2003 SUMMARY REPORT
of
DEEP LAKE

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Deep Lake, located in Lake Villa Township and the Village of Lake Villa, is a glacial lake. Settlement of the land around the lake began in the early 1800's, and the lake was used by summer residents through the 1930's, when summer cottages were replaced by year-round homes. The lake has a surface area of 225.7 acres and a mean depth of 17.5 feet. It is used by the general public for swimming, boating and fishing.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature and water clarity were measured each month from May-September 2003. Total phosphorus and total suspended solids concentrations were very low, and water clarity was high throughout the summer. The concentrations of many parameters in Deep Lake have changed only slightly in the past 5-10 years. This is exceptional, and is a testimony, due to the excellent water quality in both Cedar (which drains into Deep Lake) and Deep Lake, to efforts by the lake homeowners and the Village of Lake Villa to limit activities that might threaten water quality.

Eurasian watermilfoil (EWM) dominated the plant community in 2003. However, twenty-five different plant species were found in Deep Lake over the course of the summer. This very healthy plant community provided Deep Lake with excellent fish habitat and kept water clarity high. There is currently a herbicide program in place to remove EWM and several native plant species. This program has been successful over the years in reducing EWM density in specific areas for a short period of time during the summer months. Three Illinois endangered plant species occur in Deep Lake: white stem pondweed (*Potamogeton praelongus*), fern leaf pondweed (*Potamogeton robbinsii*) and water marigold (*Bidens beckii*). Deep Lake and Cedar Lake are the only two lakes in the state with records of water marigold. These plant species should be protected at all costs from herbicide application or disturbance by motor boats.

Although 48% of the Deep Lake shoreline is residentially developed, the shoreline is dominated by wetland and woodland. These shoreline types should be maintained and buffer strips should be added to residential areas. Although very little erosion was occurring around Deep Lake, buckthorn, honeysuckle, Canada thistle, common reed and reed canary grass were present along 60% of the shoreline. These are exotic plant species that out-compete native vegetation and provide poor habitat for wildlife.

A relatively large number of waterfowl and bird species were observed during the summer, despite the residential development of approximately half the shoreline on Deep Lake. Deep Lake also has five Illinois threatened and endangered fish species present. Threatened: Banded killifish (*Fundulus diaphanus*) and Blackchin shiner (*Notropis heterodon*). Endangered: Blacknose shiner (*Notropis heterolepis*), Pugnose shiner (*Notropis anogenus*) and Iowa darter (*Etheostoma exile*). It is very rare and exceptional that all five of these species occur in one lake. These fish are very sensitive to water quality degradation and require clear water and dense plant beds to thrive. Currently, Deep Lake is providing these conditions, but much care should be taken to ensure that a high quality habitat remains intact in future years to support these fish populations.

LAKE IDENTIFICATION AND LOCATION

Deep Lake is located near the northeast corner of Illinois State Route 132 and Illinois State Route 83 in the Village of Lake Villa, Lake Villa Township (T 46N, R 10E, S 33, 34). A large part of the eastern shoreline is located in unincorporated Lake County and remains on septic systems, while the incorporated areas of the lake are on the Lake Villa sewer system. Deep Lake has a surface area of 225.7 acres (GIS calculation) and mean and maximum depths of 17.5 feet and 48.0 feet, respectively. It has a volume of 3,955 acre-feet and a shoreline length of 3.44 miles (Figure 1, Appendix A). The watershed of Deep Lake encompasses approximately 1,472 acres, draining Cedar Lake to the west, the downtown Lake Villa business district to the south, and unincorporated residential areas east of the lake. Cedar Lake drainage and stormwater from the downtown Lake Villa area are directed into three stormwater pipes, which enter Deep Lake through Lake Villa Creek on the southwest shore. Historically, the Lake Villa Waste Water Treatment Plant discharged raw sewage into Lake Villa Creek during overflows at the plant. This was rectified, but, until recently, there were still sanitary sewer-stormwater cross connections emptying into the creek. Water samples taken from Lake Villa Creek in 1992 and 1993 indicate that nitrogen, ammonia, phosphorus and solids were elevated in the creek, and that the concentration of these parameters was highly dependent on rainfall amounts. 1992 was a much drier year than 1993 (nearly six inches less rain from May-August) and concentrations of the above parameters were 2-15 times higher than in 1993, when water was flushed through the creek more frequently. The cross connections have since been upgraded and the creek is now fed only by stormwater. However, water quality in the creek and the condition of the creek bed continue to be a concern. In 1998, Hey & Associates, an environmental consulting firm, was hired to develop a concept plan for treating stormwater coming through Lake Villa Creek. A plan and report were created, but were not utilized at that time. However, with our help, and the help of several homeowners on the lake, Deep Lake Improvement Association used this concept plan to apply for a C2000 grant for the 2005 fiscal year. This grant would provide funds to remove buckthorn and other exotic plant species from around the creek and re-grade the creek bed to create a wetland buffer on either side. The Village of Lake Villa has agreed to help with tree clearing and Lake Villa Township has agreed to help with re-grading work. Volunteers from the Deep Lake Improvement Association would be responsible for planting and maintaining the wetland areas, as well as collecting water samples from the creek for the next several years. The grant application was approved and rated by the Fox River Ecosystem Partnership for the Illinois Environmental Protection Agency (IEPA), who will make a final decision on grant awards by September 2004.

Additional runoff into Deep Lake occurs through a creek on the north side of the lake that drains the Painted Lakes subdivision and areas to the east of Deep Lake Road. The creek originates from a detention pond surrounded by wetlands. A large storm grate allows water to exit the pond and flow through the creek at a high rate. As a result, the creek bed is exhibiting severe erosion (up to six feet high) along much of its length. This creek enters Deep Lake almost exactly where a large area of water marigold (a state endangered plant species) is growing. This plant only occurs in two lakes (Deep and Cedar) in the state and requires very clear water to grow and thrive. It is very important that the erosion along this creek bed be eliminated.

The watershed to lake surface area ratio of 6.5:1 is relatively small and may help prevent serious water quality problems that often accompany a larger watershed to lake ratio (Figure 2). According to the most recent land use survey of the Deep Lake watershed, conducted in 2000, residential areas make up a relatively large part of the watershed, with single family, multi-family and transportation (roads) encompassing 26.1% of the total area. However, non-developed areas such as wetlands, pubic & private open space and forest & grasslands also dominate a large part of the watershed (25.6% combined). The presence of a high amount of vegetated land likely contributes to the high quality of Deep Lake. Other land uses are listed in Table 1, Appendix A. Water exits Deep Lake and flows into Sun Lake via a creek from the northwest shore. The lake is located in the Sequoit Creek sub basin, within the Fox River watershed.

BRIEF HISTORY OF DEEP LAKE

Deep Lake is of glacial origin, created approximately 10,000 years ago during the last ice age. Settlement of the land around Deep Lake began in the early 1800's. Aaron Parker was the original owner of the now-residential land on the northeast side of the lake. He sold the land in 1857 to the Kerr family, who broke it up into 17 lots and sold them in 1909 for construction of summer cottages. Also in 1909, William Wilmington bought land on the south shore for the construction of an icehouse, where Glacier Park is now located. More land on the east shore was subdivided and sold by Pauly and Johnson in the 1920's. Prior to 1920, travel to Deep Lake was only by railroad and the nearest town was three miles away. The Deep Lake Improvement Association (DLIA) was formed in 1922 as a community organization that assumed the responsibility for problems around the lake associated with drainage, roads, increased auto traffic, overfishing and litter. The Association still exists today and operates on a $15,000 annual budget. By the early 1940's most of the cottages around Deep Lake were year-round homes, and around 1949 work began on a sewage treatment plant for Lake Villa. This replaced the seepage bed system and was supposed to end pollution to Deep Lake. Unfortunately, in the 1970's and early 1980's raw sewage was still being discharged to Deep Lake from the Lake Villa wastewater treatment plant. This, along with runoff from cattle farms along 2.8 miles of the shoreline, contributed nutrients to the lake. Large-scale management activities of the lake are controlled by the DLIA, Village of Lake Villa and various homeowner associations around the lake, and have been ongoing since the 1970's.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Detailed records of historical lake management techniques for Deep Lake are limited. As a result of agricultural runoff and raw sewage discharges, filamentous algae and excessive plant growth were concerns in the early 1970's. In 1971 the DLIA installed an aeration system with three diffusers in the deepest areas of the lake in an attempt to prevent stratification, increase the rate of organic decomposition and reduce algae

growth. It is not known how long these aerators operated, but they most likely did not cause any improvements in water quality. Herbicide applications were first proposed in 1972 but finances were a concern for the Association at the time. It is not known when the first herbicide treatment actually took place. In 1989, harvesting was conducted in front of Deep Lake Shores. Currently, access to Deep Lake is open to Lake Villa village residents through Glacier Park and to the general public through Jack and Lidia's Resort. Access to other beach areas (6^{th} Street and 1^{st} Street Beaches and Humphrie Memorial Park) is limited to DLIA members, while access to Ishnala Estates Beach, Hermitage Apartment Beach and Deep Lake Shores Park is limited to residents of those housing developments (Figure 3).

The lake's main uses are swimming, boating and fishing. Boat restrictions on the lake include a 10-horsepower motor limit for any boat launched at the Glacier Park launch. However, larger motors are allowed for residents living on the lake. Currently, the biggest management concerns expressed by the DLIA are low lake levels, plant growth, boat operation and point and nonpoint source runoff, including failing septic systems. The lake level is currently being debated, as some want to add boards to the spillway in order to store more water during the spring, while some believe that the lake should remain at its natural level. Conflicts between larger boat owners and those who would like to see the lake allow only minimal motorized boat operation are common in Lake County lakes. Overuse of a lake like Deep Lake by large boats could be detrimental to the lake ecosystem in future years. Boats help to spread Eurasian watermilfoil by fragmenting the plants and may also decrease water clarity by stirring up sediment in shallow areas. Heavy powerboat traffic will also reduce the likelihood that high quality wildlife will nest around or use the lake. This concern regarding powerboats operating on the lake could be addressed by increasing communication between lake users, educating lake users and/or removing the Lake Villa ordinance exemption to restrict horsepower on Deep Lake. Additionally, to prevent both power boats and smaller water craft from entering sensitive areas of the lake that contain threatened and endangered fish and plant species, "no wake" buoys should be deployed to mark the area 150 feet from the shoreline. Any knowledge of a leaking septic system should be reported to a Lake County Health Department sanitarian, who will go to the home in question and look for evidence of septic failure. If the septic system in that home is failing, the homeowner will be issued a notice of violation and ordered to have the system fixed. Homeowners with septic systems can also conduct their own dye tests on their systems to ensure that they are working properly.

