake	22%	26%	26%	4%	13%	9%
g.	Monitoring the lake to id pollution	52%	39%	0%	0%	0%	9%
h.	Land use controls to protect water quality	39%	52%	0%	0%	0%	9%
i.	Erosion and sediment control laws to protect water quality	26%	57%	4%	0%	4%	9%
j.	Programs to limit nutrients that cause algae and weed growth	35%	52%	0%	0%	4%	9%
k.	Boating rules and regulations	48%	30%	4%	4%	0%	13%
l.	More education on watershed practices	39%	52%	0%	0%	0%	9%

14. Funding sources for recommendations in question 13. How would you pay for the recommendations:

		Strongly Support	Support	Against	Strongly Against	Unsure	No Response
a.	User fees (per foot dock or boating fees)	17%	22%	35%	13%	0%	13%
b.	Fund raising events	17%	57%	9%	0%	4%	13%
c.	Donations	26%	57%	4%	0%	4%	9%
d.	Watershed resident tax: per capita	4%	13%	35%	22%	13%	13%
e.	Watershed resident tax: by acreage owned	4%	13%	39%	17%	13%	13%

What is the maximum dollar amount you would pay per year to institute and keep good watershed practices:

Average= $107
Maximum=$350
Most people would be willing to pay between $50-100.

15. Do you feel that any of the following programs are needed in the Duck Lake Watershed:

		Strongly Support	Support	Against	Strongly Against	Unsure	No Response
a.	Voluntary programs for watershed protection	13%	74%	0%	0%	0%	13%
b.	Education programs	13%	70%	0%	0%	0%	17%
c.	Boating regulations	30%	43%	9%	0%	4%	13%
d.	Septic system programs	26%	57%	0%	4%	0%	13%
e.	Stormwater/erosion control programs and/or construction practices	9%	70%	4%	0%	4%	13%
f.	Programs for runoff on farmlands	22%	52%	4%	0%	9%	13%
g.	Programs for herbicide, pesticide and fertilizer controls	26%	57%	0%	0%	4%	13%
h.	Existing programs and regulations are adequate as they are	4%	39%	9%	0%	30%	17%

16. Who do you think should carry out those programs:

Total is more than 100 percent because many chose more than one.

a.	Local Government	30%
b.	County Government	26%
c.	Duck Lake Association	52%
d.	Unsure	17%
e.	No Response	9%
f.	Other (NYS, NYSDEC)	9%

17. Are there any problems or issues, which as a property owner in the Duck Lake Watershed you feel has not been emphasized enough in this questionnaire? Please share your main concerns and comments below:
    - Weed control.
    - Changes in watershed protection as to creek dredging and private preserve development near Duck Lake causing creek flows to be altered and change courses.
    - Wish the local government would help defray some of the expenses needed for the lake such as weed control.
    - Unsafe jet ski use
    - Erosion and sediment is an issue that continues throughout this survey. I have as big a concern from improper boating tactics and practices as I do stormwater runoff, watershed issues, etc. Boats need to be farther from shore and dock ends. This wake activity has to affect the shoreline.
    - My main concern right now is the septic tank next door-year round use- (it, the tank) was not designed to be used. My tank is a 1200 gallon one-the next two cottages down have been pumped.

References

Cayuga County Planning Board. 1969. *Master Plan Background Study: Natural Resources.* Cayuga County Planning Board, Auburn, NY.

Cayuga County Soil and Water Conservation District (CCSWCD), Cayuga County Water Quality Management Board, Cayuga County Environmental Management Council, Cayuga County Health Department and Cayuga County Planning Board. Undated. *Aquatic Vegetation Profile: Duck Lake Profile - Aquatic Vegetation Control.* Cayuga County, New York.

Cook, Ed. 1994. Letter to US. Army Corps of Engineers.

EcoResearch. 1976. *Duck Lake Biological Survey 22, 23 July, 1976.*

Effler, S.W., M.G. Perkins, D. Kent, C.M. Brooks, B. Wagner, M.L. Storey, and H. Greer. 1988. *Limnology of Lake Como, Duck Lake, Otter Lake, Parker Pond, and Little Sodus Bay, 1988.* Upstate Freshwater Institute, Inc., Syracuse, New York.

