2003 SUMMARY REPORT
of
LITTLE SILVER 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

TABLE OF CONTENTS

APPENDIX A. DATA TABLES FOR LITTLE SILVER LAKE.

APPENDIX B. METHODS FOR FIELD DATA COLLECTION AND LABORATORY ANALYSES.

APPENDIX C. 2003 AND 1999 MULTIPARAMETER DATA FOR LITTLE SILVER LAKE.

APPENDIX D. LITTLE SILVER LAKE STORMWATER SAMPLING SUMMARY 2002-2003.

EXECUTIVE SUMMARY

Little Silver Lake, located in unincorporated Lake County, Antioch Township, was created over 10,000 years ago by receding glaciers. Settlement of the land around the lake began in the 1800's when the lake was used by summer residents. The lake has a surface area of 42.7 acres and a mean depth of 7.4 feet. It is used by private homeowners for swimming, boating and fishing. There is one beach, located on the northeast side of 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. Little Silver Lake was stratified from May-August. Total phosphorus (TP) levels were very low throughout the summer, increasing only in September during fall turnover and plant decomposition. Total suspended solids (TSS) concentrations were also very low and water clarity was high throughout the summer. The concentrations of many parameters in Little Silver Lake have changed only slightly in the past 10 years. This is exceptional, as it is unusual for a lake in Lake County, where residential and agricultural land use is so prevalent, to maintain its TP, TSS and Secchi depth clarity over that period of time. This is a testimony to the efforts by the lake homeowners to limit activities that might threaten water quality. Stormwater pollution from Pine Hill Lakes Subdivision and, previously, from Hillcrest Elementary School has been a large concern for watershed stakeholders over the past several years and continues to be monitored by county and state agencies.

White water lilies, coontail and Eurasian watermilfoil (EWM) dominated the plant community in 2003. However, twenty-three different plant species were found in Little Silver Lake over the course of the summer, including the state threatened plant, grass leaved pondweed. This very healthy plant community provided Little Silver Lake with good fish habitat and kept water clarity high by reducing sediment resuspension in shallow areas and competing with planktonic algae for nutrients. The milfoil weevil is present in Little Silver Lake, but does not appear to be controlling the EWM at this time. It is recommended that either very limited herbicide applications or hand pulling be used to address excessive vegetation along private beach and pier areas.

Although 45% of the Little Silver Lake shoreline consisted of residential parcels, the shoreline was dominated by buffer, wetland and woodland. The presence of so much buffer along developed shorelines is exceptional, and these shoreline types should be maintained. Although almost no erosion was occurring around Little Silver Lake, Canada thistle, buckthorn, honeysuckle, purple loosestrife and reed canary grass were present along 40% of the shoreline. These are exotic plant species that out-compete native vegetation and provide poor habitat for wildlife. Many of the exotic plants were occurring along residential shoreline and can easily be removed. An extremely large number and diversity of waterfowl and bird species were observed during the spring of 2002 and the summer of 2003.

LAKE IDENTIFICATION AND LOCATION

Little Silver Lake is located north of Illinois State Route 173 and east of Deep Lake Road in unincorporated Antioch Township (T 46N, R 10E, S 9, 16). All homes around the lake have septic systems. Little Silver Lake has a surface area of 42.7 acres and mean and maximum depths of 7.4 feet and 22.5 feet, respectively. It has a volume of 316 acre-feet and a shoreline length of 1.3 miles (Figure 1, Appendix A). The watershed of Little Silver Lake encompasses approximately 638.6 acres, draining McGreal Lake and residential developments to the north, and farm fields and wetlands to the east and south (Figure 2).

Recently, stormwater has been a big concern to the stakeholders in the Little Silver Lake watershed. A large storm event in June 2000 resulted in stormwater pollution to the lake from Pine Hill Lakes Subdivision and Hillcrest Elementary School and prompted a letter from concerned stakeholders of the Little Silver Lake Improvement Association (LSLIA). In March 2002, an evaluation of the condition of the soil erosion and sediment control measures in the Pine Hill Lakes Subdivision was conducted by a representative from the Lake County Stormwater Management Commission (SMC). Problem areas were identified and recommended solutions were to be carried out within 10 days of the notification. On May 14, 2002, staff from the Natural Resources Conservation Service visited the Pine Hill Lakes Subdivision and concluded that the detention ponds just upstream from Little Silver Lake were functioning well as sediment traps for normal flow events and that there was very little that could be done to improve their function for trapping sediment. On May 16th and June 4th, 2002, water samples were collected by our staff from two pipes in the stormwater system of Pine Hill Lakes Subdivision (Sites 1 and 2) and tested for total suspended solids (TSS) (Figure 3). TSS concentrations were elevated at Site 2, which flows into Pine Hills Pond 3 on June 4, 2002, but not on the other sample date. Regardless, concern was still high among lakeshore homeowners, and on May 28th and June 18th, 2003, water samples were again collected by our staff from the same two sites at Pine Hill Lakes. Additionally, samples were collected from a large stormwater pipe draining the property of Hillcrest Elementary School, which was under construction at the time (Site 3) (Figure 3). TSS concentrations from samples at Sites 1 and 2 were much more elevated than in 2002 and TSS concentrations were extremely high at Site 3 (Appendix D). After we sent a report of these results to several agencies or persons with a vested interest in this erosion control failure, action was taken via repaired silt fences, placement of hay bales and seeding of exposed soil to reduce soil erosion and runoff from the school site. As a result of the high levels of TSS potentially entering Little Silver Lake from the subdivision and the school, and additional concern regarding runoff from Phase II of the Wal-Mart Supercenter that will be constructed on Illinois State Rte. 173, a public meeting was held on August 4, 2003 by the Illinois Environmental Protection Agency (IEPA). The meeting was for any concerned citizens and Great Lakes Principals, the contractor for Wal-Mart. The result of that meeting was that the IEPA determined that the Wal-Mart project complied with water quality standards, and Great Lakes Principals was granted Section 401 certification to continue with current Phase I construction (which drains into East Loon Lake). On December 10, 2003, despite the installation of a riser tube in the Wal-Mart detention pond and a double