Licensed beaches on Deep Lake (Hermitage Apartments and Jack and Lidia's Resort) were sampled every two weeks by us to test for the presence of high *E. coli*. *E. coli* bacteria is found virtually everywhere, but is in very high numbers in the feces of warm-blooded animals, including humans. While most strains of *E. coli* are not harmful, the bacteria may indicate the presence of other pathogens such as *Giardia*, which can cause serious illness in humans. In 2003, Jack and Lidia's Resort Beach was closed on August 12^{th} due to *E. coli* concentrations that exceeded 235 MPN/100 mL. These high counts can be caused by a number of things, including a large number of waterfowl, rain and high wind and wave events. The presence of a high density of waterfowl in the vicinity

of the beach area could cause problems because their feces contain *E. coli*. When these feces make their way into the water, they can cause high *E. coli* counts. Rain events can increase *E. coli* counts because runoff picks up *E. coli* that is washed into the lake. The beach closing at Jack and Lidia's does not appear to be rain-related and the high *E. coli* may have been linked to waterfowl, such as geese, in the area. Despite the high concentration on August 12th, *E. coli* contamination does not appear to be a serious problem for Deep Lake beaches, as this was the only violation during the summer of 2003.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples collected from Deep Lake were analyzed for a variety of water quality parameters (See Appendix B for methodology). Samples were collected at 3 foot and 42-43 foot depths (depending on site water depth) from the deep hole location in the lake (Figure 3). Deep Lake was thermally stratified from May-September. Thermal stratification occurs when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically becomes anoxic in nutrient-enriched lakes (dissolved oxygen (DO) = 0 mg/l) by mid-summer. This phenomenon is a natural occurrence and is not necessarily a bad thing if enough of the lake volume remains oxygenated. The surface waters of Deep Lake remained well oxygenated during the summer. Near surface DO concentrations did not fall below 5.0 mg/l (a level below which aquatic organisms can become stressed) at any time during the study period. For most of the summer at least 69% of the lake volume (the volume at 10 feet and above) had a dissolved oxygen concentration of at least 5.0 mg/l, and approximately 94% of the lake volume (the volume at 20 feet and above) was oxic (DO>1.0 mg/l). As a result, there was minimal threat to aquatic life in the lake, as most of the lake volume was inhabitable by fish and other aquatic organisms.

Phosphorus is a nutrient that can enter lakes through runoff or be released from lake sediment, and high levels of phosphorus typically cause algal blooms or produce high plant density. The 2003 average epilimnetic phosphorus concentration in Deep Lake was 0.024 mg/l, while the average hypolimnetic phosphorus concentration was 0.158 mg/l (Table 2, Appendix A). Although the hypolimnetic concentration was close to the county median (0.186 mg/l), the epilimnetic concentration was over two times lower than the median (0.059 mg/l). The hypolimnetic phosphorus concentration in 2003 was over six times higher than the epilimnetic concentration. This is typical in a stratified, nutrient-enriched lake, especially if stratification begins early in the summer like it did in Deep Lake. During stratification, oxygen is depleted in the hypolimnion, triggering chemical reactions at the sediment surface. These reactions result in the release of phosphorus from the sediment into the water column, and are known as internal phosphorus loading. Typically, the hypolimnion is thermally isolated from the epilimnion during the summer and phosphorus builds up in the bottom waters, reaching the sunlit surface waters only during fall turnover. At this time, the hypolimnetic phosphorus is distributed throughout the water column. If the lake volume is large, the TP concentration will be diluted. However, even after dilution, the increase in TP to the epilimnion can produce late season algae blooms. Since complete turnover had not yet occurred in Deep Lake at the time of September sampling, TP levels in the upper water were still very low and algae density had not increased.

The average epilimnetic phosphorus concentration in 1998 (0.023 mg/l) was nearly identical to the 2003 concentration, and the 1998 average hypolimnetic concentration (0.225 mg/l) was actually much higher than in 2003 (Table 2, Appendix A). The similarity in the average epilimnetic TP concentrations between the two years is a testimony to the excellent water quality of Deep Lake (and Cedar Lake, which flows into Deep Lake) and to efforts by homeowners to prevent activities that might threaten the water quality of Deep Lake. It is also noteworthy that the 1992 epilimnetic TP concentration was 0.021 mg/l and the hypolimnetic TP concentration was 0.136 mg/l (Table 3, Appendix A). It is very unusual for a lake in Lake County, where residential and commercial development is so prevalent and has had detrimental impacts on many lakes, to maintain its epilimnetic and hypolimnetic TP levels over the course of 11 years. The small watershed and deep morphometry of Deep Lake, as well as the excellent water quality of Cedar Lake promotes this stability. Since 1990, the epilimnetic TP of Cedar Lake has changed very little and is very similar to Deep Lake's epilimnetic TP concentration (Table 4, Appendix A). However, as mentioned above, efforts to protect the lake ecosystem as much as possible by controlling large-scale management of the plant community and, to some degree, protecting the lake from over use is an important factor in maintaining nutrient and suspended solids concentrations.

Total suspended solids (TSS) is a measure of the amount of suspended material, such as algae or sediment, in the water column. High TSS values are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem, including the plant and fish communities. A large amount of material in the water column can inhibit successful predation by sight-feeding fish, such as bass and pike, or settle out and smother fish eggs. High turbidity caused by sediment or algae can shade out native aquatic plants, resulting in their reduction or disappearance from the littoral zone. This eliminates the benefits provided by plants, such as habitat for many fish species and stabilization of the lake bottom. The average 2003 epilimnetic TSS concentration in Deep Lake (less than 2.4 mg/l) was one-third the median value for Lake County Lakes (7.5 mg/l). The low TSS values resulted in high water clarity, as evidenced by higher than average Secchi depth measurements that coincided with low TSS concentrations (Figure 4). The average epilimnetic TSS concentration (less than 2.4 mg/l) has decreased by 8% when compared to 1998 (2.6 mg/l), and was only slightly higher than the average epilimnetic TSS concentration in Cedar Lake in 2003 (2.2 mg/l) (Tables 2 & 4, Appendix A). This, again, indicates that Deep Lake is very stable.

As a result of the low TP and TSS concentrations throughout the summer, Secchi depth (water clarity) of Deep Lake was higher than the county median (3.41 feet) every month during the summer of 2003, and reached a maximum of 17.77 feet in June. This good

water clarity allowed a healthy and diverse plant community to thrive in Deep Lake and helped to prevent algae dominance. Secchi depth measurements were collected and recorded by volunteer lake monitors (VLMs) in 1986, 1987, 1988, 1990, 2000 and 2002, and our past studies were conducted in 1989, 1992, 1993 and 1998. Average Secchi depths in the late 1980's were very low relative to the more recent past when Secchi depth ranged between 8 and 12 feet (Figure 5). Between 1988 and 1989, Secchi depth more than doubled. Without historical data, an accurate explanation of why clarity improved cannot be determined. Differences in Secchi depth from year to year can result from differences in rainfall amounts, external phosphorus loading, water temperature (which affects algae growth) and plant density.

Having accurate and consistent VLMP data is very important, especially for a lake like Deep Lake. The water quality is currently very good and any changes in water clarity and quality that may occur from changes in the watershed in the future can be tracked over time and can give early warning of problems in the watershed. We will probably not perform a full water quality study on Deep Lake again until 2008. Having a quality VLMP in place in the meantime can help provide valuable information to lake managers who may be able to take action on certain issues before they become irreversible problems. VLMP data can also be used to give accurate historical data about the lake, water quality and management activities so that variations such as those mentioned above can be more readily and accurately explained.

Conductivity is the measure of different chemical ions in solution. As the concentration of these ions increases, conductivity increases. The conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, evaporation and bacterial activity. Conductivity has been shown to be highly correlated (in urban areas) with chloride ions found in road salt mixtures. Water bodies most subject to the impacts of road salts are streams, wetlands or lakes draining major roadways and large parking lots. Average 2003 epilimnetic conductivity (0.9520 mS/cm) in Deep Lake had increased by 17% since sampling in 1998 when the epilimnetic average was 0.8112 mS/cm. The 2003 levels were also much higher than the county median (0.7503 mS/cm) throughout the summer. Epilimnetic total dissolved solids (TDS) concentrations, which have also been shown to be correlated with conductivity, were also above the county median (451 mg/l) during every month of the study (Table 2, Appendix A). Additionally, the average epilimnetic conductivity in Cedar Lake in 2003 was 60% lower than the 2003 conductivity in Deep Lake, and the average TDS concentration in Cedar Lake was 50% lower than in Deep Lake in 2003 (Table 4, Appendix A). The higher percentage of impervious surfaces in the Deep Lake watershed, as compared to the Cedar Lake watershed is likely the reason for this difference. The watershed of Deep Lake includes the Cedar Lake watershed. However, land use maps indicate that approximately 53.2 additional acres of impervious land use plots (Office, Multi-family, Retail Commercial, Transportation and Single family) exist in the Deep Lake watershed that does not include the Cedar Lake watershed (Figure 6). Much of this additional impervious surface is located in the downtown area of Lake Villa and to the northeast of the watershed, which drain directly to Deep Lake.

Conductivity changes can occur seasonally and even with depth, but over the long term, increased conductivity can be a good indicator of potential watershed or lake problems and an increase in pollutants entering the lake if the increasing trend is noted. High conductivity (which often indicates an increase in sodium or potassium chloride) can eventually change the plant and algae community, as more salt tolerant plants and algae take over. Sodium, potassium and chloride ions can bind substances in the sediment, preventing uptake by plants and reducing native plant densities. Additionally, juvenile aquatic organisms may be more susceptible to high chloride concentrations. The increase in conductivity levels in Deep Lake is most likely the result of increased development in the watershed and winter salting of the three large roads surrounding the lake (IL Rt. 83, IL Rt. 132 and Deep Lake Rd.). The high conductivity levels are cause for concern, butthere may not be much that can be done about it. Non-point runoff picks up road salt and enters the lake during rain events. It is unlikely that any control on the amount of road salt dispersed along major roadways each winter will occur without policy changes in quantity or type of de-icer by the Illinois Department of Transportation, Lake Villa Township and the Village of Lake Villa road officials.