Hennigan, Robert D. 1991. *Management Action Plans Cayuga County Lakes: Draft Report.* Robert D. Hennigan Associates, Syracuse, NY.

Melberg, C. and D. Slingerland. 1991. *Final Environmental Impact Statement Northern Montezuma Wetlands Project.* U.S. Fish and Wildlife Service and New York State Department of Environmental Conservation.

Miller, Gary L. 1988. *An Update and Inventory of Aquatic Vegetation in Six Lakes of Cayuga County, New York.* University of North Carolina, Asheville, North Carolina.

New York State Museum. 1992. Letter to Jon Drossos regarding the Proposed Project: Stocking of Carp, Duck Lake.

NYSFOLA and NYSDEC. 2004. *2003 Interpretive Summary New York State Citizens Statewide Lake Assessment Program (CSLAP): Duck Lake.*

NYSDEC. 2005. *Duck Lake (Conquest) Contour Map.* NYSDEC Lake Map Series. NYSDEC Division of Fish Wildlife and Marine Resources. www.dec.state.ny.us .

NYSDEC. 1984. *Duck Lake (OS-P22) Survey Report.*

NYSDEC. 1996. *The 1996 Priority Waterbodies List for the Oswego-Seneca-Oneida River Basin.* NYSDEC Division of Water.

Topozone. 2005. www.topozone.com

WQMA. 1994. *WQMA Minutes from 9/9/04.* co.cayuga.ny.us/wqma/meeting/minutes/index.htm.

LIST OF ACRONYMS

ACOE - U.S. Army Corps of Engineers

AEM - Agricultural Environmental Management

AVC - Aquatic Vegetation Control

BMP - Best Management Practices

CCSWCD – Cayuga County Soil and Water Conservation District

DO - Dissolved oxygen

EPA - U.S. Environmental Protection Agency

FLLOWPA - Finger Lakes-Lake Ontario Watershed Protection Alliance

FWS - U.S. Fish & Wildlife Service

HHW - Household Hazardous Waste

NOAA – National Oceanic and Atmospheric Administration

NWS – National Wildlife Service

NYSDEC - New York State Department of Environmental Conservation

NYSDOH - New York State Department of Health

ppb - Parts Per Billion (µg/L)

ppm -Parts Per Million (mg/L)

SRP - Soluble Reactive Phosphorus

TP - Total Phosphorus

USGS - United States Geological Survey

WQMA - Water Quality Management Agency

GLOSSARY OF TERMS

Buffer strips - Strips of grass or other erosion-resisting vegetation between or below cultivated strips or fields.

Coliform organism - microorganisms found in the intestinal tract of humans and animals. The presence of fecal coliform in water indicates pollution by bird or mammal waste and potentially dangerous bacterial contamination by disease causing microorganisms.

Dimictic - A lake characterized by two turnover periods in between which the water layers stratify.

Dissolved oxygen (DO)- The oxygen freely available in water. DO is vital to fish and other aquatic life and for the prevention of odors.

Eutrophic – Lake that is rich in phosphorus, nitrates, and other nutrients that promote the growth of algae, which deplete the water of oxygen.

Effluent - Wastewater--treated or untreated--that flows out of a treatment plant, sewer, or industrial outfall.

Epilimnion – The upper, warmer water of a lake, above the thermocline.

Erosion - The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by human practices.

Hypoliminion - The lower, cooler water of a lake, below the thermocline.

Lacustrine - Lake associated.

Littoral Zone - The zone close to the water's edge where one finds rooted aquatic plants.

Mesotrophic – Lake that contains moderate quantities of nutrients and is moderately productive in terms of aquatic animal and plant life.

Nitrate -A compound containing nitrogen which can exist dissolved in water and which can have harmful effects on humans and animals.

Oligotrophic - Lakes with low nutrient supplies. They contain little organic matter and have a high dissolved-oxygen level.

Outcrop - Coming out of the surface of the earth.

Palustrine - Having to do with a marsh or marshy.

Pesticides -Any substance or mixture intended for preventing, destroying, repelling, or mitigating any pest. Includes insecticides, herbicides, fungicides, and rodenticides. Pesticides can accumulate in the food chain and/or contaminate the environment if misused.