line of silt fences, a large rain event caused the detention pond and silt fences to be overcome by water running off the construction site. Although a TSS sample was not collected, visual observation of the runoff suggested that TSS concentration was extremely high. Afterward, it was determined that the riser tube had not been installed to a correct height and had not been wrapped with filter fabric. These adjustments were made (although the type of fabric used to wrap the tube was not correct), but during the next storm events recorded on March 2 and March 5, 2004, water coming off of the construction site through the detention pond and silt fences was still very turbid (March 2nd: TSS in pond= 36.0 mg/l; TSS from pipe= 36.6 mg/l, March 5th: TSS in pond = 442 mg/l; TSS from pipe= 482 mg/l). From these TSS results, it appeared that the stormwater treatment measures were not treating the water at all. Steps were, again, taken to try to improve stormwater treatment of the Wal-Mart site. A polymer system was installed. This system consists of a 15 inch pipe carrying water 1000 feet from the detention basin. In the upper portions of the pipe, 16 APS 706b Floc Logs® were placed to introduce polymers into the treatment system. These polymers bound suspended particles, causing a floc to form. The treated water then traveled down 1000 feet to a newly constructed grit pit (8' wide, 6' deep and 10' long), where most of the floc settled out immediately. The remaining lighter floc fraction in suspension was then filtered out by a baffle grid system made up of 10 jute baffles. These baffles filtered this finer floc and suspended sediment still left in the water column before they reached an outflow pipe that pulls treated surface water from the pond (Figure 4). Samples collected on March 24, 2004, showed that the polymer system reduced TSS discharge by 73% from the temporary sediment basin during a heavy rain event (In Pond TSS: 181 mg/l; Polymer Outlet TSS: 49 mg/l). However, the gains made by the new polymer system were negated by turbid water flowing in the ditch running along Rt. 173 and mixing with the polymer discharge before entering the adjacent wetland leading to East Loon Lake (Combined water TSS: 177 mg/l). The Village of Antioch is currently working with it's Public Works Department and Wal-Mart to reduce or eliminate the ditch flow mixing with discharge from the Wal-Mart site.

The watershed to lake surface area ratio of 15:1 is of moderate size, but may help prevent serious water quality problems that often accompany a larger watershed to lake ratio. For lakes with large watershed to lake ratios (>20:1), watershed activities such as agricultural practices and residential and/or commercial development can potentially exert a greater influence on the water quality of a lake than lakes possessing small watershed to lake ratios. Conversely, for lakes with small ratios, shoreline activities such as heavy fertilizer use or failing septics may have a greater influence on the lake's water quality. According to the most recent land use survey of the Little Silver Lake watershed, conducted in 2000, residential areas make up about one third of the watershed, while open space areas such as forest/grassland and wetland make up about 44% of the watershed (Figure 5). The presence of a high amount of vegetated land in the watershed likely contributes to the high quality of Little Silver Lake. McGreal Lake lies upstream of Little Silver Lake in its watershed. The water quality of McGreal Lake is very poor compared to Little Silver Lake, with elevated phosphorus concentrations, relatively low Secchi depths and an enormous infestation of curlyleaf pondweed, coontail and Eurasian watermilfoil. However, since there is not a direct link from McGreal Lake to Little Silver Lake (water

exiting McGreal Lake passes through several wetland areas and small detention basins), it does not appear that the water quality of Little Silver Lake is affected by the water quality of McGreal Lake (Figure 2). Water exits Little Silver Lake and flows into Sequoit Creek via two outlets on the western shore. The lake is located in the Sequoit Creek sub basin, within the Fox River watershed.

BRIEF HISTORY OF LITTLE SILVER LAKE

Little Silver Lake is of glacial origin, created approximately 10,000 years ago during the last ice age. Settlement of the land around Little Silver Lake began in the 1800's. According to a county plat map dated 1861, the land around the lake was owned by five individuals. Duke Rutchford was also one of the early land owners on the lake, running a fishing resort , Duke's Resort, on the northwest end of the lake until the 1940's, when it was sold to Wayne Erickson who renamed it Jacey's Resort. The Little Silver Lake Improvement Association (LSLIA) was unofficially formed in the 1920's as a group of lake stewards. The association became established in 1948. Management activities of the lake, controlled by the LSLIA have been ongoing since the 1970's. Sometime in the 1960's the outlet of the lake was channelized and deepened. By 1970, Illinois Department of Natural Resources (IDNR) staff noted that the lake was 12-15 inches shallower than in the early 1960's. This IDNR staff member also indicated that the spread of aquatic plants had increased because of the lower water level. His suggestion at that time was the installation of a spillway to maintain the water level at 765 feet. This was accomplished in 1972.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Detailed records of historical lake management techniques on Little Silver Lake are limited. The application of copper sulfate and 2, 4-D was first noted in 1972. A weed cutter was purchased and is still minimally used to cut plants in the north bay. Because the plants were just cut and not harvested, this practice may have promoted the spread of Eurasian watermilfoil (EWM) to different parts of the lake through plant fragmentation. EWM has been present in the lake since the 1950's and became problematic in the early 1960's. Although no large-scale herbicide applications are currently made through the LSLIA, a few individual homeowners treat the plants in front of their property, targeting EWM and water lilies. These homeowners should consult a parcel map, indicating property lines extending into the lake before continuing this practice. In Illinois, it is illegal to treat aquatic plants if you do not own the lake bottom in the area being treated. Currently, access to Little Silver Lake is only open to homeowners and their guests