Typically, lakes are either phosphorus (P) or nitrogen (N) limited. This means that one of these nutrients is in short supply relative to the other and that any addition of phosphorus or nitrogen to the lake might result in an increase of plant or algal growth. Other resources necessary for plant and algae growth include light or carbon, but these are typically not limiting. Most lakes in Lake County are phosphorus limited, but to compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting. Ratios greater than or equal to 15:1 indicate that phosphorus is limiting. Ratios greater than 10:1, but less than 15:1 indicate that there are enough of both nutrients to facilitate excess algal or plant growth. Deep Lake had a 2003 average TN:TP ratio of 39:1. This indicates that the lake is highly phosphorus limited and that a small increase in phosphorus concentrations in the epilimnion could result in algae blooms in the future. Although the average epilimnetic total Kjeldahl nitrogen (TKN) concentration was lower than the majority of the lakes in Lake County, high nitrogen concentrations relative to phosphorus concentrations resulted in this high ratio. In highly nutrient-enriched lakes, phosphorus levels have often reached the point where either very large increases or very large decreases in phosphorus would be necessary to trigger changes in algae density. On the other hand, less enriched lakes, such as Deep Lake, are typically more sensitive to increases or decreases in phosphorus, and algae could become a problem with relatively small increases in TP. The 1998 TN:TP ratio was 41:1, further indicating that very little change has occurred in the nutrient concentrations in the lake over the past five years. This is exceptional, and care should be taken to ensure that the nutrient concentrations (especially phosphorus) continue to remain low.

Phosphorus levels can also be used to indicate the trophic state (productivity level) of a lake. The Trophic State Index (TSI) uses phosphorus concentrations, chlorophyll *a* (algae biomass) levels and Secchi depth to classify and compare lake trophic states using just one value. The TSI is set up so that an increase in phosphorus concentration is related to an increase in algal biomass and a corresponding decrease in Secchi depth. A moderate TSI value (TSI ≥40<50) indicates mesotrophic conditions, typically characterized by relatively low nutrient concentrations, low algae biomass, adequate DO concentrations and relatively good water clarity. High TSI values indicate eutrophic (TSI ≥ 50<70) to hypereutrophic (TSI ≥70) lake conditions, typically characterized by high nutrient concentrations, high algal biomass, low DO levels, a rough fish population, and low water clarity. Deep Lake had an average phosphorus TSI (TSIp) value of 50, indicating slightly eutrophic conditions. Although the lake falls into the eutrophic category, it does not exhibit many of the characteristics of eutrophic lakes mentioned above. This is likely the result of a diverse and healthy plant community. Plants compete with algae for resources and prevent sediment resuspension, both of which help reduce TP levels in the water column. When the Secchi depth TSI (TSIsd) is calculated (40.7), Deep Lake falls into the slightly mesotrophic category, indicating a mostly unenriched system with excellent water quality for Lake County. Water quality of Deep Lake is well above average and the lake ranked 14th out of 130 lakes studied in Lake County since 1999. Most man-made lakes in this geographical area fall into the eutrophic and hypereutrophic categories, while many of the deeper, glacial lakes rank higher (Table 5, Appendix A).

Most of the water quality parameters just discussed can be used to analyze the water quality of Deep Lake based on use impairment indices established by the Illinois Environmental Protection Agency (IEPA). According to this index, Deep Lake provides *Full* support of aquatic life and swimming, and *Partial* support of recreational activities (such as boating) as a result of the high percent plant coverage. The lake provides *Full* overall use.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant surveys were conducted every month for the duration of the study (See Appendix B for methodology). Shoreline plants of interest were also recorded. However, no quantitative surveys were made of these shoreline plant species and these data are purely observational. Light level was measured at two-foot intervals from the water surface to the lake bottom. When light intensity falls below 1% of the level at the water surface, plants are no longer able to grow. Using this information, as well as a bathymetric map, the lake area that has the potential to support aquatic plant growth can be determined. Depth of percent light intensity increased from May to June and then decreased throughout the rest of the summer as water clarity decreased (Appendix C). Based on 1% light level in June, Deep Lake could have supported plants over approximately 65**%** of the lake bottom. Additionally, in 2003 GPS satellite readings were taken in late June to determine the area of plant coverage based on visual observation of those plants growing to within approximately two feet of the water surface. Based on GPS data, approximately 53% of the lake surface area was covered with plants growing near the water surface (Figure 7). Twenty-five different plant species were present in Deep Lake during the summer of 2003, including three state endangered species (water marigold, fern leaf pondweed and white stem pondweed) and

one species that is considered rare in Illinois (clasping leaf pondweed) (Tables 6 & 7). Only two of the 25 species (Eurasian watermilfoil (EWM) and curly leaf pondweed) are exotic species. Although EWM dominates most areas of the lake, Deep Lake has an exceptional plant community with regard to diversity of species and types of species found. This very healthy plant community provided Deep Lake with excellent fish habitat and kept water clarity high by reducing sediment resuspension in the littoral zone and competing with planktonic algae for resources.

As mentioned above, EWM was the dominant plant in the lake in 2003, occurring at 94% of the plant sampling sites throughout the summer. This exotic plant species invaded Deep Lake prior to 1990 and has been a dominant species in the plant community. In 1998, the milfoil weevil (*Euhrychiopsis lecontei*) was first observed in the lake. This very tiny insect serves as a biological control for EWM, and when present in large enough numbers, can cause significant damage to milfoil beds. In 1998, the weevil had caused minimal damage to the EWM in Deep Lake. No adult weevils were observed but weevil damaged was noted during 2003. The reasons for weevil success or failure in controlling EWM are still being researched and there are no definite answers at this time. Research has shown that approximately 1-2 weevils per stem are needed in order to see significant damage and decline of a EWM bed. Weevil density in Deep Lake has not been quantitatively analyzed, but qualitative surveys suggest that weevil density is not at this level.

Table 6. Aquatic and shoreline plants on Deep Lake, May-September 2003.

<u>Aquatic Plants</u>	
Water Marigold*	*Bidens beckii*
Chara	*Chara* sp.
Coontail	*Ceratophyllum demersum*
Elodea	*Elodea canadensis*
Water Stargrass	*Heteranthera dubia*
Duckweed	*Lemna minor*
Northern Watermilfoil	*Myriophyllum sibiricum*
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Southern Naiad	*Najas guadalupensis*
Slender Naiad	*Najas flexilis*
White Water Lily	*Nymphaea tuberosa*
Largeleaf Pondweed	*Potamogeton amplifolius*
Curlyleaf Pondweed^	*Potamogeton crispus*
Illinois Pondweed	*Potamogeton illinoensis*
Floatingleaf Pondweed	*Potamogeton natans*
American Pondweed	*Potamogeton nodosus*
Whitestem Pondweed*	*Potamogeton praelongus*

***Endangered in Illinois**
^Exotic plant or tree species

Table 6. Aquatic and shoreline plants on Deep Lake, May-September 2003 (cont'd).

<u>*Aquatic Plants*</u>	
Small Pondweed	***Potamogeton pusillus***
Claspingleaf Pondweed	*Potamogeton richarsonii*
Fernleaf Pondweed*	*Potamogeton robbinsii*
Flatstem Pondweed	*Potamogeton zosterifomis*
White Water Crowsfoot	*Ranunculus longirostris*
Sago Pondweed	*Stuckenia pectinatus*
Eel Grass	*Vallisneria americana*
Common Bladderwort	*Utricularia vulgaris*
<u>*Shoreline Plants*</u>	
Canada Thistle^	*Cirsium arvense*
Jewelweed	*Impatiens pallida*
Blue Flag Iris	*Iris* sp.
Common Reed^	*Phragmites australis*
Reed Canary Grass^	*Phalaris arundinacea*
Pickerel Weed	*Pontederia cordata*
Softstem Bulrush	*Scirpus validus*
Common Cattail	*Typha latifolia*
Wild Grape	*Vitis* sp.
<u>*Trees/Shrubs*</u>	
Silver Maple	*Acer saccharinum*
Honey Locust	*Gelditsia triacanthos*
Honeysuckle^	*Lonicera* sp.
Cottonwood	*Populus deltoids*
Burr Oak	*Quercus macrocarpa*
Common Buckthorn^	*Rhamnus cathartica*
Staghorn Sumac	*Rhus typhina*
Sandbar Willow	*Salix interior*
Elm	*Ulmus* sp.

*Endangered in Illinois
^Exotic plant or tree species

One of the main concerns of Deep Lake residents is aquatic plant density in the lake, especially that of EWM. Based on Spray Reports from Marine Biochemists, in June and August 1998, EWM, curlyleaf pondweed and filamentous algae were treated with liquid 2,4-D, Reward®, Aquathol-K® and Cutrine Plus® along Ishnala Estates and any property whose owners had given written permission. In 1999, the same chemicals were used in many areas, including the northeast end of the lake (6th Street Beach and private residences), Jack & Lidia's, Humphrie's Park, 1st Street Beach, Deep Lake Shores, Glacier Park and all along Ishnala Estates. A small area in the middle of the lake on the northern end was also treated. However, notes indicated that besides EWM and curlyleaf, some native pondweeds were also target species. In 2000, it appears that herbicide application was stepped up, with several native pondweeds, coontail and eel grass added to the target plant list. Granular 2,4-D was recommended for EWM control and was used on a 10-acre test plot on the north end of the lake in September, while liquid 2,4-D and Reward® were used in June and August, respectively. From 2001-2003, Reward® has been used at all sites (typically ranging from 14-20 acres for each treatment) for its non-selective characteristics, and granular 2,4-D has been used where requested (6-10 acres). Once again, several beneficial native plant species were targeted for treatment in June and late July/early August.