Runoff - The part of precipitation, snowmelt, or irrigation water that flows over the land into streams or other surface water. It can carry pollutants from the air and land into the receiving waters.

Thermocline – Layer of water between the epilimnion and hypolimnion, or an area of rapid temperature change between upper warmer waters and lower cooler waters in a thermally stratified lake.

Turbidity - Cloudiness in water caused by the presence of particles (suspended silt or organic matter) and pollutants.

Tributaries - River or stream flowing into a larger river or lake.

Watershed - Land area that surrounds and drains into a lake, river, stream or pond.

Wetland - An area that is regularly saturated by surface or ground water and subsequently is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include swamps, bogs, fens, and marshes. Some wetlands are known for their ability to

Appendix 1. Fecal Coliform Results (colonies/100 mL) (Cayuga County Department of Environmental Health and Duck Lake Association)

Sample Site #	9/24/97	7/6/98	7/7/99	9/8/99	10/13/99	7/17/00	9/13/00	5/15/01	7/9/01	7/23/01
West Side										
11	24	70	97	107		182	364	72	4360	182
12	10	44	17	143		207	2000	909	636	545
13	31	37	600	4200	6	2000		1270	454	727
14	16	87	9	150		1000	198	182	1730	818
15	11	33	27	170		117	545	1090	2540	1180
16	17	73	54	205	22	818	364	727	4000	454
17	30	70	22	79		273	3360	1180	2540	636
18	46	80	23	77		<10	1180	273	2090	545
19	20	65	194	90		1090	3730	818	6000	153
20	64	87	77	310	14	1000	1450	108	2820	2090
25							153			
30										
31										
East Side										
21		30	30	80		10	1730	81	2900	1640
22		67	25	34		364	273	54	545	2900
23		30	36	400	12	454	72	273	4360	182
24								63	3820	727
26										
27										
28										
29										
32										
33										
34										
35										
36										
37										
38										
39										
Middle of the Lake										
40										

***2000 site 18 is the same as 2001 Site 16.**
The New York State Department of Health Standard for bathing beaches is an instantaneous reading above 1000 colonies/100mL.

Appendix 1. Fecal Coliform Results (colonies/100 mL) (Cayuga County Department of Environmental Health and Duck Lake Association) Continued

Sample Site #	9/18/01	4/17/02	6/24/02	7/9/02	9/10/02	5/15/03	9/8/03	6/22/04
West Side								
11		81	2270		1000	91	50	
12		72	1910		450	182	30	
13		99	243		2910	252	80	
14		81	234		2000	90	60	
15		63	631		1000	91	64	
16		126	2000		636	364	727	1000
17		81	818		545	273	50	
18		72	2000		364	135	72	
19		27	2000		1000	364	54	
20		171	4270		4000	273	50	108
25		90	1000		273	81	180	
30	189			909				273
31	108			2000				2000
East Side								
21		10	2540		454	144	90	
22		10	3450		3000	126	505	135
23		180	909		468	99	252	2180
24		189	727		545	45	180	
26	27			545				
27	81			727				
28	1540			454				
29	1910			2000				818
32	72			5000				
33	3360			8000				2000
34	545			2000				
35	636			4000				
36	545			2270				
37	2910			1000				
38	1180			2000				
39	3090			364				
Middle of the Lake								
40	545			5000				

***2000 site 18 is the same as 2001 Site 16.**

The New York State Department of Health Standard for bathing beaches is an instantaneous reading above 1000 colonies/100mL.

Part 2:

Duck Lake

Watershed Management Plan

December 2005

Duck Lake Watershed Management Plan

AGRICULTURE

Goal:

Reduce the impact of agricultural sources of sediment, nutrients, pesticides and pathogens to the water resources of Duck Lake.

Issues:

- Agriculture can be a source of sediment, nutrients, pesticides and pathogens to Duck Lake.
- Maintain viability of agricultural land use in Duck Lake watershed while minimizing the negative impacts of agriculture on the environment and reducing the migration of pollution to Duck Lake.