The lake's main uses are boating, swimming and fishing. Boat restrictions on the lake include a no gas motor policy. Currently, the biggest management concerns expressed by the LSLIA are plant growth and sediment and nutrient pollution from residential and proposed commercial development in the watershed.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples collected from Little Silver Lake were analyzed for a variety of water quality parameters (See Appendix B for methodology). Samples were collected at 3 foot and 16-18 foot depths (depending on site water depth) from the deep hole location in the lake (Figure 6). Little Silver Lake was thermally stratified from May-August. 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 nutrient enriched, deep lakes and is not necessarily a bad thing if enough of the lake volume remains oxygenated. The surface waters of Little Silver Lake remained well oxygenated during the summer. Near surface DO concentrations only fell below 5.0 mg/l (a level below which many warm-water fish become stressed) in September, when fall turnover and plant decomposition were occurring. For most of the summer at least 61% of the lake volume (the volume at 6 feet and above) had a dissolved oxygen concentration of at least 5.0 mg/l, and approximately 88% of the lake volume (the volume at 14 feet and above) was oxic (DO>1.0 mg/l). As a result, there was minimal threat (September only) to aquatic life in the lake, as most of the lake volume was inhabitable by fish and other aquatic organisms. It should be noted that although the hypolimnion had become nearly anoxic by July, the August hypolimnetic DO concentrations were much higher. This was the result of an algae bloom occurring at a depth of approximately 12-14 feet. Extremely high hypolimnetic phosphorus concentrations, coupled with high water clarity produced this bloom, which replenished the DO levels in the hypolimnion in August.

Phosphorus is a nutrient that can enter lakes through runoff or be released from lake sediment, and high levels of phosphorus typically cause algal blooms or produce high plant density. The 2003 average epilimnetic phosphorus concentration in Little Silver Lake was 0.025 mg/l, while the average hypolimnetic phosphorus concentration was 0.201 mg/l (Table 1, Appendix A). Although the hypolimnetic concentration was slightly higher than the county median (0.186 mg/l), the epilimnetic concentration was over two times lower than the median (0.059 mg/l). The hypolimnetic phosphorus concentration in 2003 was nearly ten times higher than the epilimnetic concentration. This is typical in a nutrient enriched stratified lake, especially if stratification begins early in the summer like it did in Little Silver Lake. During stratification, oxygen may be depleted in the hypolimnion, triggering chemical reactions at the sediment surface. These reactions result in the release of phosphorus from the sediment into the water column, and are known as internal phosphorus loading. Typically, the hypolimnion is thermally isolated from the epilimnion during the summer, and phosphorus builds up in the bottom water, reaching the sunlit surface waters only during fall turnover, when it can cause late-season algae blooms. At this time, all of the hypolimnetic phosphorus is distributed throughout the water column. Because DO had been replenished in the hypolimnion in August, average hypolimnetic TP concentration dropped by nearly half from July to August and had likely dropped even more by the time the lake turned over prior to the September 30th sampling date. When we arrived at the lake, the smell of hydrogen sulfide was apparent at the water surface. However, because the hypolimnion had been oxygenated in August, the smell could not have been due to the upwelling of anoxic, hypolimnetic water. The likely source of this smell, and to the substantial increase of average epilimnetic TP in September (2.5 times higher than August), was the decomposition of decaying aquatic plants. This increase can be seen in other parameters too and will be discussed below.

The average epilimnetic phosphorus concentration in 1999 (0.016 mg/l) was lower than the 2003 concentration, and the 1999 average hypolimnetic concentration (0.087 mg/l) was much lower than in 2003 (Table 1, Appendix A). The apparent increase in epilimnetic and hypolimnetic phosphorus is likely the result of the difference in thermal stratification between the two years. In 1999, the lake was re-oxygenated in July vs. in August (2003). This would have reduced the duration of internal phosphorus loading during the summer, resulting in a lower hypolimnetic average TP concentration in 1999. The lower concentration of hypolimnetic TP entering the epilimnion during mixing, would then explain the lower average epilimnetic TP concentration as well. Regardless, the similarity in the average epilimnetic TP concentrations over the past 11 years is a testimony to the high water quality of Little Silver Lake and to efforts by homeowners to prevent activities that might threaten the water quality of the lake. It is very unusual for a lake in Lake County, where residential and agriculture is so prevalent and has had detrimental impacts on many lakes, to maintain its epilimnetic TP levels over the course of so many years.