While limited spot treatment of plants in Deep Lake with 2,4-D (Navigate®) and Reward® does not appear to be resulting in a negative change in water quality, it is very important that herbicide treatment remains selective for EWM. One of the main reasons that the water quality of Deep Lake is so good is its diverse plant community. Although EWM is the dominant plant in the lake and has reached nuisance levels in some areas, many other plant species that are integral to the quality of the lake ecosystem are also present. These native plants provide fish habitat, stabilize bottom sediment and compete with algae for resources, resulting in clear water and a healthy fish population. Removing too many native plants will take away these benefits and could result in a decline in water clarity, an increase of planktonic and filamentous algae and may impact threatened and endangered fish species. Limited herbicide treatment to shoreline and beach areas should be a practice that is maintained, not expanded. According to GPS data, approximately 110 acres of Deep Lake remain open water, available for recreational boating activities. Additionally it is recommended that homeowners associations request that 2,4-D (i.e., Navigate®) be used over Reward® for treatment of most areas. Reward® is a non-selective herbicide that affects all plants. Three state endangered plant species were found in Deep Lake in 2003. Water marigold (endangered) was found along the north-northeast end of the lake, fernleaf pondweed (endangered) was found near the launch at Glacier Park and whitestem pondweed (endangered) was found throughout the lake. Claspingleaf pondweed, a rare species in Illinois was found along the north end of the lake, as well. These plants should be protected against herbicide treatment. 2,4-D is a selective herbicide that does not normally affect pondweeds, eel grass or naiads. Therefore, it could be applied in areas with a mix of EWM and whitestem pondweed. Additionally, no herbicides should be applied in the areas where water marigold was observed (Figure 7). The presence of this plant in Deep Lake is exceptional, as it only occurs in Cedar and Deep Lakes. Water marigold is intolerant of poor water conditions and should be protected as an important part of the Deep Lake ecosystem.

Of the eighteen emergent plant and trees species observed along the shoreline of Deep Lake, five (Canada thistle, common reed, reed canary grass, honeysuckle and buckthorn) are invasive species that do not provide ideal wildlife habitat and have the potential to dominate the emergent plant community. Their removal is always recommended.

FQI (Floristic Quality Index) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts (Nichols, 1999). Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2003 Lake County lakes is 14.7. Deep Lake has an FQI of 33.9, the 3rd highest of all county lakes studied since 2000. Despite the dominance by EWM, the high diversity of plant species places Deep Lake well above the average lake, by Lake County standards.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted at Deep Lake on August 21, 2003. The shoreline was assessed for a variety of criteria (See Appendix B for methods), and based on this assessment, several important generalizations could be made. Approximately 48% of Deep Lake's shoreline is developed and the majority of the developed shoreline is comprised of seawall (33%), woodland (19%) and rip rap (17%) (Figure 8). The remainder of the developed shoreline consists of beach (11.4%), buffer (6.5%), manicured lawn (6.5%) and wetland (6.3%). The undeveloped portions of the lake, which comprise the majority of the shoreline, are made up of wetland and woodland. Seawall is not an ideal shoreline type unless used solely for erosion control. Seawalls do not provide any wildlife habitat and can often increase sediment resuspension as waves are reflected back into the lake by the seawall. Although rip rap is also not an ideal shoreline type with regard to wildlife habitat, it can also help to prevent shoreline erosion. Woodland, wetland and buffer are the most desirable shoreline types, providing wildlife habitat and, typically, protecting the shore from excessive erosion. The high percentage of wetland and woodland shoreline along Deep Lake is very encouraging and these shorelines should be protected from new development or degradation. Although seawalled shoreline dominated the developed portions of the lake, the most prevalent overall shoreline types were woodland (28%) and wetland (24%). As a result of the dominance of these shorelines, 89.3% of Deep Lake's shoreline exhibited no erosion. Slight erosion was occurring primarily along woodland dominated shoreline that had not been properly maintained, while manicured lawns exhibited much of the remainder of the erosion (Figure 9). Although manicured lawn made up very little of the overall shoreline, 48% of all manicured lawn was exhibiting slight erosion. Manicured lawn is considered undesirable because it provides a poor shoreline-water interface due to the short root structure of turf grasses. These grasses are incapable of stabilizing the shoreline and will typically lead to erosion. Wetland, buffer and, especially, woodland shorelines should be maintained or added as much as possible, and the addition of manicured lawns, seawalls and rip rap should be discouraged.

Although almost no erosion was occurring around Deep Lake, invasive plant species, including Canada thistle, common reed, reed canary grass, honeysuckle and buckthorn were present along 60% of the shoreline. These plants are extremely invasive and exclude native plants from the areas they inhabit. Buckthorn provides very poor shoreline stabilization and may lead to increasing erosion problems along already eroded shoreline in the future. Reed canary grass and common reed inhabit mostly wetland areas and can easily outcompete native plants. Additionally, they do not provide the quality wildlife habitat or shoreline stabilization that native plants provide. Although most of the exotic plant occurrences were along non-developed shoreline, steps to eliminate these plants should be carried out in order to improve the wildlife habitat and overall aesthetics of Deep Lake.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Although fish stocking and fish surveys in Deep Lake have likely taken place throughout this past century, current LMU records date back to 1972. Most recently, in 1989, 1993 and 2003, the Illinois Department of Natural Resources (IDNR) conducted fish surveys utilizing electroshocking, gill nets and trap nets. In 1989, 223 fish comprising 18 species were collected. Sunfish species (bluegill, pumpkinseed and redear sunfish) constituted 50% of the sample in terms of relative abundance. Blackchin shiners (state threatened) were also collected in the sample. The recommendation that largemouth bass, northern pike and walleye be stocked was carried out in 1990. In 1993, 267 fish were collected comprising 17 species, including blackchin shiners. The size of sunfish had increased since 1989 and perch appeared to be more numerous. In 1995, 12,000 3-inch crappie were stocked. No stocking took place in 1996. Approximately 2,000 2-4 inch largemouth bass (LMB), 1,000 4-6 inch LMB and 1,000 4-6 inch walleye were stocked in 1997. Approximately 1,500 black crappie fingerlings and 2,200 LMB fingerlings were stocked in 1998. In 2001, 2,000 2-4 inch LMB, 600 4-5 inch LMB and 675 4-5 inch crappie were stocked in Deep Lake. Twenty-six hundred largemouth bass were stocked in 2003. While stocking may be beneficial for sportfishing, the long-term impact on the various threatened and endangered fish species is unknown.

In a fish survey conducted by Southern Illinois University and Max McGraw Wildlife Foundation in 2002, using seining nets and electrofishing, 894 fish comprising 16 species were collected. Two state threatened fish species (Banded killifish (*Fundulus diaphanus*) and Blackchin shiner (*Notropis heterdon*)) and three state endangered fish species (Blacknose shiner (*Notropis heterolepis*), Pugnose shiner (*Notropis anogenus*) and Iowa darter (*Etheostoma exile*)). were found along seven 100-m study reaches. As mentioned before, the presence of these five species is exceptional and very rare. It is vitally important that their habitat is protected by maintaining a high diversity of native plants in the lake. It is also important that lake managers consult with a fisheries biologist before stocking predatory fish species. The threatened and endangered fish species present in Deep Lake are known to be forage fish for walleye, northern pike and largemouth bass. Care should be taken in the stocking of these sport fish species as they could have a negative impact on the threatened and endangered species. The IDNR conducted a fish survey again in 2003 using 60 minutes of electrofishing. Thirteen fish species were collected, including the state-threatened blackchin shiner. Six schools of this shiner were observed during the 60 minutes and they seemed fairly abundant. Other fish species found included largemouth bass, redear sunfish, grass pickerel, central mudminnow and lake chubsuckers. The largemouth bass collected represented at least seven age groups, suggesting consistent reproduction. The lake appears to have a diverse fishery that is in relative balance.

Wildlife observations were made on a monthly basis during water quality and plant sampling activities (See Appendix B for methodology). Because the abundance of wildlife habitat in the form of wetland and woodland areas was relatively high around Deep Lake, a moderate number of wildlife species were observed, including the state threatened pied-billed grebe and the state endangered osprey (Table 8). These two species were not nesting on the lake. Considering that Deep Lake is a partially developed lake, the number of wildlife species is encouraging. The maintenance of wetland, wooded and buffered shorelines and the establishment of additional buffer strips (especially along the shoreline of developed areas) is very important and strongly recommended to continue to provide the appropriate habitat for birds and other animals in the future.

In 2003, zebra mussels (*Dreissena polymorpha*) were discovered in Cedar Lake, which drains into Deep Lake. As of the writing of this report, zebra mussels have not been found in Deep Lake. However, it may be just a matter of time before this occurs. These mussels are believed to have been spread to this country in the mid 1980's by cargo ships from Europe that discharged their ballast water into the Great Lakes. The mussels spread throughout the Great Lakes and by 1991 had made their way into the Illinois and Mississippi Rivers. In 1999, the first sighting of the mussel in Lake County (besides Lake Michigan and the Chain of Lakes) occurred. Currently, 11 inland lakes in the county are known to be infested with the zebra mussel, but this number could be much higher, since the mussel has probably gone unnoticed in many lakes. The mussels were discovered in three new lakes in 2003. Due to their quick life cycle and explosive growth rate, zebra mussels can quickly edge out native mussel species. Negative impacts on native bivalve populations include interferences with feeding, habitat, growth, movement and reproduction. The impact that the mussels have on fish populations is not fully understood. However, zebra mussels feed on algae, which is also a major food source for planktivorous fish, such as bluegills, which are food for bass and pike. Zebra mussels have also caused economic problems for large power plants, public water supplies, and industrial facilities, where they clog water intake pipes. Recent studies on the transport of the zebra mussel have shown that they can be found in any area of a boat that holds water, including the engine cooling system, bilge water, and bait buckets used in fishing. The researchers also found that many of the mussel larvae were being transported via aquatic plants that were taken from one lake to another on boats or boat trailers. The larvae did not appear to be transported by attaching to the sides of the boats themselves.