Suggested Actions:

1. Miscellaneous

a. Encourage use of Agricultural Environmental Management (AEM) plans for farms in the Duck Lake Watershed. Identify best management practices (BMPs) from AEM plans, look for assistance to implement these BMPs and measure the effectiveness of these BMPs.

b. Encourage use of whole farm plans.

c. Encourage farmer participation in state and federal programs that relate to water quality and issues in the Duck Lake Watershed and pursue forms of assistance such as continued federal and state grants and cost share programs.

d. Continue hazardous waste collection days for farm pesticides.

e. Take advantage of new technologies to deal with agricultural waste.

AQUATIC VEGETATION MANAGEMENT

Goal:

Prevent the introduction of invasive aquatic plant species and properly manage the aquatic vegetation that is present in Duck Lake.

Issues:

- Excessive aquatic vegetation growth can complicate or restrict certain uses of the lake.
- The invasive exotic plant Eurasian watermilfoil has become the most abundant species in Duck Lake and makes up the majority of the nuisance vegetation. Other invasive exotic aquatic plant species such as water chestnut have not spread into Duck Lake, but are a threat.
- Excessive nutrients can lead to excessive vegetation growth.
- Different control methods have different benefits and concerns.

Suggested Actions:

1. Education:

a. Utilize the materials from the Weeds Watch Out! (W2O!) Program to inform lake users and homeowners about the spread and characteristics of invasive aquatic species, how to prevent the spread of invasive aquatic species, and teach volunteers to identify aquatic plant species and map them.

b. Educate public on how to reduce nutrient loading to the lake utilizing materials from the P-Project.

2. Assessment:

a. Inventory and map aquatic vegetation in Duck Lake, compare to historical data and determine management needs. Publish findings as an educational tool.

b. Conduct annual surveys to monitor aquatic plant species in Duck Lake.

c. Create a map to document the extent of aquatic plant growth based on annual plant surveys and sightings from lake users

3. Funding

a. Continue to utilize the funding from the Finger Lakes-Lake Ontario Watershed Protection Alliance (FL-LOWPA) program to continue the Citizens Lake Assessment Program (CSLAP).

b. Search for funding to inventory and map aquatic vegetation in Duck Lake, compare to historic data and determine management needs.

c. Search for funding for education including expanding the Weeds Watch Out! (W2O!) Program and P-Project to Duck Lake.

d. Search for funding to take sediment samples to pinpoint high phosphorus sediment areas.

4. Miscellaneous

a. Continue to apply chemicals as approved by the NYSDEC for control of aquatic vegetation.

b. Examine dredging and explore funding opportunities to spot dredge high nutrient areas of Duck Lake.

BOATING/JET SKIS/WAVE RUNNERS

Goal:

Reduce boat and personal watercraft impacts on Duck Lake

Issues:

- Boating and the use of personal watercraft are popular past times, but there are a number of safety, environmental and quality of life issues that are of concern such as excessive speed and noise, lack of boating courtesy, water quality impacts and importing of exotic species.

Suggested Actions:

1. Education

a. Provide public education on perceived problems of boaters, speed limit, courtesy rules and boating setbacks, as well as the required safe boating classes for all personal watercraft users.

b. Provide information on safe and proper fuel storage of boats, slips, etc. Include information on what to do in a spill.

c. Develop a coordinated appreciation/education program that includes: courtesy rules/signs, flyers distributed to shoreline property owners, public service announcements, etc.

d. Examine distributing NYS Boaters Guide.

e. Develop and continue education to prevent spread of invasive exotic species into Duck Lake from boaters.

2. Assessment

a. Explore options and public opinion of motorized watercraft.

3. Funding

a. Search for funding to conduct education for boaters.

b. Search for funding to conduct research on boating.

4. Regulation

a. Work with law enforcement to increase enforcement of existing navigation laws locally.

FISHERIES

Goal:

Maintain a healthy and diverse fishery in Duck Lake.

Issue:

- It is important to maintain a healthy and diverse fishery in Duck Lake.

Suggested Actions:

1. Assessment

a. Determine water quality, including phosphorus level, dissolved oxygen and chlorophyll in Duck Lake and the effect it has on aquatic vegetation and fish.

