2003 SUMMARY REPORT
of
GAGES LAKE

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES
LAKES MANAGEMENT UNIT
3010 Grand Avenue
Waukegan, Illinois 60085

Christina L. Brant
Mary Colwell
Michael Adam
Joseph Marencik
Mark Pfister

June 2004

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EXECUTIVE SUMMARY

Gages Lake, located in Warren Township, is a glacial lake, created over 10,000 years ago by receding glaciers. The lake has a surface area of 143.4 acres and mean and maximum depths of 8.1 feet and 55 feet, respectively. It is located entirely in unincoporated Lake County and is predominantly managed by the Gages Lake Conservation Committee (GLCC) and the Wildwood Park District. It is used by residents for swimming, boating and fishing. There are a small number of beaches, parks and boat launches on the lake.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature and water clarity were measured and the plant community was assessed each month from May-September 2003. Gages Lake was stratified from May-September. 2003 phosphorus concentrations were very low throughout the summer in both the epilimnion and hypolimnion. Although total suspended solids (TSS) concentrations were moderately low, Secchi depths (water clarity) were fairly poor throughout the summer, but did correspond with increases and decreases in TSS concentrations. Average 2003 epilimnetic and hypolimnetic conductivities had increased since sampling in 1999, and were also much higher than the county medians throughout the summer. Epilimnetic total dissolved solids (TDS) concentrations, which have also been shown to be correlated with conductivity, were well above the county average in Gages Lake during every month of the study. Conductivity changes can occur seasonally and even with depth, but over the long term, increased conductivity levels can be a good indicator of potential watershed or lake problems or an increase in pollutants entering the lake if the trend is noted over a period of years. The concentrations of other parameters in Gages Lake have increased slightly in the past 5-10 years, possibly as a result of the manipulation of the plant community in the lake.

Eurasian watermilfoil (EWM) was the dominant species of the plant community in 2003. Very small amounts of curly leaf pondweed, largeleaf pondweed and *Chara* were also observed. Avast® was used to treat EWM and curlyleaf pondweed. The plant management plan for Gages Lake appears to be successfully treating the target plant species. However the GLCC may want to consider several recommendations regarding initial and final target concentrations, application schedule and additional tests on the EWM plants. Re-establishment of native plants may be possible through a planting program in areas where light penetration is adequate.

Although very little erosion was occurring around Gages Lake, buckthorn, honeysuckle and reed canary grass were present along 17% 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 dominance of residential shoreline.

LAKE IDENTIFICATION AND LOCATION

Gages Lake is located near the intersection of Illinois State Route 45 and Illinois State Route 120 in unincorporated Lake County, Warren Township (T 45N, R 11E, S 30). Gages Lake has a surface area of 143.4 acres (GIS calculation) and mean and maximum depths of 8.1 feet and 55.0 feet, respectively. It has a volume of 1152.6 acre-feet and a shoreline length of 3.7 miles (Figure 1, Appendix A). The watershed of Gages Lake encompasses approximately 430 acres, draining large residential areas to the south and north of the lake. The watershed to lake surface area ratio of 3:1 is very small (Figure 2). This is positive in that it may help prevent serious water quality problems that often accompany a larger watershed to lake ratio. However, lakes with small ratios often experience more severe water level fluctuations throughout the summer because changes in water level are based primarily on precipitation and evaporation. Water level fluctuations during the summers of 1994-2003 can be found in Table 1, Appendix A. Changes varied from year to year, but drops in water level could be fairly dramatic (over 1.0 foot in 1996). The lake appears to drop by at least ½ foot every year before rising again with fall rains. Although this yearly water level drop is probably annoying to local lake users, it does not pose a significant problem to wildlife or recreation and should continue to be monitored. It is recommended that in the future, staff gauge readings be taken weekly or bi-weekly if possible. This will give lake managers a much better idea of lake level fluctuations relative to rainfall events and can aid in future decisions regarding lake level.

Based on the most recent 2000 land use map of the Gages Lake watershed, residential areas (single family and multi-family homes and roadways) dominate the watershed, encompassing 82% of the land around Gages Lake. Other land uses are listed in Table 2, Appendix A. Water exits Gages Lake and flows into Druce Lake via a storm sewer from the northwest shore. However, water levels from May-September 2003 did not overflow the spillway. The lake is located in the Mill Creek sub basin, within the Des Plaines River watershed.

BRIEF HISTORY OF GAGES LAKE

Gages Lake is of glacial origin, created approximately 10,000 years ago during the last ice age. Richard W. Sears and the Allen family were the original owners of the land around the lake before it was sold off in the 1920's for development. The Gages Lake Conservation Committee (GLCC) was formed in the 1970's, and management activities on the lake began at that time. The committee still exists today. Large-scale management activities of the lake are controlled by the GLCC and the Wildwood Park District. The current volunteer lake monitor has been recording the lake level every year since 1994, and a staff gage was installed in 2001 to provide more accurate readings. The collection of this data has been important in calculations made for the application of fluridone over the past several years and will continue to be vital to these calculations in the future. In 2003, water levels did not fluctuate dramatically and were similar to the previous two summers.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Detailed records of historical lake management techniques on Gages Lake are limited. The lake has been treated with Sonar™ and Avast™ and 2,4-D during various years since 1994. The schedule of treatments and results are outlined in a different section of this report. Access to Gages Lake is available through approximately eight sites, all of which are privately owned. The Wildwood Park District owns and operates four beaches and two boat launches, which are open to Wildwood residents and their guests. The Gages Lake Campground was open to the public for a fee, but has been recently sold to Cambridge Homes. They will begin construction of a 66-unit townhome development with 16 boat slips in late summer 2004. The development is to be completed by late 2005. Several other privately run beaches and boat launches are available only to respective homeowner association members (Figure 2). The lake's main uses are swimming, boating and fishing. GLCC, the primary lake manager, meets once per month from January-June and September-November and is operating on a budget of approximately $9,600 per year. This money is generated by donations requested of each homeowners association. The amount of the donation requested by GLCC is based on a $3.87 assessment per home belonging to a particular association. The new Cambridge Homes development will require an annual lakes management fee of $120 per unit. Currently, the biggest management concerns include controlling Eurasian watermilfoil, increased planktonic algae in recent years, lakeshore homeowner education programs, current fish population status, plant re-introduction and shoreline erosion.