Although it may be impossible to prevent zebra mussels from entering Deep Lake via direct flow from Cedar Lake, several steps can be taken to prevent the introduction of the mussel via transport by boat. It is recommended that residents (1) educate themselves on what the species looks like and how it can be spread; (2) remain diligent about removing plants and emptying all sources of water from boats being transferred from any lake back into Deep Lake; and (3) post signs at the Glacier Park Launch educating boaters about the zebra mussel (and Eurasian watermilfoil), the negative impacts it can have on a lake and ways to prevent the spread of the organism. These signs can be purchased for approximately $15.00 from the Indiana-Illinois Sea Grant College Program web site at http://www.iisgcp.org. Once on the home page, go to Outreach, Biological Resources, Publications, Exotic Species Advisory Sign. It is important that the presence of the zebra mussel in Deep Lake (if they are ever observed) be reported to the us immediately so that records can be updated and educational steps can be taken to prevent its further spread.

Table 8. Wildlife species observed at Deep Lake, May-September 2003.

<u>Birds</u>	
Pied-billed Grebe+	*Podilymbus podiceps*
Double Crested Cormorant	*Phalacrocorax auritus*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
American Coot	*Fulica americana*
Ring-billed Gull	*Larus delawarensis*
Great Blue Heron	*Ardea herodias*
Osprey*	*Pandion haliaetus*
Belted Kingfisher	*Megaceryle alcyon*
Eastern Pewee	*Contopus virens*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Marsh Wren	*Cistothrorus palustris*
Red-winged Blackbird	*Agelaius phoeniceus*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
<u>Fish</u>	
Iowa Darter*	*Etheostoma exile*
Banded Killifish+	*Fundulus diaphanus*
Pugnose Shiner*	*Notropis anogenus*
Blackchin Shiner+	*Notropis heterolepis*
Blacknose Shiner*	*Notropis heterodon*

+Threatened in Illinois
*Endangered in Illinois

EXISTING LAKE QUALITY PROBLEMS

- *Inconsistent Participation in the Volunteer Lake Monitoring Program (VLMP)*

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection agency (Illinois EPA) to gather fundamental information on Illinois inland lakes, and to provide an educational program for citizens. Annually, approximately 165 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 300 citizen volunteers. The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake. Although Deep Lake does participate in the VLMP, data collection was non-existent in the 1990's and has been somewhat inconsistent since 2000 (see Figure 5). Deep Lake should have a consistent VLMP to monitor possible changes in the near future due to additional development in the watershed.

- *Canada Geese*

Large numbers of Canada Geese were observed at Glacier Park and Jack and Lidia's throughout the summer. These birds, once heavily hunted by wolf, coyote and man, now experience a nearly predator-free environment on many of our lakes. They are drawn to the beaches and manicured lawns along many of our shorelines, as these provide easy access to the water and a clear view for sighting predators. Geese reproduce prolifically and flocks can number in the hundreds. They can tear up grassy areas through their feeding, causing erosion, and they can contribute a large amount of phosphorus to the water through their feces. Goose feces contains a very high concentration of *E. coli* bacteria and phosphorus. Since one goose can produce 0.072 pounds of fecal matter per day, a flock of 100 geese can produce over 7 pounds of feces per day on a lakeshore. This fecal matter (and the phosphorus it contains) will eventually end up in the lake by leaching into the soil and/or being carried into the water via runoff.

- *Invasive Shoreline Plant Species*

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. The outcome is a loss of plant and animal diversity. Buckthorn and honeysuckles are aggressive shrub species that grow along lake shorelines as well as most upland habitats. They shade out other plants and are quick to become established on disturbed soils. Reed canary grass and common reed are present in wetland areas and can very quickly outcompete cattails and other native wetland plants. Honeysuckle, buckthorn, purple loosestrife, Canada thistle, common reed and reed canary grass are present along 60% of the shoreline of Deep Lake and attempts should be made to control their spread.

- *Limited Wildlife Habitat*

Although a relatively large amount of shoreline is dominated by wetland and woodland, much of Deep Lake's shoreline is dominated by residential homes, which do not always encourage a diverse bird and animal community. Several of the residents along Deep Lake already have buffer strips in place along their shoreline property. However, many of the residents also have seawalls and beaches along their shoreline. It is recommended that those residents that already have buffer consider widening their strips to a width of at least 20 feet, and that those residents that do not have a buffer strip consider planting 10-20 feet of native plants along their shoreline.

- *User Conflicts and Protection of Sensitive Areas*

One of the concerns expressed by lakeshore homeowners is the increase in number and size of boats operating on Deep Lake. Although there is a Township horsepower restriction on any boat launched at the Village of Lake Villa Glacier Park boat launch, lake homeowners own and run boats with much higher horsepower. Conflicts often arise between those who want to use the lake for power boating and those who enjoy the lake for its aesthetic qualities and do not want the noise and disturbance caused by powerboats and personal watercraft. Action has already been taken by the DLIP to establish lake use guidelines, restricting hours of operation of powerboats and establishing "no wake" zones within 150 feet of the shoreline. These measures are very important in helping to prevent conflicts between early-morning fishermen and powerboaters, as well as helping to protect sensitive areas of threatened and endangered plants and fish. An additional step that could be taken is the deployment of "no wake" buoys to provide further protection to these sensitive areas, as well as the shoreline. The buoys will help increase awareness of where this "no wake" zone actually lies, as many people may not be adept at estimating this distance, especially when driving at high speeds. It is strongly recommended that the DLIA invest in the purchase of these "no wake" buoys.

- *Public Education and Protection of Threatened and Endangered Fish and Plant Species*

Deep Lake contains: three state endangered plant species (white stem pondweed (*Potamogeton praelongus*), fern leaf pondweed (*Potamogeton robbinsii*) and water marigold (*Bidens beckii*)), two state threatened fish species (Banded killifish (*Fundulus diaphanus*) and Blackchin shiner (*Notropis heterdon*)), and three state endangered fish species (Blacknose shiner (*Notropis heterolepis*), Pugnose shiner (*Notropis anogenus*) and Iowa darter (*Etheostoma exile*)). These species should be protected at all costs, as Deep Lake is one of the few lakes in Illinois to contain such a diversity of threatened and endangered (T&E) species. To protect both plants and fish, minimal and selective herbicide use should be practiced, as the fish need diverse and heavy plant cover. All three plant species can be affected by the use of Diquat, and water marigold can be affected by 2,4-D use. Lake managers, as well as lake and village residents who recreate on Deep Lake should be educated on the importance of protecting these species. Lake managers may want to invest in signage similar to that found at Lehman Park boat launch on Cedar Lake, which also has a good diversity of T&E species. This sign identifies the various species found in the lake and briefly educates on the importance of maintaining good water quality and plant diversity in order to protect these species.

POTENTIAL OBJECTIVES FOR THE DEEP LAKE MANAGEMENT PLAN

I. Increase Participation in the Volunteer Lake Monitoring Program
II. Alleviate Excessive Numbers of Canada Geese (*Branta canadensis*)
III. Eliminate or Control Exotic Species
IV. Enhance Wildlife Habitat Conditions
V. Purchase "No Wake" Buoys For Lake and Shoreline Protection
VI. Promotion and Education of Threatened and Endangered Fish and Plant Species

Objective I: Increase Participation in the Volunteer Lake Monitoring Program

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection agency (Illinois EPA) to gather fundamental information on Illinois inland lakes, and to provide an educational program for citizens. Annually, approximately 165 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 300 citizen volunteers. The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake.

The VLMP relies on volunteers to gather a variety of information on their chosen lake. The primary measurement is Secchi disk transparency or Secchi depth. Analysis of the Secchi disk measurement provides an indication of the general water quality condition of the lake, as well as the amount of usable habitat available for fish and other aquatic life.

Microscopic plants and animals, water color, and suspended sediments are factors that interfere with light penetration through the water column and lessen the Secchi disk depth. As a rule, one to three times the Secchi depth is considered the lighted or euphotic zone of the lake. In this region of the lake there is enough light to allow plants to survive and produce oxygen. Water below the lighted zone can be expected to have little or no dissolved oxygen. Other observations such as water color, suspended algae and sediment, aquatic plants, and odor are also recorded. The sampling season is May through October with volunteer measurements taken twice a month. After volunteers have completed one year of the basic monitoring program, they are qualified to participate in the Expanded Monitoring Program. In the expanded program, selected volunteers are trained to collect water samples that are shipped to the Illinois EPA laboratory for analysis of total and volatile suspended solids, total phosphorus, nitrate-nitrite nitrogen and ammonia nitrogen. Other parameters that are part of the expanded program include dissolved oxygen, temperature, and zebra mussel monitoring. Additionally, chlorophyll *a* monitoring has been added to the regiment of selected lakes. These water quality parameters are routinely measured by lake scientists to help determine the general health of the lake ecosystem.

Deep Lake currently has a VLMP. However, data collection during the past decade has been very inconsistent. It is strongly recommended that the current VLM increase participation in the program or find a different lake resident or member of the DLIA who can make a commitment to collect data twice per month from May-September and to carry this task out consistently each year until he or she is not longer able. Additionally, a program should be implemented to train a new VLM in an efficient manner once the current volunteer is no longer able to perform data collection.

Currently the number of volunteers in the six county northeast Illinois region has reached its limit with regard to how many volunteers NIPC can handle. New volunteers wishing to be part of the VLMP will be trained by the Lake County Health Department Lakes Management Unit (LMU).

If you would like to be placed on this training list or would simply like more information, contact the Lakes Management Unit Local Coordinator:

LMU Local Coordinator:
Mary Colwell
3010 Grand Ave.
Waukegan, IL 60085
(847) 377-8009
mcolwell@co.lake.il.us

VLMP Regional Coordinator:
Holly Hudson
Northeast Illinois Planning Commission
222 S. Riverside Plaza, Suite 1800
Chicago, IL 60606
(312) 454-0400

Objective II: Alleviate Excessive Numbers of Canada Geese (*Branta canadensis*)

Canada geese are migratory waterfowl common throughout North America. Geese in urban areas can be undesirable primarily due to the large amount of feces they leave behind. Recreational activities on lawns and parks are impeded due to goose feces. Large amounts of feces may end up in the water, either directly from geese on the water or rainwater runoff from lawns where feces have accumulated. Goose feces is high in organic phosphorus. High nutrient levels, particularly phosphorus, can contribute to excessive algae growth in lakes. This may inhibit other recreational activities such as boating or swimming, as well as create poor habitat for fish and wildlife, and possibly bad odors when the algae decays.