2. Miscellaneous

a. Identify areas of Duck Lake where keeping woody debris, stumps, and logs imbedded in the shallow water is feasible. This will provide a shaded area and serve as habitat for bait fish, birds and other animals.

b. Request that the New York State Department of Environmental Conservation contact the Duck Lake Association before any stocking is conducted to discuss why stocking is being conducted and get their input.

INVASIVE EXOTIC SPECIES

Goal:

Contain or reduce current populations of invasive exotic species and prevent the introduction of new invasive exotic species in the watershed.

Issues:

- Invasive exotic species have been found in Duck Lake and its watershed.
- Many invasive exotic species such as zebra mussels threaten Duck Lake and its watershed.
- Invasive exotic species can have an economic, ecologic and aesthetic impact on Duck Lake and its watershed.

Suggested Actions:

1. Education

a. Develop and continue educational programs to inform lake users and homeowners about the spread and characteristics of invasive exotic species.

b. Teach volunteers to identify invasive exotic species and map them.

c. Continue educational programs to prevent the spread of exotic species into Duck Lake and its watershed.

2. Assessment

a. Initiate a regular inventory and monitoring program for exotic, introduced and invasive species in the lake and watershed.

3. Funding

a. Search for funding to conduct inventory, monitoring and control programs for invasive exotic species.

b. Search for funding to conduct education on invasive exotic species.

4. Miscellaneous

a. Utilize expertise to monitor and control invasive species before they become established.

b. With Cayuga County WQMA or other agency, develop watchlist and list of infestations of nearby water bodies so boat, jet ski, canoe, etc. owners know what to look for.

LAKE LEVEL

Goal:

Protect Duck Lake and maintain a proper lake level.

Issues:

- High and low water levels can impact fisheries, wildlife habitat, navigation, and recreation as well as lakeshore residences.
- Have changes in the Duck Lake watershed and areas nearby affected the hydrology and watershed of Duck Lake?

Suggested Actions:

1. Assessment

a. Conduct a study to confirm the Duck Lake Watershed.

b. Conduct a hydrologic study of Duck Lake.

c. Examine getting an official lake level gauge for Duck Lake.

d. Create GIS watershed maps that will assist with lake level issues.

2. Funding

a. Search for funding for the hydrologic study.

b. Search for funding to confirm the Duck Lake watershed.

c. Search for funding to install an official lake gauge.

d. Search for funding to conduct education on lake level and flooding issues.

LAKE WATER DIVERSIONS

Goal:

Protect Duck Lake water quality and quantity from diversions.

Issue:

- Diversions of water from Duck Lake may have a negative impact on its water quality and quantity.

Suggested Actions:

1. Assessment

a. Conduct a hydrologic study of Duck Lake.

2. Regulation

a. Examine passing laws to prevent diversions from Duck Lake.

3. Miscellaneous

a. Request that any water diversions in, near or upstream of the Duck Lake Watershed be subject to a formal public comment process, especially those that require local, state and federal permits.

MONITORING

Goal:

Continue and expand monitoring of Duck Lake.

Issues:

- Reliable long term information on water quality, problem areas, and use impairment is needed to manage Duck Lake and its surrounding watershed.

- Data can be used to gain insight into the present condition of Duck Lake compared to historic data, and can be used to determine whether water quality conditions are improving, degrading, or stable.

- Data can also serve as a baseline for comparing future trends and examining the effect of changing land and lake use patterns and watershed activities.

- Data from monitoring can identify or confirm areas of concern within the watershed and set priorities for implementing best management practices (BMPs).

Suggested Actions

1. Assessment

a. Continue monitoring Duck Lake through the Citizens Lake Assessment Program (CSLAP). Examine expanding this monitoring program.

b. Conduct other water quality testing including coliform testing, etc.

c. Conduct testing on sediment samples to pinpoint high phosphorus sediment areas.

2. Funding

a. Continue to utilize the funding from the Finger Lakes-Lake Ontario Watershed Protection Alliance (FL-LOWPA) program to continue the Citizens Lake Assessment Program (CSLAP).

b. Seek funding for other water quality testing.

c. Search for funding to test sediment samples to pinpoint high phosphorus sediment areas.