Every two weeks (from May to September) we sampled the two licensed beaches on Gages Lake (Pebble Beach and the Gages Lake Campground Beach) and tested for *E. coli*. *E.coli* bacteria is found virtually everywhere, but is present in very high numbers in the feces of animals and humans. The bacteria may indicate the presence of other pathogens such as *Giardia*, which can cause serious illness in humans. In 2003, both beaches were closed on May 6th, and Pebble Beach was also closed on August 12th due to *E. coli* concentrations that exceeded 235 colonies/100 mL. High counts can be caused by a number of things, including a large number of waterfowl, stormwater inflow, and high wind and wave events. The presence of a large number of waterfowl in the vicinity of the beach area could cause problems because their waste contain *E. coli*. Rain events can increase *E. coli* counts because as rain runs over the land, it picks up *E.coli,* which are then washed into the lake. Additionally, if a storm sewer discharges near the beach, non-point source runoff from the discharge can increase counts. From May 5-6, a little over one inch of rainfall was recorded at Gages Lake. This may help explain the high counts at both beaches on May 6th. Although water entering the lake via a storm pipe at the Pebble Beach Boat Launch does not appear to be reaching the swim area (water samples collected by Rob Flood of the North Shore Sanitary District at the Pebble Beach storm pipe:1120 colonies/ 100 mL and 236 colonies/100 mL on 6/27/02 and 8/6/03, respectively and at the Pebble Beach swim area: 43 colonies/100 mL and 3 colonies/100 mL on 6/27/02 and 8/6/03, respectively), other non-point runoff from the rain event likely entered the beach area directly from overland flow. The Pebble Beach closing in August was not related to rain and was most likely the result of a high goose population at the beach. Despite the high concentrations on May 6th and August 12th, *E. coli* contamination does not appear to be a serious problem at Gages Lake beaches, as these were the only violations during the summer of 2003.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples collected from Gages Lake were analyzed for a variety of water quality parameters (See Appendix B for methodology). Samples were collected at 3 foot and 45-51 foot depths (depending on site water depth) from the deep hole location in the lake (Figure 2). Gages 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 (dissolved oxygen (DO) = 0 mg/l) by mid-summer. This phenomenon is a natural occurrence in deep lakes and is not necessarily a bad thing if enough of the lake volume remains oxygenated. The surface waters of Gages Lake remained relatively well oxygenated during the summer. Near surface DO concentrations did not fall below 5.0 mg/l (a level below which some aquatic organisms, such as fish, become stressed) at any time during the study period. For the entire summer, at least 68% of the lake volume (the volume at 8 feet and above) had a dissolved oxygen concentration of at least 5.0 mg/l, and approximately 75% of the lake volume (the volume at 12 feet and above) was oxic (DO>1.0 mg/l). As a result, there was no threat to aquatic life in the lake, as most of the lake volume was inhabitable by fish and other aquatic organisms.

Phosphorus (P) is a nutrient that can enter lakes through runoff or be released from lake sediment, and high levels of phosphorus typically trigger algal blooms or produce high plant density. The average near surface total phosphorus (TP) concentration in Gages Lake was 0.034 mg/l, less than most of the lakes in the county studied since 1999 (county median = 0.059 mg/l). The average hypolimnetic TP concentration was 0.094 mg/l, almost half the hypolimnetic county median of 0.186 mg/l (Table 3, Appendix A). One of the reasons for the low hypolimnetic TP concentration was a significant drop in TP and soluble reactive phosphorus (SRP) in the hypolimnion in August and September, which decreased the average concentration. This drop also occurred in 1999. Without additional data, it is not possible to determine the cause of this drop.

The hypolimnetic phosphorus concentration in 2003 was approximately three times higher than the epilimnetic concentration. This is typical in a stratified lake, especially if stratification begins early in the summer like it did in Gages 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 is 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, all of 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 Gages Lake at the time of September sampling, TP levels were still very low and algae density had not increased.

The average epilimnetic TP concentration (0.034 mg/l) has increased since the 1999 study conducted on Gages Lake, when the average TP concentration was 0.022 mg/l. This relatively large increase (55%) may indicate that the lake is becoming more eutrophic, but it may also be a function of yearly fluctuations based on differences in rainfall or plant density. Because the plants in Gages Lake are treated almost every year and because plant density varies from year to year, TP concentrations may simply be responding to the condition of the plant community during a given year. Regardless, care should be taken and education of homeowners in the watershed should be carried out to ensure that the current phosphorus levels in Gages Lake do not increase much further in future years. It is also noteworthy that the 1996 epilimnetic TP concentration was 0.025 mg/l (Table 4, 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 glacial origin and deep morphometry of Gages Lake is likely contributing to this stability.

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 such as 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 epilimnetic TSS concentration (7.0 mg/l) in Gages Lake was slightly less than the county median (7.5 mg/l). TSS appeared to be closely related to total rainfall during the week prior to sampling (Figure 3). Typically, in eutrophic lakes, TP and TSS concentrations are correlated because high TP levels lead to an increase in planktonic algae and TSS levels rise as a result. Additionally, if high TSS concentrations are the result of dense planktonic algae, TSS and total volatile solids (TVS- a measure of organic solids such as algae) will be correlated as well. If TSS is mostly made up of sediment particles, NVSS (non-volatile suspended solids) will make up a high percentage of TSS. A relationship did exist between TP and TSS (Figure 4), but not between TSS and TVS, indicating that TSS concentrations were more closely linked to sediment particles in the water column. This conclusion was further supported by the high NVSS percentage (80%) of TSS. The relationship observed between TSS and TP was likely due to the amount of TP sorbed to those sediment particles. The average 1999 epilimnetic TSS concentration (5.5 mg/l) was 21% lower than the current average TSS concentration. This difference could be the result of numerous things, including differences in rainfall amounts and differences in plant density. Because no Sonar® treatment was carried out in 1999, plant density was likely higher and served to stabilize sediment and compete more readily with algae, reducing TSS in the water column.