Total suspended solids (TSS) is a measure of the amount of suspended material, such as algae or sediment, in the water column. High TSS values are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem, including the plant and fish communities. A large amount of material in the water column can inhibit successful predation by sight-feeding fish, such as bass and pike, or settle out and smother fish eggs. High turbidity caused by sediment or algae can shade out native aquatic plants, resulting in their reduction or disappearance from the littoral zone. This eliminates the benefits provided by plants, such as habitat for many fish species and stabilization of the lake bottom. The average 2003 epilimnetic TSS concentration in Little Silver Lake (1.8 mg/l) was one-quarter the median value for Lake County Lakes (7.5 mg/l). The low TSS values resulted in high water clarity, as evidenced by higher than average Secchi depth measurements.

The average 2003 epilimnetic TSS concentration (1.8 mg/l) has increased only slightly since 1999 (1.5 mg/l) and has remained relatively stable for the past 11 years (Table 2, Appendix A). This, again, indicates that Little Silver Lake is very stable and has not yet been negatively impacted by activities in the watershed over the past decade.

As a result of the low TP and TSS concentrations throughout the summer, Secchi depth (water clarity) of Little Silver Lake was much higher than the county median (3.41 feet) every month during the summer of 2003, and reached a maximum of 11.68 feet in May (Table 1, Appendix A). This high water clarity allowed a healthy and diverse plant community to thrive in Little Silver Lake and helped to prevent algae dominance. Secchi

depth fell to a low of 7.15 in September as a result of the increase in TSS that occurred during fall turnover and plant decomposition. Secchi depth measurements were collected and recorded as part of the volunteer lake monitoring program (VLMP) from 1997-2003. There has been very little change in average Secchi depths over the past six years, with averages hovering around ten feet (Figure 7). These stable, high Secchi depths are very likely the result of the high quality plant community present in Little Silver Lake. Plants can help maintain high water quality in many ways, including stabilizing sediment to prevent resuspension, helping soils in runoff to settle out, competing with planktonic algae for resources and providing high quality habitat for fish. Removing too many plants from a lake can lead to higher turbidity and lower overall water clarity, as well as a decline in the quality of the fish community.

Having accurate and consistent VLMP data is very important, especially for a lake like Little Silver Lake. The water quality is currently very good and any changes in water clarity and quality that may occur from changes in the watershed in the future can be tracked over time and can give early warning of problems in the watershed. We will probably not perform a full water quality study on Little Silver Lake again until 2008. Continuing a quality VLMP in the meantime can help provide valuable information to lake managers who may be able to take action on certain issues, such as stormwater pollution, before they become irreversible problems.

Conductivity is the measure of different chemical ions in solution. As the concentration of these ions increases, conductivity increases. The conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, evaporation and bacterial activity. Conductivity has been shown to be highly correlated (in urban areas) with chloride ions found in road salt mixtures. Water bodies most subject to the impacts of road salts are streams, wetlands or lakes draining major roadways and large parking lots. The average 2003 epilimnetic conductivity (0.7619 mS/cm) in Little Silver Lake was moderate and was very close to the county median (0.7503 mS/cm). However, it has increased by 26% since sampling in 1999 when the epilimnetic average was 0.6024 mS/cm (Table 1, Appendix A).

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 and an increase in pollutants entering the lake if the increasing trend is noted over a period of years. High conductivity levels (which often indicate an increase in sodium or potassium chloride) can eventually change the plant and algae community, as more salt tolerant plants and algae take over. Sodium, potassium and chloride ions can bind substances in the sediment, preventing their uptake by plants and reducing native plant densities. Additionally, juvenile aquatic organisms may be more susceptible to high chloride concentrations. The increase in conductivity levels in Little Silver Lake is most likely the result of the increased development and current construction in the watershed of the lake and of winter salting of the roads in Pine Hill Subdivision. The higher conductivity levels are cause for concern, but there may not be much that can be done about it. Non-point runoff, such as that which picks up road salt and enters the lake during rain events, is very difficult to control and it is unlikely that any control could be placed on the amount of road salt dispersed along major roadways each winter without policy changes in quantity or type of de-icer by the Illinois Department of Transportation road workers.

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. Little Silver Lake had a 2003 average TN:TP ratio of 42:1. This indicates that the lake is highly phosphorus limited and that a small increase in phosphorus concentration in the epilimnion could result in algae blooms in the future. Although the average epilimnetic total Kjeldahl nitrogen (TKN) concentration was slightly lower than the majority of the lakes in Lake County, high nitrogen concentrations relative to phosphorus concentrations resulted in this high ratio. In highly nutrient-enriched lakes, phosphorus levels have often reached the point where either very large increases or very large decreases in phosphorus would be necessary to trigger changes in algae density. On the other hand, less enriched lakes, such as Little Silver Lake, are typically more sensitive to increases or decreases in phosphorus, and algae could become a problem with relatively small increases in TP. The 1999 TN:TP ratio was 58:1. This difference is the result of the timing of fall turnover, which increased the average TP concentration in 2003. If the September TP concentration is removed in the calculation of average TP in 2003, the TN:TP ratio is 57:1. Regardless, these high ratios further indicate the sensitivity of Little Silver Lake to increased inputs of phosphorus and care should be taken to ensure that the nutrient concentrations (especially phosphorus) do not increase substantially.