NUTRIENTS

Goal:

Reduce the introduction of nutrients and their effect on Duck Lake.

Issue:

- Duck Lake is a eutrophic lake. Any addition of nutrients should be avoided.

Suggested Actions:

1. Education

a. Educate homeowners and residents how to reduce the amount of nutrients that enter Duck Lake. Topics could include proper lawn maintenance, pet waste, yard waste management, etc.

b. Educate residents utilizing materials from the P-Project.

2. Assessment

a. Continue monitoring Duck Lake through the CSLAP program. Examine expanding this monitoring program.

b. Conduct testing on sediment samples to pinpoint high phosphorus sediment areas.

3. Funding

a. Search for funding for education on nutrients.

b. Search for funding to expand the P-Project to Duck Lake.

c. Search for funding to continue and possibly expand the monitoring of Duck Lake.

d. Search for funding to test sediment samples to pinpoint high phosphorus sediment areas.

4. Miscellaneous

a. Recommend the use of low or no phosphorus fertilizer.

b. Examine dredging and explore funding opportunities to dredge high nutrient areas of Duck Lake.

c. Examine the process to upgrade Duck Lake to a Class B or Class A waterbody.

PETROLEUM STORAGE AND SPILLS

Goal:

Protect Duck Lake and its watershed from petroleum storage and spills.

Issues:

- Improper use or storage of petroleum can impact water quality.
- Spills of petroleum can impact water quality.

Suggested Actions:

1. Education

a. Provide education on petroleum spill prevention and what to do in the event of a spill or leak.

b. Educate owners of underground storage tanks around Duck Lake on the danger of tank rupture due to floatation that could occur during a flood event. Examine ways to encourage and fund their removal.

c. Educate boaters on proper fueling.

2. Assessment

a. Survey fire departments and other agencies to verify who has materials for an immediate response to a petroleum spill (spill response kits). Examine funding options for where spill response kits are lacking.

b. Obtain and modify the NYS Department of Environmental Conservation database on bulk petroleum storage facilities to develop a watershed database. On an annual basis, obtain updates from the NYSDEC.

3. Funding

a. Search for funding for containment vessels or converting to an aboveground tank.

b. Search for funding for education on petroleum storage and spills.

4. Miscellaneous

a. Create a local spills database.

b. WQMA or designated county agency develop, update and provide on an annual basis a listing of who to contact on water quality issues, including who to call to report spills.

c. Program development for petroleum storage tank owners to implement BMPS, replace or remove underground storage tanks.

PRIVATE WASTEWATER TREATMENT

Goal:

Protect public health and reduce the impacts of nutrients and pathogens from on-site household wastewater treatment systems on surface and groundwater.

Issues:

- Inadequate and malfunctioning septic systems have the potential to introduce nutrients and pathogens to ground and surface waters.

- Shoreline residences can present special challenges to the proper operation of septic systems due to soils, slopes and small lot sizes.

- Conversion of homes from seasonal to year round without upgrading septic systems can lead to system failure.

Suggested Actions:

1. Education

a. Distribute educational literature that provides examples of good septic system and holding tank use and maintenance practices.

b. Distribute a septic maintenance log sheet for homeowners.

2. Funding

a. Explore federal or state assistance to replace or upgrade septic systems of people with limited incomes.

b. Explore what grants and loans are available for water and waste disposal systems for rural communities.

PUBLIC ACCESS

Goal:

To encourage public access while minimizing its environmental impact within Duck Lake watershed.

Issues:

- There is limited public access because all of the shoreline around the lake is privately owned.

- Protect the lake from the negative impacts of public access such as introduction of invasive exotic species.

Suggested Actions:

1. Education

a. Encourage low impact use such as hiking, canoeing and fishing instead of motorized use.

b. Develop and continue education to prevent spread of invasive exotic species into Duck Lake.

2. Funding

a. Search for funding to conduct education on the spread of invasive exotic species into Duck Lake.

SHORELINE EROSION

Goal:

Reduce the impacts of shoreline erosion on Duck Lake.

Issue:

- Impacts of shoreline erosion are many: decreased property values, excessive nutrients, thermal pollution, release of nutrients, loss of underwater habitat, and stressed fish and wildlife populations.