Secchi depth (water clarity) in Gages Lake was relatively low throughout the summer, ranging from 2.97 feet in May to 5.38 feet in August. Decreases in Secchi depth coincided with increases in TSS as the summer progressed (Figure 5). An excellent volunteer lake monitoring program (VLMP) has been in place on Gages Lake since 1994. This Illinois Environmental Protection Agency (IEPA) program, organized and run by the Northeastern Illinois Planning Commission (NIPC), involves the collection of water quality data by a volunteer in the same sampling location and along the same time frame each year. Although the amount of data collected is often limited, it can provide valuable historical information on water clarity and, therefore, water quality on many Lake County lakes. Average Secchi depth has fluctuated since 1994, potentially increasing and decreasing with differences in rainfall amounts and/or plant density (Figure 6). For example, average Secchi depth was 7.5 feet in 1995, when plant density was very high because fluridone was not used to treat the lake that year. Secchi was over 9.0 feet in 2000. No large-scale herbicide treatment had been carried out the year before and only spot treatments were carried out in 2000. Plant density that year was higher, resulting in an increase in seasonal water clarity.

Average Secchi depth as measured by the volunteer on Gages Lake has been higher than the average Secchi depth as measured by us in 1996, 1999 and 2003, and monthly VLMP Secchi depth measurements were dramatically higher than ours in May, June and July 2003. This is likely because the volunteer is using a braided nylon line marked in specific intervals for Secchi depth measurement. Although originally supplied as standard equipment for the VLMP, this type of rope has a tendency to shrink when it is wetted over and over, and may be providing incorrect readings. It is recommended that the VLM and our staff perform side-by-side Secchi depth measurements to determine if human error or equipment error is to blame. Additionally, NIPC has now made 25-foot tape measures available as standard equipment for Secchi depth measurements and could provide this equipment to the Gages Lake VLM.

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, and 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. Average 2003 epilimnetic and hypolimnetic conductivities (1.3440 mS/cm and 1.3271 mS/cm, respectively) in Gages Lake had increased since sampling in 1999 when averages were 1.0910 mS/cm and 1.1013 mS/cm, respectively. The 2003 levels were also much higher than the county medians (0.7503 mS/cm and 0.7917 mS/cm, respectively) throughout the summer (Table 3, Appendix A). Epilimnetic total dissolved solids (TDS) concentrations, which have also been shown to be correlated with conductivity, were well above the county average (451 mg/l) in Gages Lake during every month of the study (Table 3, Appendix A). Further, the increases in conductivity and TDS from 1999 to 2003 were almost exactly the same (23%). Conductivity changes can occur seasonally and even with depth, but over the long term, increased conductivity levels can be a good indicator of potential watershed or lake

problems or an increase in pollutants entering the lake if the trend is noted over a period of years. The 2003 average conductivity has increased even more dramatically since 1996 (Table 4, Appendix A), indicating such a trend. High conductivity levels (which often indicate an increase in sodium or potassium chloride) can eventually change the plant community, as more salt tolerant plants take over. Sodium, potassium and chloride ions can bind substances in the sediment, preventing their uptake by plants and reducing native plant densities. Additionally, juvenile aquatic organisms may be more susceptible to high chloride concentrations. The general increase in conductivity levels observed in Gages Lake during the last seven years may be the cumulative result of years of road salt application to surrounding roads and higher road salt use due to the widening of some of the roads in the watershed (i.e., work on Illinois SR 45 in 2003). Gages Lake has an estimated retention time of four years. This means that any water, sediment, salt, etc. entering the lake this spring during heavy rain events will not potentially exit the lake for four years. This is a relatively high retention time that could explain the increase in some of the water quality parameters over the past 5-10 years. Although the increasing conductivity levels are cause for concern, there may not be much that can be done about it. Non-point runoff that picks up road salt and enters the lake during rain events, is very difficult to control and it may be unlikely that the amount of road salt dispersed along surrounding roads each winter would be reduced without policy changes in quantity or type of de-icer by the Illinois Department of Transportation and Warren Township 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. Gages Lake had an average TN:TP ratio of 34:1. This indicates that the lake is phosphorus limited and that a small increase in the phosphorus concentration could result in more filamentous or planktonic algae in the future. 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 Gages Lake, are typically more sensitive to increases or decreases in phosphorus, and planktonic or filamentous algae could become a problem with relatively small increases in TP. Care should be taken to ensure that no unnecessary sources of P are created around the lake. This may mean decreasing the amount of fertilizer applied to lawns in the watershed, or changing to the use of phosphorus-free fertilizer.

Phosphorus concentrations can also be used to indicate the trophic state (productivity level) of a lake. The Trophic State Index (TSI) uses phosphorus, chlorophyll *a* (algae biomass) 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=40-49) 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=50-69) 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. Gages Lake had an average phosphorus TSI (TSIp) value of 55, indicating eutrophic conditions (this is up from the 1999 TSIp of 49.0, which indicates the uppermost mesotrophic condition). Although a TSI of 55 is not extreme, this increase may indicate that Gages Lake is becoming a more eutrophic lake as a result of herbicide treatments and other residential influences such as stormwater input, lawn fertilizer and increased boat traffic. When compared to other lakes in the county, Gages Lake ranks 39th out of 130 lakes studied, with regard to total phosphorus concentration (Table 5, Appendix A).

Most of the water quality parameters just discussed can be used to analyze the water quality of Gages Lake based on use impairment indices established by the Illinois Environmental Protection Agency (IEPA). According to this index, Gages Lake provides *Full* support of aquatic life and swimming, and *Partial* support of recreation because of high levels of sediment in the water column. The lake has *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. Gages Lake currently has a plant management plan in place. Herbicide treatments have been carried out on Gages Lake for many years, but the first fluridone treatment was carried out in 1994. This herbicide is a systemic herbicide and differs from contact herbicides in that it must be taken up by the plant and kills the entire plant. It takes a longer amount of time to affect the plant, but is a longer lasting treatment that typically does not have to be repeated throughout the summer. Sonar™ was applied in 1996, 1998 and 2001. Avast™, a different fluridone product, was applied in 2003. Granular 2,4-D was applied as a spot treatment in 2000 and 2002. This is also a systemic herbicide. It is fast-acting, but does not always provide long-term control.