Phosphorus levels can also be used to indicate the trophic state (productivity level) of a lake. The Trophic State Index (TSI) uses phosphorus concentrations, chlorophyll *a* (algae biomass) levels and Secchi depth to classify and compare lake trophic states using just one value. The TSI is set up so that an increase in phosphorus concentration is related to an increase in algal biomass and a corresponding decrease in Secchi depth. A moderate TSI value (TSI $\geq 40 < 50$) indicates mesotrophic conditions, typically characterized by relatively low nutrient concentrations, low algae biomass, adequate DO concentrations and relatively good water clarity. High TSI values indicate eutrophic (TSI $\geq 50 < 70$) to hypereutrophic (TSI ≥ 70) lake conditions, typically characterized by high nutrient concentrations, high algal biomass, low DO levels, a rough fish population, and low water clarity. Little Silver Lake had an average phosphorus TSI (TSIp) value of 50.6, indicating slightly eutrophic conditions. Although the lake falls into the eutrophic category, it does not exhibit many of the characteristics of eutrophic lakes mentioned above. This is the result of a diverse and healthy plant community. Plants compete with algae for resources and prevent sediment resuspension, both of which help reduce TP levels in the water column. When the Secchi depth TSI (TSIsd) is calculated (43.7), Little Silver Lake falls into the slightly mesotrophic category, indicating a mostly unenriched system with excellent water quality. Water quality in Little Silver Lake is well above average and the lake ranked 17th out of 130 lakes studied in Lake County since 1999. Besides the healthy plant community present, this may also be partly due to its glacial origin. Most man-made lakes in this geographical area fall into the eutrophic and hypereutrophic categories, while many of the glacial lakes rank higher (Table 3, Appendix A).

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

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant surveys were conducted every month for the duration of the study (See Appendix B for methodology). Shoreline plants of interest were also recorded. However, no quantitative surveys were made of these shoreline plant species and these data are purely observational. Light level was measured at two-foot intervals from the water surface to the lake bottom. When light intensity falls below 1% of the level at the water surface, plants are no longer able to grow. Using this information, as well as a bathymetric map, the lake area that has the potential to support aquatic plant growth can be determined. Depth of percent light intensity varied throughout the summer and ranged from 10.2 feet to 16.33 feet (Appendix C). Based on the shallowest and deepest 1% light level, respectively, Little Silver Lake could have supported plants over a minimum of 71**%** and a maximum of 83% of the lake bottom. Plant coverage likely reached these levels, as coontail was found at a depth of 17.1 feet in July. However, these plants were not growing to the water surface. GPS satellite readings were taken in late June 2003 to determine the area of dominant plant coverage based on visual observation of those plants growing to within approximately two feet of the water surface. Based on GPS data, approximately 41% of the lake surface area (17.6 acres) was covered with white water lilies (WWL). This was the most dominant plant found in the lake. Other areas dominated by specific plants (American pondweed (AMER PW) and Eurasian watermilfoil (EWM)) covered less than 5% of the surface area (Figure 8). The possible spread of water lilies is a concern for lake users. However, 16.24 of the 17.58 acres of WWL (92%) are along the relatively undeveloped south/southwest shoreline. Approximately 1.3 acres of WWL are present in front of homes in the northwest lobe of the lake, but these beds are not solid and do not inhibit access to the lake. About 1.5 acres along the southeast shore of the north lobe of the lake and 0.92 acres along the northeast shore reduce accessibility to the lake for a handful of homeowners. These areas could be cleared by hand pulling early in the season or by treating certain areas with an

herbicide. However, it is unlikely that the lilies will spread much further into the lake due to depth limitation. Typically, water lilies will not grow in water deeper than five feet. The outer line of lilies is currently at that depth on the south and southwest sides of the lake (Figure 8).

Twenty-three different plant species were present in Little Silver Lake during the summer of 2003, including one state threatened species (grass leaved pondweed) (Tables 4 & 5). Only two of the 23 species (EWM and curly leaf pondweed) are exotic species. Although WWL (69%) and coontail (65%) dominate the lake and EWM dominates one specific area of the lake (Figure 8), Little Silver Lake has an exceptional plant community with regard to diversity of species and types of species found. This very healthy plant community provided Little Silver Lake with good fish habitat and kept water clarity high by reducing sediment resuspension in the littoral zone and competing with planktonic algae for resources.

As mentioned above, EWM was one of the dominant plants in the lake in 2003, occurring at 42% of the plant sampling sites throughout the summer. This exotic plant species invaded Little Silver Lake in the 1950's and has been a dominant species in the plant community. This year, the milfoil weevil (*Euhrychiopsis lecontei*) was first observed in the lake. This very tiny insect serves as a biological control for EWM, and when present in large enough numbers, can cause significant damage to milfoil beds. In 2003, the weevil had caused minimal damage to the EWM in Little Silver Lake. No adult weevils were observed but weevil eggs were noted during plant sampling. The reasons for weevil success or failure in controlling EWM are still being researched and there are no definite answers at this time. Research has shown that approximately 1-2 weevils per stem are needed in order to see significant damage and decline of a EWM bed. Weevil density in Little Silver Lake has not been quantitatively analyzed, but qualitative surveys suggest that weevil density is not at this level. It is possible that in the future, the weevil population may increase, but, at this time, the milfoil weevil does not appear to be decreasing or controlling the EWM in Little Silver Lake.

Table 4. Aquatic and shoreline plants on Little Silver Lake, May-September 2003.