Geese become problematic for many reasons. They seek locations that have open water, adequate food supplies, and safety from predators. If these factors are present, geese may not migrate. Since geese exhibit a high level of site fidelity, they return to (or stay at) the same area each year. Thus, adults will likely come back to the same area year after year to nest. If conditions remain optimal, one pair of geese can quickly multiply, causing additional problems. Increased development in Lake County has inadvertently created ideal habitat for goose populations. Manicured lawns mowed to the edge of lakes and detention ponds provide geese with open areas with ample food and security. Other conditions that encourage goose residency include open water during winter (primarily the result of aerators in lakes and ponds), mild winters, and people feeding birds with bread or similar human food.

Large populations of geese pose a potential disease threat both to resident and wild populations of waterfowl. This problem may be more serious in residential populations since these birds stay in one area for long periods of time are more likely to transmit any disease to neighboring groups of geese. There is no threat of disease transmission to humans or domestic dogs and cats since most of the diseases are specific to birds.

<u>Option 1: No Action</u>

Pros

This option has no costs, however, increasing numbers of geese will most likely exacerbate existing problems and probably create new ones, which in the future may cost more than if the problems are addressed immediately.

Cons

If current conditions continue and no action is taken, numbers of Canada Geese and problems associated with them will likely increase. An increase of goose feces washed into a lake will increase the lake's nutrient load and eventually may have a detrimental impact on water quality through excessive algae growth. One study (Manny et al. 1975) documented that a goose excretes 0.072 lbs of feces per day. This may not seem like a significant amount, but if 100 geese are present (many lakes in the county can experience 1,000 or more at a time) that equates to over 7 lbs of feces per day! Algae blooms may negatively impact recreational uses such as swimming, boating, and fishing. In addition, when algae dies, odor problems and depleted oxygen levels in the water occur. Increased numbers of geese may also result in overgrazed areas of grass.

Costs

There are a few short-term financial costs with this option. Costs of cleaning feces off lawns or piers are probably more psychological or physical than financial. Long-term costs may be more indirect, including increased nutrient deposition into lakes, which may promote excessive algae and plants. Costs incurred may include money needed to control algae with algaecides.

Option 2: Removal

Since Canada Geese are considered migratory waterfowl, both state and federal laws restrict taking or harassing geese. Under the federal Migratory Bird Treaty Act, it is illegal to kill or capture geese outside a legal hunting season or to harass their nests without a permit. If removal of problematic geese is warranted or if nest and egg destruction is an option, permits need to be obtained from the Illinois Department of Natural Resources (217- 782-6384) and the U.S. Fish and Wildlife Service (217-241-6700).

Hunting is one of the most effective techniques used in goose management. However, since many municipalities have ordinances prohibiting the discharge of firearms, reduction of goose numbers by hunting in urban areas (i.e., lakes, ponds, and parks) may not be an option. Hunting does occur on many lakes in the county, but certain regulations apply (e.g., 100 yard minimum distance from any residential property). Contact the Illinois Department of Natural Resources for dates and regulations regarding the waterfowl hunting seasons. Also, contact local and county law enforcement agencies regarding any ordinances concerning hunting within municipal boundaries.

Egg addling, or destroying the egg by shaking, piercing, or freezing, can be used to reduce or eliminate a successful clutch. Eggs should be returned to the nest so the hen goose does not re-lay another clutch. However, if no eggs hatch, she may still lay another clutch. Leaving one or two eggs unaltered and allowing them to hatch may prevent another clutch from being laid and reduces the total year’s reproduction. Egg addling requires a state and federal permit.

The capture and relocation of geese is no longer a desirable option. First, relocated geese may return to the same location where they were captured. Second, there is a concern over potential disease transmission from relocated geese to other goose populations. Finally, since goose numbers in Illinois are already high there is no need to supplement other populations in the area.

Pros

Removing a significant portion of a problem goose population can have a positive effect on the overall health of a lake. Reduction of feces on lawns and parks is beneficial to recreation users of all types. Less feces in the water means less phosphorus available for nuisance plant and algae growth. Thus, the overall water quality of the lake may be improved by this reduction in phosphorus.

Cons

If the habitat conditions still exist, more geese will likely replace any that were removed. Thus, money and time used removing geese may not be well spent unless there is a change in habitat conditions.

Costs

A Illinois residential waterfowl hunting license (including state and federal waterfowl stamps) is $39.00 for the 2001-2002 hunting season. For depredation permits, there is a $25 fee for the federal permit. Once the federal permit is issued the state permit can be obtained at no charge.

Option 3: Dispersal/Repellent Techniques

Several techniques and products are on the market that claim to disperse or deter geese from using an area. These techniques can be divided into two categories: harassment and chemical. With both types of techniques it is important to implement any action early in the season, before geese establish territories and begin nesting. Once established, the dispersal/repellant techniques may be less effective and geese more difficult to coerce into leaving.

The goal with harassment techniques is to frighten geese from an area using sounds or objects. Various products are available that simulate natural predators (i.e., plastic hawks and owls) or otherwise make geese nervous (i.e., balloons, shiny tape, and flags). Other products emit noises, such as propane cannons, which can be set on a timer to go off at programmed intervals (e.g., every 20-30 seconds), or recorded goose distress calls which can be played back over a loudspeaker or tape player. Over time these techniques may be ineffective, since geese become acclimated to these devices. Most of these products are more effective when used in combination with other techniques.

Another technique that has become popular is using dogs or swans to harass geese. Dogs can be used primarily in the spring and fall to keep birds from using an area by herding or chasing geese away from a particular area. Any dogs used for this purpose should be well trained and under the owners control at all times. Professional trainers can be contracted to use their dogs for this purpose. Dogs should not be used during the summer when geese are unable to fly due to molting. Swans are used because they are naturally aggressive in defending their territory, including chasing other waterfowl away from their nesting area. Since wild swans cannot be used for this technique, non-native mute swans are used. However, mute swans are not as aggressive and in some case are permissive of geese. Again, using a combination of techniques would be most effective.

Chemical repellents can be used with some effectiveness. New products are continually coming out that claim to rid an area of nuisance geese. Several products (ReJeX-iT® and GooseChase™) are made from methyl-anthranilate, a natural occurring compound, and can be sprayed on areas where geese are feeding. The spray makes the grass distasteful and forces geese to move elsewhere to feed. Another product, Flight Control™, works similarly, but has the additional benefit of absorbing ultra violet light making the grass appear as if it was not a food source. The sprays need to be reapplied every 14-30 days, depending upon weather conditions and mowing frequency.

Pros

With persistence, harassment and/or use of repellants can result in reduced or minimal usage of an area by geese. Fewer geese may mean less feces and cleaner yards and parks, which may increase recreational uses along shorelines. If large numbers of geese were once present, the reduction of fecal deposits into the lake may help minimize the amount of phosphorus entering the water. Less phosphorus in the water means less "food" available for plant and algae growth, which may have a positive effect of water quality. Finally, any areas overgrazed by geese may have a chance to recover.

Cons

The effectiveness of harassment techniques is reduced over time since geese will adapt to the devices. However, their effectiveness can be extended if the devices are moved to different locations periodically, or used in conjunction with other techniques.

Use of dogs can be time consuming, since the dog must be trained and taken care of. Dogs must also be used frequently in the beginning of the season to be effective at deterring geese. This requires time of the dog owner as well. Dogs (frequently herding dogs, like border collies) that are effective at harassing or herding geese are typically not the best pets for the average homeowner. They are bred as working dogs and consequently have high levels of energy that require the owner's attention.

Repelling or chasing away geese from an area only solves the goose problem for that area and most likely moves the geese (and the problem) to another area. As long as there is suitable habitat nearby, the geese will not wander very far.

Costs

Costs for the propane cannons are approximately $660 ($360 for the cannon, $300 for a timer), not including the propane tank. The cost of ReJeX-iT® is $80/gallon, GooseChase™ is $95/gallon, and Flight Control™ costs $200/gallon. One gallon covers one acre of turf using ReJeX-iT® and, GooseChase™, and two acres using Flight Control™.

Option 4: Exclusion

Erecting a barrier to exclude geese is another option. In addition to a traditional wood or wire fence, an effective exclusion control is to suspend netting over the area where geese are unwanted. Geese are reluctant to fly or walk into the area. A similar deterrent that is often used is a single string or wire suspended a foot or so above the ground along the length of the shoreline.

> ***Pros***
>
> Depending on the type of barrier used, areas of exclusion will have less fecal mess and may have higher recreational uses. Vegetation that was overgrazed by geese may also be able to recover.
>
> ***Cons***
>
> This technique will not be effective if the geese are using a large area. Also, use of the area by people is severely limited if netting is installed. Fences can also limit recreational uses. The single string or wire method may be effective at first, but geese often learn to go around, over, or under the string after a short period of time. Finally, excluding geese from one area will force them to another area on a different part of the same lake or another nearby lake. While this solves one property owners problem, it creates one (or makes one worse) for another. Also, problems associated with excess feces entering the lake (i.e., increased phosphorus levels) will continue.
>
> ***Costs***
>
> The costs of these techniques are minimal, unless a wood or wire fence is constructed. String, wire, or netting can be purchased or made from materials at local stores.

Option 5: Habitat Alteration

One of the best methods to deter geese from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for geese. Low vegetation near the water allows geese to feed and provides a wide view with which to see potential predators. In general, geese do not favor habitats with tall vegetation. To achieve this, create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn. Planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally can create buffer strips. Table 9 (Appendix A) has a list of native plants, seeding rates, and approximate costs that can be used when creating buffer strips.

Geese prefer ponds and lakes that have shorelines with gentle slopes to ones with steep slopes. While this alone will not prevent geese from using an area, steeper slopes used along with other techniques will be more effective. This option may not be practical for existing lake shorelines since any grading and/or filling would require permits and surveys, which would drive up the costs of redoing the shoreline considerably.

Aeration systems that run into the fall and winter prevent the lake from freezing, thus not forcing geese to migrate elsewhere. To alleviate this problem, turn aerators off during fall and early winter. Once the lake freezes over and the geese have left, wait a few weeks before turning the aerators on again if needed.