Observations by John Cortell of Marine Biochemists were as follows: In the fall of 1997, sago, largeleaf and Illinois pondweeds were growing in large beds in several locations of the lake and were often present in Eurasian watermilfoil (EWM) beds as well. A spring treatment of Sonar™ was carried out in April 1998. By September 1998, no EWM or sago pondweed could be located throughout the lake, and largeleaf and Illinois pondweeds were reduced in density. Planktonic algae blooms were occurring in shallow and shoreline areas. A new bathymetric map for Gages Lake was created in 1999. This was able to provide calculation of a more accurate application rate of Sonar™ based on lake volume. In 2001, Sonar™ was applied by Rich Rollins of Aquatic Weed Technology. For the first time, FasTEST was used to monitor the herbicide concentration for the first 60 days after application. FasTEST is a product that will quickly and effectively test the concentration of Sonar™ in the water column at different times throughout the application process. With the use of FasTEST, the actual concentration of Sonar™ could be determined one day after, two weeks after and four weeks after the original application. A check one day after the initial application would ensure that the desired concentration was actually achieved. A check two weeks after the first application would allow the applicator to determine if a "bump up" (a additional application to bring the concentration back up to a specific level) is needed, and, if so, how much product is necessary. A check 4 weeks after the original application would show the actual concentration at 30 days to ensure the Sonar™ concentration is still high enough to remove the target plants.

In 2003, the herbicide used for the whole lake treatment was Avast™. This herbicide has the same active ingredient as Sonar™, but is manufactured and sold by a different company. The application of 31 quarts Avast™ was conducted on May 2, with a target concentration of 10 ppb. AvasTEST (same function as FasTEST) was performed 5, 13, 35, 45 and 60 days after treatment. Concentrations were over double the target in both the north and east channels and was half the target in the main lake after five days. After 13 days, all three areas were below the overall target of 8 ppb and a bump-up application of 12.5 quarts Avast™ with a bump-up target concentration of 4 ppb was carried out on June 2, 2003. After 35 days, concentrations were just slightly below target of 8 ppb in the main lake and north channel. The 45 day AvasTEST on June 16th showed that concentrations were much closer to the target of 6 ppb on that date, as well as 60 days after treatment (Table 6, Appendix A). Several recommendations can be made for future applications based on the 2003 AvasTEST results.

1) Fluridone applications are being carried out such that most of the product is concentrated along the shorelines. However, in 2003, water samples for AvasTEST were collected in the center of the lake and were not collected at the same location each time. This methodology should be rectified by taking two samples in the main lake (one at a specific location along the shoreline and one in the center of the lake) and by maintaining consistency in the water sampling location through the use of GPS.

2) Consideration should be given to waiting an additional year before the scheduled fluridone treatment. In May, EWM, while present, was very sparse throughout the lake and was not topped out anywhere. It is our opinion that it would not have been problematic in 2003 and may have only required some spot treatments later in the summer. As fluridone is applied to EWM year after year, it may reduce the seed bank and the viability of overwintering plants. This may eventually reduce the EWM density during the summer, and smaller or less frequent application may be needed. It may also help to give native plants a foothold during non-treatment years. A three-year Avast™ treatment program should be considered.

3) Prior to any future fluridone applications, the volume of Gages Lake AT THE TIME OF THE APPLICATION should be calculated based on lake water level compared to the bathymetric map water level. Under no circumstances should an application be made without knowing the estimated lake volume being treated. If the lake level is down relative to the April 1999 lake level (date of the bathymetric map measurements), overtreatment of the lake will occur. Overtreatment with fluridone will not only hinder the survival and re-establishment of native plants, but will be a waste of money. In 2003, lake level was not used to calculate lake volume. Based on the amount of product used (31 quarts), the actual concentration applied was calculated to be 11 ppb, 1 ppb over the target concentration. Although this is not a huge difference in total concentration, it is important to note that a 0.1 foot difference in water level resulted in a 1 ppb difference in product concentration. This difference could be much more dramatic if spring lake levels are unusually low. GLCC should determine the proper lake level and pass this information along to the applicator providing chemical treatment. The lake level relative to lake level in 1999 can be determined by measuring lake level on the staff gage relative to the southeast corner of the seawalled boat slip at the home at 33242 N. Island Ave. Water levels were at the top of the seawall during the creation of the bathymetric map. This corresponds to a reading of 1.99 feet on the staff gage.

4) The first bump-up application should have been made much sooner. The main lake Avast™ concentration had fallen to 3.5 ppb by day 13, but was not bumped up until 17 days later (day 30). This may have allowed the concentration to drop below 2 ppb, reducing the effectiveness of the herbicide for that time period.

5) Although the initial application of fluridone can be calculated based on whole lake volume (taking into account current lake level relative to the lake level used to make the bathymetric map), a temperature profile should be done prior to any bump-up applications to determine the volume of water that is still mixing at the time of the bump-up. In 2003, the thermocline remained between 18 and 22 feet, affecting relatively little of the total volume. This is something that should be monitored closely to ensure that overtreatment of the mixed volume does not occur.

6) The initial target concentration is too high and is being kept too high throughout the 60-day treatment period. Studies have shown that a final concentration of 2 ppb will successfully remove EWM without harming native plant species. The reduction of the initial application target concentration to 6 ppb should be considered. Gray's Lake, located in the Village of Grayslake, reduced their target Sonar™ concentration from 15 ppb in the early 1990's to 12 ppb in the mid-late 1990's to 10 ppb in 2003 and have successfully gained control of EWM on a two-year treatment cycle. In 2001, a 12 ppb treatment was applied in mid-April and bumped-up 21 days later. No additional bump-up was applied and control of EWM lasted for two years. Spot treatments for curly leaf pondweed are applied in the off-years. Gray's Lake has seen the resurgence of native plant species and

an increase in water clarity (2002 Secchi depth was the highest in 14 years). Because Gages Lake does not have the same native plant community as Gray's Lake, a substantial increase in native plant density may not occur. However, a reduction of Sonar™/Avast™ concentration would provide a better chance for native plants to become established and remain viable throughout the summer. In a recent study of four Michigan lakes, results showed that a low-dose 5 ppb whole lake fluridone treatment stategy can provide control of EWM approaching 100% in the year of treatment and near 90% control through 15 months post-treatment, provided that adequate fluridone concentration/exposure time relationship is maintained. This relationship dictates that 5 ppb fluridone be maintained during the first 2-3 weeks of a treatment, followed by an exposure of ≥2 ppb for a period of at least 60 consecutive days (Madsen, et al., 2002). This study demonstrated that fluridone treatments, as described, did not have a negative impact on native plant diversity or percent cover.