<u>*Aquatic Plants*</u>	
Chara	*Chara* sp.
Coontail	*Ceratophyllum demersum*
Elodea	*Elodea canadensis*
Water Stargrass	*Heteranthera dubia*
Duckweed	*Lemna minor*
Star Duckweed	*Lemna trisulca*
Northern Watermilfoil	*Myriophyllum sibiricum*
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Slender Naiad	*Najas flexilis*

+Threatened in Illinois
^Exotic plant or tree species

Table 4. Aquatic and shoreline plants on Little Silver Lake, May-September 2003 (cont'd)

<u>*Aquatic Plants*</u>	
Spiny Naiad	*Najas marina*
Spatterdock	*Nuphar variegata*
White Water Lily	*Nymphaea tuberosa*
Curlyleaf Pondweed^	*Potamogeton crispus*
Grass Leaved Pondweed+	*Potamogeton graminius*
Floatingleaf Pondweed	*Potamogeton natans*
American Pondweed	*Potamogeton nodosus*
Small Pondweed	*Potamogeton pusillus*
White Water Crowsfoot	*Ranunculus longirostris*
Giant Duckweed	*Spirodella polyrhiza*
Sago Pondweed	*Potamogeton pectinatus*
Eel Grass	*Vallisneria americana*
Common Bladderwort	*Utricularia vulgaris*
Watermeal	*Wolffia columbiana*
<u>*Shoreline Plants*</u>	
Marsh Milkweed	*Asclepaias incarnuta*
Hummock Sedge	*Carex stricta*
Canada Thistle^	*Cirsium arvense*
Day Lily	*Hemerocallis* sp.
Jewelweed	*Impatiens pallida*
Purple Loosestrife^	*Lythrum salicaria*
White Sweet Clover^	*Melilotus alba*
Reed Canary Grass^	*Phalaris arundinacea*
Swamp Smartweed	*Polygonum coccineum*
Common Arrowhead	*Sagittaria latifolia*
Softstem Bulrush	*Scirpus validus*
Common Cattail	*Typha latifolia*
Blue Vervain	*Verbena hastate*
Wild Grape	*Vitis* sp.
<u>*Trees/Shrubs*</u>	
Barberry	*Berberis vulgaris*
Honeysuckle^	*Lonicera* sp.
Cottonwood	*Populus deltoids*
Common Buckthorn^	*Rhamnus cathartica*
Staghorn Sumac	*Rhus typhina*
Sandbar Willow	*Salix interior*

+Threatened in Illinois
^Exotic plant or tree species

One of the main concerns of Little Silver Lake residents is the high density of aquatic plants in the lake, especially that of WWL. In the past, a weed cutter was used on the lake. Approximately ten years ago, the decision was made to dispose of the cutter. This never occurred and the cutter is still used by a few homeowners today. The danger in using the cutter is that it can very easily spread EWM throughout more areas of the lake as it does not collect the cut plants. **It is recommended that use of the cutter be stopped**. In the past, Sonar® pellets were also used in an attempt to clear areas in front of homeowners' properties, but these were haphazardly and illegally applied without measurement, and no quantitative results were documented. If lilies and EWM are going to be treated, a spot treatment of 2,4-D would be the most selective, with minimal drift. Great care should be taken in Little Silver Lake to ensure that beneficial native plants are not accidentally treated with the 2,4-D. If all of the concentrated EWM (1.9 acres) is treated and if approximately 2.0 acres of WWL in front of homes on the north side are treated, the minimum cost would be: ***100 lbs/surface acre times 3.0 acres at a cost of $350-$435 per 100 lbs: $1,050-1,275.*** However, these areas cannot be treated by the Little Silver Lake Improvement Association (LSLIA) if they do not obtain permission of the bottom owners in the desired treatment area. Additionally, one must be licensed by the Illinois Department of Agriculture to treat a lake with herbicides or algaecides. It is recommended that the LSLIA hire a professional applicator to perform the desired herbicide treatment, and that areas to be treated and herbicide amounts to be used are spelled out very clearly. If desired, we can help the LSLIA write a very specific Request For Proposal for this work. One of the main reasons that the water quality of Little Silver Lake is so good is its diverse plant community. Although WWL and EWM are two of the dominant plants in the lake, many other plant species that are integral to the quality of the lake ecosystem are also present. These native plants provide fish habitat, stabilize bottom sediment and compete with algae for resources, resulting in clear water and a healthy fish population. Removing too many native plants will take away these benefits and could result in a decline in water clarity, an increase of planktonic and filamentous algae and an unbalanced fishery. Herbicide treatment should be limited to areas that do not allow access as a result of dense plant cover or that have specific uses, such as swimming. While it is understandable to want swimming areas clear in front of homes, the lake should not be viewed as a major recreational resource for boating. It is mainly a lake to be enjoyed via canoe, kayak or rowboat, and most areas of the lake are easily navigable by these watercraft. Having unrealistic expectations of what the lake should look like can end up leading to a substantial decrease in the aesthetic beauty of the lake.