Pros
Altering the habitat in an area can not only make the habitat less desirable for geese, but may be more desirable for many other species of wildlife. A buffer strip has additional benefits by filtering run-off of nutrients, sediments, and pollutants and protecting the shoreline from erosion from wind, wave, or ice action. Finally, the more of the area that is in natural vegetation, the less turfgrass that needs to be constantly manicured and maintained.

Cons
Converting a portion or all of an area to tall grass or shrub habitat may reduce the lake access or visibility. However, if this occurs, a small path can be made to the lake or shorter plants may be used at the access location in the buffer strip.

Costs
If minimal amount of site preparation is needed to create a buffer strip, costs can be approximately $10 per linear foot, plus labor. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

Once established, a buffer strip of native plants needs little maintenance. If aerators are not run for several months, there will be a reduction in electrical costs.

Option 6: Do Not Feed Waterfowl!

There are few “good things”, if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the “foods” (i.e., white bread) given to geese and other waterfowl are quite low. Since geese are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese that are accustomed to hand feeding may become aggressive toward other geese or even the people feeding the geese.

Costs

There are no costs to this option, except the public education that is needed to encourage people not to feed waterfowl. In some cases, signs could be posted to discourage waterfowl feeding. A sign designed by the Lake County Health Department can be purchased for approximately $35.

Reference:

Manny, B. A., R. G. Wetzel, and W. C. Johnson. 1975. Annual contribution of carbon, nitrogen, and phosphorus by migrant Canada geese to a hardwater lake. Verh. Internat. Verein. Limnol. 19:949-951.

Objective III: Eliminate or Control Exotic Species

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. Plants such as purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus cathartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. The outcome is a loss of plant and animal diversity. This section will address terrestrial shoreline exotic species.

Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants, its roots exude a chemical that discourages other plant growth, and it is quick to become established on disturbed soils. Reed canary grass is an aggressive plant species that was introduced as a shoreline stabilizer. It is found on lakeshores, stream banks, marshes and exposed moist ground. Although it does serve to stabilize shorelines to some extent, it has low food value and does not provide winter habitat for wildlife. It is very successful in taking over disturbed areas and, if left unchecked, will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

The presence of exotic species along a lakeshore is by no means a death sentence for the lake or other plant and animal life. If controlled, many exotic species can perform many of the original functions that they were brought here for. For example, reed canary grass was imported for its erosion control properties. It still contributes to this objective (offering better erosion control than commercial turfgrass), but needs to be isolated and kept in control. Many exotics are the result of garden or ornamental plants escaping into the wild. One isolated plant along a shoreline will probably not create a problem by itself, but its removal early on is best. Problems arise when plants are left to spread, many times to the point where treatment is difficult or cost prohibitive. Although the length of shoreline inhabited by exotic species is 60% of the total shoreline, only seven land parcels are represented. The largest area of concern is the wooded area along the western side of the lake that is currently infested with buckthorn. Very little of any other exotic species is present along the shoreline of Deep Lake. A monitoring program should be established, problem areas specifically identified, and control measures taken. This is particularly important in remote areas of lake shorelines where the spread of exotic species has gone unnoticed for some time.

<u>Option 1: No Action</u>

No control will likely result in the expansion of the exotic species and the decline of native species. This option is not recommended if possible.

Pros

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics whenever possible. A table in Appendix A lists several native plants that can be planted along shorelines.

Cons

Native plant and wildlife diversity will be lost as stands of exotic species expand. Exotic species are not under the same stresses (particularly diseases and predators) as native plants and thus can out-compete the natives for nutrients, space, and light. Few wildlife species use areas where exotic plants dominate. This happens because many wildlife species either have not adapted with the plants and do not view them as a food resource, the plants are not digestible to the animal, or their primary food supply (i.e., insects) are not attracted to the plants. The result is a monoculture of exotic plants with limited biodiversity.

Recreational activities, especially wildlife viewing, may be hampered by such monocultures. Access to lake shorelines may be impaired due to dense stands of non-native plants. Other recreational activities, such as swimming and boating, may not be affected.

Costs

Costs with this option are zeroing initially, however, when control is eventually needed, costs will be substantially more than if action was taken immediately. Additionally, the eventual loss of ecological diversity is difficult to calculate financially.

Option 2: Control by Hand

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Some exotics, such as purple loosestrife and reed canary grass, can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is removed. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored since regrowth is common. Many exotic species, such as purple loosestrife, buckthorn, and garlic mustard are proficient at colonizing disturbed sites.

Pros
Removal of exotics by hand eliminates the need for chemical treatments. Costs are low if stands of plants are not too large already. Once removed, control is simple with yearly maintenance. Control or elimination of exotics preserves the ecosystem's biodiversity. This will have positive impacts on plant and wildlife presence as well as some recreational activities.
Cons
This option may be labor intensive or prohibitive if the exotic plant is already well established. Costs may be high if large numbers of people are needed to remove plants. Soil disturbance may introduce additional problems such as providing a seedbed for other non-native plants that quickly establish disturbed sites, or cause soil-laden run-off to flow into nearby lakes or streams. In addition, a well-established stand of an exotic like purple loosestrife or reed canary grass may require several years of intense removal to control or eliminate.

Costs
Cost for this option is primarily in tools, labor, and proper plant disposal.

Option 3: Herbicide Treatment

Chemical treatments can be effective at controlling exotic plant species. However, chemical treatment works best on individual plants or small areas already infested with the plant. In some areas where individual spot treatments are prohibitive or impractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option because in order to chemically treat the area, a broadcast application would be needed. Because many of the herbicides are not selective, meaning they kill all plants they contact, this may be unacceptable if native plants are found in the proposed treatment area.

Herbicides are commonly used to control nuisance shoreline vegetation such as buckthorn and purple loosestrife. Herbicides are applied to green foliage or cut stems. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. The herbicide solution is wiped on foliage, bark, or cut stems using an herbicide-soaked device. Trees are normally treated by cutting off a ring of bark around the trunk (called girdling). Herbicides are applied onto the ring at high concentrations. Other devices inject the herbicide through the bark. It is best to apply herbicides when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

Pros
Herbicides provide a fast and effective way to control or eliminate nuisance vegetation. Unlike other control methods, herbicides kill the root of the plant, which prevents regrowth. If applied properly, herbicides can be selective. This allows for removal of selected plants within a mix of desirable and undesirable plants.

Cons
Since most herbicides are non-selective, they are not suitable for broadcast application. Thus, chemical treatment of large stands of exotic species may not be practical. Native species are likely to be killed inadvertently and replaced by other non-native species. Off target injury/death may result from the improper use of herbicides. If herbicides are applied in windy conditions, chemicals may drift onto desirable vegetation. Care must also be taken when wicking herbicides as not to drip on to non-targeted vegetation such as native grasses and wildflowers. Another drawback to herbicide use relates to their ecological soundness and the public perception of them. Costs may also be prohibitive if plant stands are large. Depending on the device, cost of the application equipment can be high.

Costs
Two common herbicides, triclopyr (sold as Garlon ™) and glyphosate (sold as Rodeo®, Round-up™, Eagre™, or AquaPro™), are sold in 2.5 gallon jugs, and cost approximately $200 and $350, respectively. Only Rodeo® is approved for water use. A Hydrohatchet®, a hatchet that injects herbicide through the bark, is about $300.00. Another injecting device, E-Z Ject® is $450.00. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. A girdling tool costs about $150.

Objective IV: Enhance Wildlife Habitat Conditions

The key to increasing wildlife species in and around a lake can be summed up in one word: habitat. Wildlife need the same four things all living creatures need: food, water, shelter, and a place to raise their young. Since each wildlife species has specific habitat requirements, which fulfill these four basic needs, providing a variety of habitats will increase the chance that wildlife species may use an area. Groups of wildlife are often associated with the types of habitats they use. For example, grassland habitats may attract wildlife such as northern harriers, bobolinks, meadowlarks, meadow voles, and leopard frogs. Marsh habitats may attract yellow-headed blackbirds and sora rails, while manicured residential lawns attract house sparrows and gray squirrels. Thus, in order to attract a variety of wildlife, a mix of habitats are needed. In most cases quality is more important than quantity (i.e., five 0.1-acre plots of different habitats may not attract as many wildlife species than one 0.5 acre of one habitat type).

It is important to understand that the natural world is constantly changing. Habitats change or naturally succeed to other types of habitats. For example, grasses may be succeeded by shrub or shade intolerant tree species (e.g., willows, locust, and cottonwood). The point at which one habitat changes to another is rarely clear, since these changes usually occur over long periods of time, except in the case of dramatic events such as fire or flood.

In all cases, the best wildlife habitats are ones consisting of native plants. Unfortunately, non-native plants dominate many of our lake shorelines. Many of them escaped from gardens and landscaped yards (i.e., purple loosestrife) while others were introduced at some point to solve a problem (i.e., reed canary grass for erosion control). Wildlife species prefer native plants for food, shelter, and raising their young. In fact, one study showed that plant and animal diversity was 500% higher along naturalized shorelines compared to shorelines with conventional lawns (University of Wisconsin – Extension, 1999).

<u>Option 1: No Action</u>

This option means that the current land use activities will continue. No additional techniques will be implemented. Allowing a field to go fallow or not mowing a manicured lawn would be considered an action.

Pros

Taking no action may maintain the current habitat conditions and wildlife species present, depending on environmental conditions and pending land use actions. If all things remain constant there will be little to no effect on lake water quality and other lake uses.

Cons

If environmental conditions change or substantial land use actions occur (i.e., development) wildlife use of the area may change. For example, if a new housing development with manicured lawns and roads is built next to an undeveloped property, there will probably be a change in wildlife present.

Conditions in the lake (i.e., siltation or nutrient loading) may also change the composition of aquatic plant and invertebrate communities and thus influence biodiversity. Siltation and nutrient loading will likely decrease water clarity, increase turbidity, increase algal growth (due to nutrient availability), and decrease habitat for fish and wildlife.

Costs

The financial cost of this option may be zero. However, due to continual loss of habitats many wildlife species have suffered drastic declines in recent years. The loss of habitat affects the overall health and biodiversity of the lake's ecosystems.

Option 2: Increase Habitat Cover

This option can be incorporated with Option 3 (see below). One of the best ways to increase habitat cover is to leave a minimum 25-foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see the table in Appendix A for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species outcompete native plants and provide little value for wildlife.