7) PlanTEST and EffecTEST are two new products on the market from SePro. PlanTEST is used on the EWM plants prior to treatment to determine what concentration of fluridone is required to kill the plants. This prevents overtreatment or wasting product on plants that could be killed at a very low application rate, saving the GLCC money each treatment year. EffecTEST is used on EWM plants after treatment to determine how well the plants are absorbing the herbicide. Different plant and water chemistry in different lakes may affect absorption rate of the fluridone, requiring different application rates or exposure times. The GLCC may want to consider using these two products on their EWM plants and we can help to potentially have these tests run AT NO COST by SePro Corporation.

8) A replanting program could be started in shallow areas of the lake where light penetration is adequate. If there is substantial re-growth of sago pondweed or largeleaf pondweed in one part of the lake, some of these plants could be transplanted to other areas of the lake to promote a native plant population. Aquatic plant plugs can also be purchased from many different nurseries in the area and small areas can be re-planted (Table 11). Plants will need to be protected on all sides (including the top) from waterfowl and common carp for at least the first growing season. Treatment of EWM and the re-establishment of a native plant community could eventually reduce the amount of EWM present in the lake.

Although it was sparse, EWM dominated the plant community in 2003. Small amounts of curly leaf pondweed, largeleaf pondweed, and *Chara* were also observed, but only in May and June (Tables 7 & 8). During the study, light level was measured at two-foot intervals from the water surface to the lake bottom. When the light intensity falls below 1% of the level at the water surface, plants are no longer able to grow. Using this information, it can be determined how much of the lake has the potential to support aquatic plant growth. Based on 1% light level, Gages Lake could have supported plants over 68%-85% of the lake area , depending on the month. Plants did not grow over this surface area and were relatively sparse even before the herbicide treatment began to take effect. The inability of aquatic plants to grow in all areas as determined by percent light level may be explained by the presence of inadequate substrate in various parts of the lake, the use of herbicides and the possible depletion of the native plant seed bank.

The plant management plan for Gages Lake appears to be successfully treating the target plant species of EWM, as very little was observed in the lake during the summer. However, almost no other plant species existed in the lake. A truly healthy plant community contains a large number of plant species that provide different types of habitat and structure to the lake. As mentioned above, it is recommended that the concentration of Avast™ be lowered in order to allow some of the native pondweeds to become re-established and that other steps be taken to carefully monitor herbicide concentrations and prevent over-treatment. Some re-establishment of native plants may occur naturally, but a re-planting program may also be established in undisturbed areas of the lake. Two local lakes, Sand Lake in Lake Villa Township and Forest Lake near Hawthorn Woods, are attempting to re-establish native plants in shallow areas of the lake by planting plants and root plugs of various aquatic plant species. The GLCC could carry out a similar program on Gages Lake for relatively little cost with our input and assistance. If the residents are unhappy with the condition of the lake at a lower Avast™ concentration, spot treatments can be carried out in specific areas of growth. However, education on this matter is important and residents need to understand the beneficial role of plants in a lake ecosystem, so as not to perceive a small increase in plant variety as negative and to add their support to a plant re-establishment program.

Of the eight emergent plant and trees species observed along the shoreline of Gages Lake, three (reed canary grass, honeysuckle and buckthorn) are invasive species that do not provide ideal wildlife habitat.

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 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 14.4. Gages Lake has an FQI of 5.8, which is well below the county average and very low for a glacial lake. The lake ranks 29th out of 32 lakes studied in 2003 and 105th out of 118 lakes studied since 2000. The low FQI number reflects the fact that herbicide treatment has had a long history in Gages Lake and that much of the native seed bank may have been lost over the years.

Table 7. Aquatic and shoreline plants on Gages Lake, May-September 2003.

Aquatic Plants	
Chara	*Chara* spp.
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Largeleaf Pondweed	*Potamogeton amplifolius*
Curlyleaf Pondweed^	*Potamogeton crispus*
Shoreline Plants	
Reed Canary Grass^	*Phalaris arundinacea*
Common Cattail	*Typha latifolia*
Wild Grape	*Vitis* sp.
Trees/Shrubs	
Box Elder	*Acer negundo*
Silver Maple	*Acer saccharinum*
Honey Locust	*Gelditsia triacanthos*
Black Walnut	*Juglans nigra*
Honeysuckle^	*Lonicera* sp.
Common Buckthorn^	*Rhamnus cathartica*
Staghorn Sumac	*Rhus typhina*
Weeping Willow	*Salix alba tristis*
Elderberry	***Sambucus*** sp.

^Exotic plant or tree species

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted at Gages Lake on July 10, 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 93% of Gages Lake's shoreline is developed. The majority of the developed shoreline is comprised of seawall (42.0%) and rip rap (19.9%) (Figure 7). The remainder consists of manicured lawn (16.7%), beach (8.0%), buffer (3.6%), shrub (2.0%) and woodland (0.2%). Although rip rap and seawalls are not ideal shoreline types with regard to wildlife habitat, they do, typically, help to prevent shoreline erosion. As a result of the dominance of these two shoreline types around Gages Lake, 76.1% of the shoreline exhibited no erosion (Figure 8). However, certain types of shoreline exhibited a significant amount of erosion. The types of shoreline exhibiting the majority of the erosion were shrub (100%), woodland (100%) and manicured lawn (70.6%). Other shoreline types with erosion included beach, buffer, riprap and seawall. Although the deep roots of shrubs and trees can hold soil in place and filter some nutrients, if improperly maintained, shrub and woodland shorelines, especially those with buckthorn infestations, will typically exhibit 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 typically lead to erosion on most lakes. Although rip rap and seawalls are intended specifically to prevent or stop erosion, if improperly installed, these shorelines can exhibit significant erosion. Often, the rip rap consists of very small rocks that simply end up sloughing into the lake as a result of wave action. If they are not replaced, erosion will occur on the exposed soil. The same is true for shorelines with improperly installed seawall.