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

FQI (Floristic Quality Index) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts

(Nichols, 1999). Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2003 Lake County lakes is 14.7. Little Silver Lake has an FQI of 27.9, the 4th highest of all county lakes studied since 2000. Despite the dominance by EWM, coontail and WWL, the high diversity of plant species places Little Silver Lake well above the average lake, by Lake County standards.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted at Little Silver Lake on July 31, 2003. The shoreline was assessed for a variety of criteria (See Appendix B for methods), and based on these assessments, several important generalizations could be made. Approximately 45% of Little Silver Lake's shoreline is developed and the majority of the developed shoreline is comprised of buffer (14%), rip rap (11%), and seawall (7.8%) (Figure 9). The remainder of the developed shoreline consists manicured lawn (2.8%) and beach (0.8%). The undeveloped portions of the lake, which comprise the majority of the shoreline, are made up of wetland, woodland and a small amount of buffer. Seawall is not an ideal shoreline type unless used solely for erosion control. Seawalls do not provide any wildlife habitat and can often increase sediment resuspension as waves are reflected back into the lake by the seawall. Although rip rap is also not an ideal shoreline type with regard to wildlife habitat, it can also help to prevent shoreline erosion. Woodland, wetland and buffer are the most desirable shoreline types, providing wildlife habitat and, typically, protecting the shore from excessive erosion. The high percentage of wetland and woodland shoreline along Little Silver Lake is very encouraging and these shorelines should be protected from new development or degradation of any kind. Even more encouraging is the high percentage of buffered shoreline along developed areas. This is a testament to the homeowners on Little Silver Lake and their respect for their lakeshore. As a result of the dominance of wetland, buffer and woodland, 98.9% of Little Silver Lake's shoreline exhibited no erosion (Figure 10). Slight erosion was occurring primarily along shoreline dominated by manicured lawn. Manicured lawn is considered undesirable because it provides a poor shoreline-water interface due to the short root structure of turf grasses. These grasses are incapable of stabilizing the shoreline and will typically lead to erosion. Wetland, woodland, and especially buffered shorelines should be maintained or added as much as possible, and the addition of manicured lawns, seawalls and rip rap should be discouraged.

Although almost no erosion was occurring around Little Silver Lake, invasive plant species, including Canada thistle, reed canary grass, honeysuckle, purple loosestrife and buckthorn were present along 40% of the shoreline. These plants are extremely invasive

and exclude native plants from the areas they inhabit. Buckthorn provides very poor shoreline stabilization and may lead to increasing erosion problems along already eroded shoreline in the future. Reed canary grass and purple loosestrife inhabit mostly wetland areas and can easily outcompete native plants. Additionally, they do not provide the quality wildlife habitat or shoreline stabilization that native plants provide. Fortunately, most of the exotic plant occurrences were not dense and were observed along developed shoreline. Steps to eliminate these plants should be carried out in order to improve the wildlife habitat and overall aesthetics of Little Silver Lake.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Illinois Department of Natural Resources (IDNR) fish surveys date back to 1952. In 1963, small panfish dominated the fishery and there was concern about the small size of the largemouth bass (LMB). The same conditions were found in 1970. Fish species found at that time included LMB, bluegill, pumpkinseed, yellow perch, yellow bullhead, brown bullhead, black crappie and warmouth. Similar conditions were found in 1972. A partial winterkill occurred in 1978 and the results of electroshocking in 1979 included the collection of LMB, grass pickerel, northern pike, bluegill, pumpkinseed, warmouth, black crappie, white crappie, yellow perch, bullheads and common carp. The IDNR conducted a fish survey again in 2003 using 30 minutes of electrofishing and overnight trapnets and gillnets. Thirteen fish species were collected, including the state-threatened blackchin shiner. This species had also been collected by us in 2002 and again by us and students from Southern Illinois University in 2003. Other fish species found included largemouth bass, redear sunfish, starhead topminnow, grass pickerel, central mudminnow and lake chubsuckers. It does not appear that the fishery has changed much since the last fish survey in 1979. In addition to the blackchin shiner, the Illinois endangered fish species, blacknose shiner (*Notropis heterolepis*) was found by our staff and students from Southern Illinois University in 2003. These threatened and endangered fish species need clear water and dense plant beds.

Wildlife observations were made on a monthly basis during water quality and plant sampling activities (See Appendix B for methodology). Also included in the wildlife list are birds, mammals, amphibians and reptiles observed by our staff in April 2002, during the creation of a bathymetric map for Little Silver Lake. Because of the abundance of wildlife habitat in the form of wetland, buffer and woodland areas around Little Silver Lake, an exceptionally large diversity and number of wildlife species were observed, including the state threatened pied-billed grebe and sandhill crane, and the state endangered common tern and osprey (Table 6). None of these species were seen nesting on the lake. The maintenance of wetland, wooded and buffered shorelines, and the establishment of additional buffer strips (especially along the shoreline of developed areas) is very important and strongly recommended to continue to provide the appropriate habitat for birds and other animals in the future.

Table 6. Wildlife species observed at Little Silver Lake, April 22-25, 2002 and May-September 2003.

<u>Birds</u>	
Pied-billed Grebe+	*Podilymbus podiceps*
Double crested Cormorant	*Phalacroxorax auritus*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Lesser Scaup	*Aythya affinis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
Blue-winged Teal	*Anas discors*
American Coot	*Fulica americana*
Ring-billed Gull	*Larus delawarensis*
Common Tern *	*Sterna hirundo*
Great Blue Heron	*Ardea herodias*
Sandhill Crane+	*Grus canadensis*
Sora Rail	*Porzana carolina*
Killdeer	*Charadrius vociferous*
Red-tailed Hawk	*Bueto jamaicensis*
Osprey*	*Pandion haliaetus*
Turkey Vulture	*Cathartes aura*
Mourning Dove	*Falco sparverius*
Belted Kingfisher	*Megaceryle alcyon*
Common Flicker	*Colaptes auratus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Downy Woodpecker	*Picoides pubescens*
Eastern Phoebe	*Sayornis phoebe*
Cliff Swallow	*Petrochelidon pyrrhonota*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
Rough-wing Swallow	*Stelgidopteryx ruficollis*
Chimney Swift	*Chaetura pelagica*
Eastern Kingbird	*Tyrannus verticalis*
Eastern Pewee	*Contopus virens*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
White-breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
Marsh Wren	*Cistothorus palustris*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*

Table 6. Wildlife species observed at Little Silver Lake, April 22-25, 2002 and May-September 2003 (cont'd).