Suggested Actions:

1. Education

a. Promote and distribute existing shoreline erosion control guidebooks and information sheets with specific information on plantings that will help reduce shoreline erosion.

b. Conduct Lakeshore Homeowner Workshops on shoreline erosion, vegetative options, yard waste management, etc.

2. Miscellaneous

a. Provide assistance to design and implement preventative measures for shoreline erosion.

SPRING QUALITY

Goal:

Protect the groundwater which contributes the majority of the water to Duck Lake.

Issues:

- Groundwater contributes the majority of the water to Duck Lake and it is unknown where this groundwater comes from or its quality.
- The quality of Duck Lake is only as good as the groundwater entering it.

Suggested Actions:

1. **Education**
   a. Educate people how to protect the groundwater.
2. **Assessment**
   a. Conduct a research study to determine where the water entering Duck Lake comes from.
   b. Conduct a research study to establish annual groundwater discharge to Duck Lake.
   c. Sample and test groundwater entering Duck Lake.
3. **Funding**
   a. Search for funding to conduct groundwater studies.

STORAGE AND SPILLS OF HAZARDOUS MATERIALS

Goal: Protect Duck Lake and its watershed from hazardous materials storage and spills.

Issues:

- Improper use or storage of hazardous materials can impact water quality.
- Spills of hazardous materials can impact water quality.

Suggested Actions:

1. Education

a. Distribute hazardous materials spills information to various community groups, fire department, citizens, and Town of Conquest which includes staff in charge and who has appropriate jurisdiction in emergency situations.

b. Use existing educational materials to describe hazardous material storage issues, threat to public health and water quality, and the need to ensure that materials are stored or cleaned up properly.

2. Assessment

a. Survey fire departments and other agencies to verify who has materials for an immediate response to a hazardous material (spill response kits). Examine funding options for where spill response kits are lacking.

3. Funding

a. Search for funding for hazardous materials education.

b. Search for funding for household hazardous waste and pesticide collection events.

4. Miscellaneous

a. Create a local spills database.

b. Continue household hazardous waste and other collection events in Cayuga County.

c. WQMA or designated county agency develop, update and provide on an annual basis a listing of who to contact on water quality issues, including who to call to report spills.

WATERBORNE BACTERIA

Goal:

Reduce waterborne bacteria levels in Duck Lake and protect human health.

Issues:

- Waterborne bacteria can have potential health effects on humans.
- At times, Duck Lake water has exceeded the New York State guidance for fecal coliform for bathing beaches.
- Suspected culprits are geese and wildlife.

Suggested Actions:

1. **Education**
    a. Educate people how to reduce geese population on the lake and their property.
2. **Assessment**
    a. Implement a monitoring program of Duck Lake.
3. **Funding**
    a. Explore funding to compile and maintain WQMA database.
    b. Explore funding to conduct a monitoring program of Duck Lake.

YARD, GARDEN AND HOUSEHOLD CHEMICALS

Goal:

Advocate responsible yard, garden, and household chemical use as well as proper storage and waste disposal to minimize impacts on ground and surface waters and wastewater treatment systems.

Issues:

- Many products used around the home, garden and garage contain potentially dangerous chemicals that, if improperly used, stored or disposed of, can contribute to water pollution and adversely affect well water and septic systems.

- Improper and overuse of turfgrass and other chemicals can affect water quality.

Suggested Actions:

1. Education

a. Provide information on proper use and disposal of household chemicals.

b. Examine ways to change people's attitudes about the "perfect lawn" through education and peer pressure.

c. Provide "Home*A*Syst" type workshops to help homeowners prevent groundwater contamination, including wells, well maintenance, septic system use, yard waste, composting, etc.

d. Provide integrated pest management education for homeowners and residents.

2. Assessment

a. Explore ways to continue County household hazardous waste collection event offerings and explore ways to make it available on a year round basis.

b. Continue to find ways to reduce hazardous material releases in the watershed.

3. Funding

a. Search for funding for educational programs on yard, garden and household chemicals.

b. Search for funding to provide household hazardous waste and pesticide collection days.

4. Miscellaneous

a. Continue to provide household hazardous waste and pesticide collection events in Cayuga County