The Wildwood Park District has proposed a shoreline stabilization and planting project for the summer of 2004 along its six parks (Appendix D). We noted slight to moderate erosion occurring along three of these sites in 2003 (Figure 8). At Pebble Beach Park, a proposed 485 feet of seawall, 245 feet of native plants and 116 feet of beach will be installed. At Rule Park, which does not currently exhibit any erosion, 600 feet of new rip rap and native plants are proposed. Exotic species (buckthorn) is not proposed to be removed from the park, but park district officials should consider this additional step at this site. At Willow Point Park, which exhibited slight to moderate erosion in 2003, 560 feet of native plants, 325 feet of seawall, 85 feet of new beach and 50 feet of gravel rip rap will be added. At Sunset Park, the existing seawall will be extended by 233 feet and a small area of gravel rip rap will be added near the boat launch. Native plants (261 feet) will be established at Cove Park, which is currently lined with rip rap. Boulder Park, which had slight erosion in 2003, will be lined with 310 feet of seawall and approximately 30 feet of native plants on its northwest end. Lake Shore Drive Park will be treated in the same way as Cove Park. Rip rap already exists along the shoreline. Native plants will be added on top of this rip rap (250 feet). Stabilization of a total of 3,500 linear feet of shoreline is proposed and awaiting approval by the Illinois Environmental Protection Agency. This is an excellent project that would potentially reduce the amount of eroding shoreline on Gages Lake by 10%. However, there are other areas of shoreline around the lake that should also be addressed, including a long stretch of wooded shoreline along Il Route 45 (owned by the Board of Junior College District 53) and a shrubby/wooded shoreline in the north cove (owned by the Dady and Decker Lagoon Association) (Figure 8). These areas should be cleared of buckthorn infestations and re-planted with native upland and emergent plants (Table 10).

Very few homeowners have installed buffer strips of emergent vegetation along their shorelines. Buffers are excellent features for providing erosion control and wildlife habitat and for reducing sediment and nutrient load to the lake. It is recommended that these emergent types of buffer strips, as well as upland buffer strips, be installed along as many shorelines as possible. Upland buffers can even be installed above rip rap or seawalled shorelines to help filter non-point runoff before it enters the lake.
Although relatively little erosion was occurring around Gages Lake, invasive plant species, including reed canary grass, honeysuckle and buckthorn were present along 16.8% of the shoreline. The areas of invasion were concentrated along woodland areas on the west and south sides of the lake and in the northern channel. These plants are

extremely invasive and exclude native plants from the areas they inhabit. Buckthorn and honeysuckle provide very poor shoreline stabilization and have already led to erosion problems in wooded or shrubby areas of the Gages Lake shoreline. Reed canary grass inhabits mostly wet areas and can easily outcompete native plants. Additionally, it does not provide the quality wildlife habitat or shoreline stabilization that native plants provide. Since the relative density of the invasive species found around Gages Lake was not extremely high, steps to eliminate these plants should be carried out before they become a nuisance.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Since 1961, fish surveys have been performed on Gages Lake by the Illinois Department of Natural Resources (IDNR). A rotenone (fish poison) treatment was carried out in 1968. A fish survey in 1987 yielded 661 fish comprising 9 species. The fishery was dominated by bluegill and also made up of, carp, yellow bass, largemouth bass, black crappie and yellow perch. The 1992 fish survey yielded 459 fish comprising 16 species and their hybrids. Bluegill continued to dominate the population, followed by carp, yellow bass, pumpkinseed, yellow perch, largemouth bass, northern pike and walleye. Supplemental surveys for largemouth bass were conducted in 1997, 1999, 2000 and 2001. In 1997, 385 fish from 16 species were collected. Seventeen largemouth bass were collected. Bluegill dominated the catch, making up 57.7% of the total. Two hundred and five fish were collected from 13 species in 1999. Only 4 largemouth bass were caught, and carp represented 41% of the total catch. In 2000, 179 fish from 10 species were collected. Twelve largemouth bass were collected, which was an increase from 1999, but was still far below the 60 bass per hour goal. Fewer carp were collected in 2000, but carp will continue to be removed from the lake via an annual carp derby. In 2001, 58 fish from 8 species were collected. Twelve largemouth bass were also collected in 2001 and only 10 carp were collected. The size distribution of the bass suggested that few smaller sized fish were present and that natural reproduction may still be insufficient to maintain the population. In 2003, 19 bass were collected from seven age classes. The lack of vegetation has slowed the development of a stable fishery and impacted the diversity of species present in the lake. None of the species mentioned in other glacial lakes in 2003 (grass pickerel, lake chubsuckers, central mudminnows or bowfin) were found in Gages Lake. Re-establishment of glacial fish species is an IDNR recommendation.

Walleye have been stocked in the lake since 1986. Records of fish stocking since 1999 include approximately 3,000 walleye fingerlings (4-6 inches), approximately 400 northern pike and approximately 2,500 largemouth bass fingerlings each year. Fish limits on Gages Lake, enforced by the IDNR, include largemouth bass (15 inches/3 per day), walleye (16 inches/3 per day) and northern pike (24 inches/3 per day). An annual spring carp derby typically yields close to 50 carp, which are removed from the lake and disposed of. Approximately 20 fish cribs have been placed in Gages Lake since 1998. The cribs are located at depths that range from 12 to 16 feet around both deep holes

(Figure 1). These should be very beneficial to the fish community, considering the absence of proper fish habitat made up of vegetated areas in the lake.

Wildlife observations were made on a monthly basis during water quality and plant sampling activities (See Appendix B for methodology). Although wildlife habitat in the form of woodland, shrub and buffer areas was not abundant around Gages Lake, several species of waterfowl, as well as a good mix of songbirds were observed (Table 8). Additionally, based on verbal verification with the VLM on the lake, migratory waterfowl (loons, mergansers, bufflehead) are abundant on the lake in the spring. A study done by researchers at the University of Michigan and the Wisconsin Department of Natural Resources showed that birds that eat insects and birds that nest on the ground were less common around developed lakes, while birds that eat seeds and berries were more prevalent. When assessing bird communities using more traditional methods, the researchers found no differences in bird numbers and species around developed and undeveloped lakes. However, the more detailed analysis used in their study suggests that lakeside homeowners' habits of clearing brush, planting lawns, and stocking bird feeders contribute to the differences in bird guilds (ecological groups) and result in the high number of seed and berry eating species. It is also possible that the prevalence of domestic cats and raccoons in more developed areas may threaten ground nesting birds and their eggs.