Occasionally high mowing (with the mower set at its highest setting) may have to be done for specific plants, particularly if the area is newly established, since competition from weedy and exotic species is highest in the first couple years. If mowing, do not mow the buffer strip until after July 15 of each year. This will allow nesting birds to complete their breeding cycle.

Brush piles make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be place at least 10 feet away from the shoreline to prevent any debris from washing into the lake.

Trees that have fallen on the ground or into the water are beneficial by harboring food and providing cover for many wildlife species. In a lake, fallen trees provide excellent cover for fish, basking sites for turtles, and perches for herons and egrets.

Increasing habitat cover should not be limited to the terrestrial environment. Native aquatic vegetation, particularly along the shoreline, can provide cover for fish and other wildlife.

Pros
Increased cover will lead to increased use by wildlife. Since cover is one of the most important elements required by most species, providing cover will increase the chances of wildlife using the shoreline. Once cover is established, wildlife usually have little problem finding food, since many of the same plants that provide cover also supply the food the wildlife eat, either directly (seeds, fruit, roots, or leaves) or indirectly (prey attracted to the plants).

Additional benefits of leaving a buffer include: stabilizing shorelines, reducing runoff which may lead to better water quality, and deterring nuisance Canada geese. Shorelines with erosion problems can benefit from a buffer zone because native plants have deeper root structures and hold the soil more effectively than conventional turfgrass. Buffers also absorb much of the wave energy that batters the shoreline. Water quality may be improved by the filtering of nutrients, sediment, and pollutants in run-off. This has a "domino effect" since less run-off flowing into a lake means less nutrient availability for nuisance algae, and less sediment means less turbidity, which leads to better water quality. All this is beneficial for fish and wildlife, such as sight-feeders like bass and herons, as well as people who use the lake for recreation. Finally, a buffer strip along the shoreline can serve as a deterrent to Canada geese from using a shoreline. Canada geese like flat, open areas with a wide field of vision. Ideal habitat for them are areas that have short grass up to the edge of the lake. If a buffer is allowed to grow tall, geese may choose to move elsewhere.

Cons
There are few disadvantages to this option. However, if vegetation is allowed to grow, lake access and visibility may be limited. If this occurs, a small path can be made to the shoreline. Composition and density of aquatic and shoreline vegetation are important. If vegetation consists of non-native species such as or Eurasian water milfoil or purple loosestrife, or in excess amounts, undesirable conditions may result. A shoreline with excess exotic plant growth may result in a poor fishery (exhibited by stunted fish) and poor recreation opportunities (i.e., boating, swimming, or wildlife viewing).

Costs
The cost of this option would be minimal. The purchase of native plants can vary depending upon species and quantity. Based upon 100 feet of shoreline, a 25-foot buffer planted with a native forb and grass seed mix would cost between $165-270 (2500 sq. ft. would require 2.5, 1000 sq. ft. seed mix packages at $66-108 per package). This does not include labor that would be needed to prepare the site for planting and follow-up maintenance. This cost can be reduced or minimized if native plants are allowed to grow. However, additional time and labor may be needed to insure other exotic species, such as buckthorn, reed canary grass, and purple loosestrife, do not become established.

<u>Option 3: Increase Natural Food Supply</u>

This can be accomplished in conjunction with Option 2. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Plants found in Table 9, Appendix A should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily (*Nuphar* spp. and *Nymphaea tuberosa*), sago pondweed (*Stuckenia pectinatus*), largeleaf pondweed (*Potamogeton amplifolius)*, and wild celery (*Vallisneria americana*) to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

Providing a natural food source in and around a lake starts with good water quality. Water quality is important to all life forms in a lake. If there is good water quality, the fishery benefits and subsequently so does the wildlife (and people) who prey on the fish. Insect populations in the area, including beneficial predatory insects, such as dragonflies, thrive in lakes with good water quality.

Dead or dying plant material can be a source of food for wildlife. A dead standing or fallen tree will harbor good populations of insects for woodpeckers, while a pile of brush may provide insects for several species of songbirds such as warblers and flycatchers.

Supplying natural foods artificially (i.e., birdfeeders, nectar feeders, corn cobs, etc.) will attract wildlife and in most cases does not harm the animals. However, "people food" such as bread should be avoided. Care should be given to maintain clean feeders and birdbaths to minimize disease outbreaks.

Pros

Providing food for wildlife will increase the likelihood they will use the area. Providing wildlife with natural food sources has many benefits. Wildlife attracted to a lake can serve the lake and its residents well, since many wildlife species (i.e., many birds, bats, and other insects) are predators of nuisance insects such as mosquitoes, biting flies, and garden and yard pests (such as certain moths and beetles). Effective natural insect control eliminates the need for chemical treatments or use of electrical "bug zappers" that have limited effect on nuisance insects.

Migrating wildlife can be attracted with a natural food supply, primarily from seeds, but also from insects, aquatic plants or small fish. In fact, most migrating birds are dependent on food sources along their migration routes to replenish lost energy reserves. This may present an opportunity to view various species that would otherwise not be seen during the summer or winter.

Cons

Feeding wildlife can have adverse consequences if populations become dependent on hand-outs or populations of wildlife exceed healthy numbers. This frequently happens when people feed waterfowl like Canada geese or mallard ducks.

Feeding these waterfowl can lead to a domestication of these animals. As a result, these birds do not migrate and can contribute to numerous problems, such as excess feces, which is both a nuisance to property owners and a significant contribution to the lake's nutrient load. Waterfowl feces are particularly high in phosphorus. Since phosphorus is generally the limiting factor for nuisance algae growth in many lakes in the Midwest, the addition of large amounts of this nutrient from waterfowl may exacerbate a lake's excessive algae problem. In addition, high populations of birds in an area can increase the risk of disease for not only the resident birds, but also wild bird populations that visit the area.

Finally, tall plants along the shoreline may limit lake access or visibility for property owners. If this occurs, a path leading to the lake could be created or shorter plants may be used in the viewing area.

Costs

The costs of this option are minimal. The purchase of native plants and food and the time and labor required to plant and maintain would be the limit of the expense.

Option 4: Increase Nest Availability

Wildlife are attracted by habitats that serve as a place to raise their young. Habitats can vary from open grasslands to closed woodlands (similar to Options 2 and 3).

Standing dead or dying trees provide excellent habitat for a variety of wildlife species. Birds such as swallows, woodpeckers, and some waterfowl need dead trees to nest in. Generally, a cavity created and used by a woodpecker (e.g., red-headed or downy woodpecker, or common flicker) in one year, will in subsequent years be used by species like tree swallows or chickadees. Over time, older cavities may be large enough for waterfowl, like wood ducks, or mammals (e.g., flying squirrels) to use. Standing dead trees are also favored habitat for nesting wading birds, such as great blue herons, night herons, and double-crested cormorants, which build stick nests on limbs. For these birds, dead trees in groups or clumps are preferred as most herons and cormorants are colonial nesters.

In addition to allowing dead and dying trees to remain, erecting bird boxes will increase nesting sites for many bird species. Box sizes should vary to accommodate various species. Swallows, bluebirds, and other cavity nesting birds can be attracted to the area using small artificial nest boxes. Larger boxes will attract species such as wood ducks, flickers, and owls. A colony of purple martins can be attracted with a purple martin house, which has multiple cavity holes, placed in an open area near water.

Bat houses are also recommended for any area close to water. Bats are voracious predators of insects and are naturally attracted to bodies of water. They can be enticed into roosting in the area by the placement of bat boxes. Boxes should be constructed of rough non-treated lumber and placed >10 feet high in a sunny location.

Pros
Providing places were wildlife can rear their young has many benefits. Watching wildlife raise their young can be an excellent educational tool for both young and old.

The presence of certain wildlife species can help in controlling nuisance insects like mosquitoes, biting flies, and garden and yard pests. This eliminates the need for chemical treatments or electric "bug zappers" for pest control.

Various wildlife species populations have dramatically declined in recent years. Since, the overall health of ecosystems depend, in part, on the role of many of these species, providing sites for wildlife to raise their young will benefit not only the animals themselves, but the entire lake ecosystem.

Cons
Providing sites for wildlife to raise their young have few disadvantages. Safety precautions should be taken with leaving dead and dying trees due to the potential of falling limbs. Safety is also important when around wildlife with young, since many animals are protective of their young. Most actions by adult animals are simply threats and are rarely carried out as attacks.

Parental wildlife may chase off other animals of its own species or even other species. This may limit the number of animals in the area for the duration of the breeding season.

Costs
The costs of leaving dead and dying trees are minimal. The costs of installing the bird and bat boxes vary. Bird boxes can range in price from $10-100.00. Purple martin houses can cost $50-150. Bat boxes range in price from $15-50.00. These prices do not include mounting poles or installation.

Option 5: Limit Disturbance

Since most species of wildlife are susceptible to human disturbance, any action to curtail disturbances will be beneficial. Limiting disturbance can include posting signs in areas of the lake where wildlife may live (e.g., nesting waterfowl), establish a "no wake" area, boat horsepower or speed limits, or establish restricted boating hours. These are examples of time and space zoning for lake usage. Enforcement and public education are needed if this option is to be successful. In some areas, off-duty law enforcement officers can be hired to patrol the lake.

Pros
Limiting disturbance will increase the chance that wildlife will use the lake, particularly for raising their young. Many wildlife species have suffered population declines due to loss of habitat and poor breeding success. This is due in part to their sensitivity to disturbance.

This option also can benefit the lake in other ways. Limited boat traffic may lead to less wave action to batter shorelines and cause erosion, which results in suspension of nutrients and sediment in the water column. Less nutrients and sediment in the water column may improve water quality by increasing water clarity and limiting nutrient availability for excessive plant or algae growth.

Recreation activities such as canoeing and paddleboating may be enhanced by the limited disturbance.

Cons

One of the strongest oppositions to this option would probably be from the powerboat users and water skiers. However, this problem has been addressed on Deep Lake since 1990 by allowing powerboating only from 10 AM to sunset. Additionally, powerboats must adhere to a “no wake” restriction any time they are within 150 feet of the shoreline.

Costs

The costs of this option include the purchase and placement of signs and public educational materials as well as enforcement. Off-duty law enforcement officers usually charge $25/hour to enforce boating laws or local ordinances.