Birds	
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo	*Vireo olivaceus*
Yellow-rumped warbler	*Dendroica coronata*
Yellow warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Red-winged Blackbird	*Agelaius phoeniceus*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*
White-throated Sparrow	*Zonotrichia albicollis*
Chipping Sparrow	*Spizella passerina*
Swamp Sparrow	*Melospiza georgiana*
Song Sparrow	*Melospiza melodia*
Dark-eyed Junco	*Junco hyemalis*
Mammals	
Beaver	*Castor canadensis*
Eastern Chipmunk	*Tamias striatus*
Gray Squirrel	*Sciurus carolinensis*
Muskrat	*Ondatra zibethicus*
Amphibians	
American Toad	*Bufo americanus*
Bull Frog	*Rana catesbeiana*
Western Chorus Frog	*Psudacris triseriata triseriata*
Reptiles	
Painted Turtle	*Chrysemys picta*
Fish	
Blackchin Shiner+	*Notropis heterodon*
Blacknose Shiner*	*Notropis heterolepis*
Starhead Topminnow (rare)	*Fundulus dispar*

+Threatened in Illinois
*Endangered in Illinois

Because of the extremely high diversity of wildlife and the presence of threatened and endangered plant and fish species, we are nominating Little Silver Lake for Natural Area Inventory status, which will provide additional protection to the lake and surrounding wetlands. The residents of Little Silver Lake should continue to be diligent about protecting the lake as a high quality resource.

EXISTING LAKE QUALITY PROBLEMS

- *Invasive Shoreline Plant Species*

  Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. The outcome is a loss of plant and animal diversity. Buckthorn and honeysuckles are aggressive shrub species that grow along lake shorelines as well as most upland habitats. They shade out other plants and are quick to become established on disturbed soils. Reed canary grass and purple loosestrife are present in wetland areas and can very quickly outcompete cattails and other native wetland plants. Honeysuckle, buckthorn, purple loosestrife, white sweet clover and reed canary grass are present along 40% of the shoreline of Little Silver Lake and attempts should be made to control their spread.

POTENTIAL OBJECTIVES FOR THE LITTLE SILVER LAKE MANAGEMENT PLAN

I. Eliminate or Control Exotic Species
II. Continue Participation in VLMP to Document Water Quality Trends

Objective I: Eliminate or Control Exotic Species

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

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

The presence of exotic species along a lakeshore is by no means a death sentence for the lake or other plant and animal life. If controlled, many exotic species can perform many of the original functions that they were brought here for. For example, reed canary grass was imported for its erosion control properties. It still contributes to this objective (offering better erosion control than commercial turfgrass), but needs to be isolated and kept in control. Many exotics are the result of garden or ornamental plants escaping into the wild. One isolated plant along a shoreline will probably not create a problem by itself, but its removal early on is best. Problems arise when plants are left to spread, many times to the point where treatment is difficult or cost prohibitive. The length of Little Silver Lake's shoreline inhabited by exotic species is 40% of the total shoreline, and most of the plants are present as part of buffer strips on developed property. Because these plants are part of shoreline that is owned and maintained by property owners, it should be very easy to remove these exotic species and establish a monitoring program so that the areas are not reinfested.

<u>Option 1: No Action</u>
No control will likely result in the expansion of the exotic species and the decline of native species. This option is not recommended if possible.

Pros
There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be

preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics whenever possible. Table 7, Appendix A lists several native plants that can be planted along shorelines.

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

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

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

<u>Option 2: Control by Hand</u>
Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Some exotics, such as purple loosestrife and reed canary grass, can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is removed. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored since regrowth is common. Many exotic species, such as purple loosestrife, buckthorn, and garlic mustard are proficient at colonizing disturbed sites.

Pros
Removal of exotics by hand eliminates the need for chemical treatments. Costs are low if stands of plants are not too large already. Once removed, control is simple with yearly maintenance. Control or elimination of exotics preserves the

ecosystem's biodiversity. This will have positive impacts on plant and wildlife presence as well as some recreational activities.

Cons
This option may be labor intensive or prohibitive if the exotic plant is already well established. Costs may be high if large numbers of people are needed to remove plants. Soil disturbance may introduce additional problems such as providing a seedbed for other non-native plants that quickly establish disturbed sites, or cause soil-laden run-off to flow into nearby lakes or streams. In addition, a well-established stand of an exotic like purple loosestrife or reed canary grass may require several years of intense removal to control or eliminate.

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

Option 3: Herbicide Treatment

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

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

Pros
Herbicides provide a fast and effective way to control or eliminate nuisance vegetation. Unlike other control methods, herbicides kill the root of the plant, which prevents regrowth. If applied properly, herbicides can be selective. This

allows for removal of selected plants within a mix of desirable and undesirable plants.

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

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