While an abundance of seed-eating birds is not a problem, the loss of insect-eating birds could be. Without birds to keep them in check, insect larvae such as gypsy moths and tent caterpillars could cause damage to plants and trees. The researchers recommend that shoreline homeowners keep their lawns small, encourage native vegetation, and keep pets away from areas where birds may be nesting or feeding. Gages Lake appears to have a mix of both seed and insect eaters among the songbirds observed. However, it is important that the current buffer, woodland and shrub areas around the Gages Lake be maintained and that additional buffered areas be encouraged to provide the appropriate habitat for a continued high diversity of bird species into the future.

Table 9. Wildlife species observed at Gages Lake, May-September 2003.

<u>*Birds*</u>	
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Ring-billed Gull	*Larus delawarensis*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Belted Kingfisher	*Buteo jamaicensis*
Common Flicker	*Colaptes auratus*
Eastern Phoebe	*Sayornis phoebe*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
American Crow	*Corvus brachyrhynchos*

Table 9. Wildlife species observed at Gages Lake, May-September 2003 (cont'd).

<u>*Birds*</u>	
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Peocile atricapillus*
House Wren	*Troglodytes aedon*
Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Common Grackle	*Quiscalus quiscula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Song Sparrow	*Melospiza melodia*

EXISTING LAKE QUALITY PROBLEMS

- *Lack of Diverse Aquatic Vegetation*

  One key to a healthy lake is a healthy plant community. EWM was the dominant plant species throughout the summer, but is treated every other year with fluridone, resulting in almost no plant coverage in the lake. Avast® is being used to treat the EWM, but may also be affecting native plants, preventing the establishment of a diverse plant community. Recommendations have been made to: (1) wait an additional year before a scheduled fluridone treatment (3 year schedule) in order to save money and allow native plants to become more strongly established in between herbicide treatments, (2) calculate the volume of the lake at the time of the application to determine the correct amount of herbicide to put in the lake to achieve the target concentration, (3) carry out the mid-treatment bump-up application sooner so as to prevent the herbicide concentration from falling below an effective level, (4) determine the volume of water still mixing (above the thermocline) before the bump-up application, (5) reduce the initial target and subsequent target concentrations so as to reduce the negative impact on native plants, and (6) utilize PlanTEST and EffecTEST to determine if it is possible to reduce the number of herbicide applications or application concentrations, (7) a plant re-establishment program can be attempted in shallow, undisturbed areas of the lake.

- *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. Reed canary grass is an exotic plant found in wetland habitat. It spreads very quickly and is not well utilized by wildlife. Buckthorn and honeysuckle 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, honeysuckle and buckthorn are present along 16.8% of the shoreline of Gages Lake, and attempts should be made to control their spread before they become a large problem.

- *Limited Wildlife Habitat and Slight Shoreline Erosion*

  Nearly 93% of Gages Lake's shoreline is dominated by residential homes, which do not always encourage a diverse bird and animal community. While a few residents have buffer strips along their shore, many of the residents have rip rap, seawalls, manicured lawn and beaches. It is recommended that those residents that already have buffer consider widening their strips and do their best to encourage neighboring properties to establish buffers. It is also recommended that those residents that do not have a buffer strip or are experiencing erosion consider planting at least a 10-20 foot (or more) wide strip of native plants along their shoreline. This could increase wildlife habitat, reduce the amount of nutrients and soil particles entering the lake and decrease shoreline erosion. Pathways through these buffers could accommodate lake access for homeowners without reducing the integrity of the buffer. Slight to moderate erosion is occurring along 25% of the shoreline, especially along areas dominated by shrub, woodland and manicured lawn.

POTENTIAL OBJECTIVES FOR THE GAGES LAKE MANAGEMENT PLAN

I. Reestablish Native Aquatic Vegetation
II. Eliminate or Control Invasive Species
III. Enhance Wildlife Habitat Conditions
IV. Control Shoreline Erosion

OPTIONS FOR ACHIEVING THE LAKE MANEMENT PLAN OBJECTIVES

Objective I: Reestablish Native Aquatic Vegetation

At minimum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis. The minimum depth of the 1% light level in 2003 was 6.3 feet. No new plants should be established deeper than 5-6 feet to ensure adequate light penetration.

There are two methods by which reestablishment can be accomplished. The first involves the use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake are allowed to naturally expand into adjacent areas. If native plants were to re-emerge as herbicide treatment is decreased, this could be an option for Gages Lake. Another technique utilizing existing plants is to transplant vegetation from one area to another. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 10, Appendix A lists common, native plants that should be considered when developing a revegetation plan. Included in this list are aquatic shoreline vegetation (rushes, cattails, etc.) and deeper water plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

Pros

By revegetating barren areas, the lake will benefit in several ways. Expanded native plant populations will help with sediment stabilization. This in turn will have a positive effect on water clarity by reducing suspended solids and nutrients that decrease clarity and cause excessive algal growth. Properly revegetating shallow water areas with plants such as cattails, bulrushes, and water lilies can help reduce wave action that leads to shoreline erosion. Increases in desirable vegetation will increase the plant biodiversity and also provide better quality habitat and food sources for fish and other wildlife. Recreational uses of the lake such as fishing and boating will also increase due to the improvement in water quality.

Cons

There are few negative impacts to revegetating a lake. One potential drawback is the possibility of new vegetation expanding to nuisance levels and needing control. However, this is an unlikely outcome. Another drawback could be high costs if extensive revegetation is needed using imported plants. If a consultant were used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

Costs

See Table 11, Appendix A for local vendors.

Objective II: Eliminate or Control Invasive 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 and is quick to become established on disturbed soils. Reed canary grass is an aggressive plant that 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 purple loosestrife, 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*).

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. However, problems arise when plants are left to spread, many times to the point where treatment is difficult or cost prohibitive. A monitoring program should be established, problem areas identified, and control measures taken when appropriate. Although exotic species were found along approximately 16.8% of the shoreline of Gages Lake, the density of the plant species in these areas was not extremely high. Therefore, control measures should be carried while these exotics would still be relatively easy to control.

<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 when possible.

Table 10, 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 effected.

Costs
Costs with this option are zero 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 before seed heads appear, 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. 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 unpractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option due to the fact that in order to chemically treat the area a broadcast application would be needed. Since many of the herbicides that are used 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 a herbicide soaked device. Trees are normally treated by cutting a ring in the bark (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 unless it is a monocrop of a specific plant species. 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 III: 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).

Option 1: No Action

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 effects 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 Tables 10 and 11, Appendix A for information). 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.

Option 3: Increase Natural Food Supply

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 10, 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.

Objective IV: Control Shoreline Erosion

Erosion is a potentially serious problem to lake shorelines and occurs as a result of wind, wave, or ice action or from overland rainwater runoff. While some erosion to shorelines is natural, human alteration of the environment can accelerate and exacerbate the problem. Erosion not only results in loss of shoreline, but negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. This effect is felt throughout the food chain since poor water quality negatively affects everything from microbial life to sight feeding fish and birds to people who want to use the lake for recreational purposes. The resulting increased amount of sediment will over time begin to fill in the lake, decreasing overall lake depth and volume and potentially impairing various recreational uses. Gages Lake has slight to moderate erosion along 25% of its shoreline, concentrated along shrub, woodland and manicured lawn. The Wildwood Park District has proposed shoreline stabilization and planting at seven of its parks. The project would reduce the amount of eroding shoreline by 10%. Additional areas of erosion on the west side of the lake and in the Dady and Decker Lagoon should be addressed as soon as possible.

Option 1: No Action

Pros

There are no short-term costs to this option. However, extended periods of erosion may result in substantially higher costs to repair the shoreline in the future.

Eroding banks on steep slopes can provide habitat for wildlife, particularly bird species (e.g. kingfishers and bank swallows) that need to burrow into exposed banks to nest. In addition, certain minerals and salts in the soils are exposed during the erosion process, which are utilized by various wildlife species.

Cons

Taking no action will most likely cause erosion to continue and subsequently may cause poor water quality due to high levels of sediment or nutrients entering a lake. This in turn may retard plant growth and provide additional nutrients for algal growth. A continual loss of shoreline is both aesthetically unpleasing and may potentially reduce property values. Since a shoreline is easier to protect than it is to rehabilitate, it is in the interest of the property owner to address the erosion issue immediately.

Costs

In the short-term, cost of this option is zero. However, long-term implications can be severe since prolonged erosion problems may be more costly to repair than if the problems were addressed earlier. As mentioned previously, long-term erosion may cause serious damage to shoreline property and in some cases lower property values.

Option 2: Create a Buffer Strip

Another effective method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat. Cost of creating a buffer strip is quite variable, depending on the current state of the vegetation and shoreline and whether vegetation is allowed to become established naturally or if the area needs to be graded and replanted. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Non-native plants or noxious weedy species may be present and should be controlled or eliminated.

Stabilizing the shoreline with vegetation is most effective on slopes no less than 2:1 to 3:1, horizontal to vertical, or flatter. Usually a buffer strip of at least 25 feet is recommended, however, wider strips (50 or even 100 feet) are recommended on steeper slopes or areas with severe erosion problems. Areas where erosion is severe or where slopes are greater than 3:1, additional erosion control techniques may have to be incorporated such as biologs, A-Jacks®, or rip-rap.

Buffer strips can be constructed in a variety of ways with various plant species. Generally, buffer strip vegetation consists of native terrestrial (land) species and emergent (at the land and water interface) species. Terrestrial vegetation such as native grasses and wildflowers can be used to create a buffer strip along lake shorelines. Table 10, Appendix A gives some examples, seeding rates and costs of grasses and seed mixes that can be used to create buffer strips. Native plants and seeds can be purchased at regional nurseries or from catalogs. When purchasing seed mixes, care should be taken that native plant seeds are used. Some commercial seed mixes contain non-native or weedy species or may contain annual wildflowers that will have to be reseeded every year. If purchasing plants from a nursery or if a licensed contractor is installing plants, inquire about any guarantees they may have on plant survival. Finally, new plants should be protected from herbivory (e.g., geese and muskrats) by placing a wire cage over the plants for at least one year.

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or rip-rap. Native emergent vegetation can be either hand planted or allowed to become established on its own over time. Some plants, such as native cattails (*Typha* sp.), quickly spread and help stabilize shorelines, however they can be aggressive and may pose a problem later. Other species, such as those listed in Table 10, Appendix A should be considered for native plantings.

Pros

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e., no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have to be continuously mowed, watered, or fertilized. Occasional high mowing (1-2 times per year) for specific plants or physically removing other weedy species may be needed.

The buffer strip will stabilize the soil with its deep root structure and help filter run-off from lawns and agricultural fields by trapping nutrients, pollutants, and sediment that would otherwise drain into the lake. This may have a positive impact on the lake's water quality since there will be less "food" for nuisance algae. Buffer strips can filter as much as 70-95% of sediment and 25-60% of nutrients and other pollutants from runoff.

Another benefit of a buffer strip is potential flood control protection. Buffer strips may slow the velocity of flood waters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. Many plants can survive after being under water for several days, even weeks, while turfgrass is intolerant of wet conditions and usually dies after several days under water. This contributes to increased maintenance costs, since the turfgrass has to be either replanted or replaced with sod. Emergent vegetation can provide additional help in preserving shorelines and improving water quality by absorbing wave energy that might otherwise batter the shoreline. Calmer wave action will result in less shoreline erosion and resuspension of bottom sediment, which may result in potential improvements in water quality.

Many fish and wildlife species prefer the native shoreline vegetation habitat. This habitat is an asset to the lake's fishery since the emergent vegetation cover may be used for spawning, foraging, and hiding. Various wildlife species are even dependent upon shoreline vegetation for their existence. Certain birds, such as marsh wrens (*Cistothorus palustris*) and endangered yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) nest exclusively in emergent vegetation like cattails and bulrushes. Hosts of other wildlife like waterfowl, rails, herons, mink, and frogs to mention just a few, benefit from healthy stands of shoreline vegetation. Dragonflies, damselflies, and other beneficial invertebrates can be found thriving in vegetation along the shoreline as well.

In addition to the benefits of increased fish and wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of various colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

Cons

There are few disadvantages to native shoreline vegetation. Certain species (i.e., cattails) can be aggressive and may need to be controlled occasionally. If stands of shoreline vegetation become dense enough, access and visibility to the lake may be compromised to some degree. However, small paths could be cleared to provide lake access or smaller plants could be planted in these areas.

Costs

If minimal amount of site preparation is needed, costs can be approximately $10 per linear foot, plus labor. Cost of installing willow posts is approximately $15-20 per linear foot. 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. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.