2003 SUMMARY REPORT
of
WILLOW LAKE

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Willow Lake, located in the Village of Grayslake, is a detention pond created in 1968 when the College of Lake County was being built. The lake is entirely contained on the grounds of the college and is surrounded by large upland and wetland buffer areas. The lake is not open to the public, but is used by members of the college for fishing and by several Environmental Biology classes as a location for field work. Willow Lake has a surface area of 11.43 acres with mean and maximum depths of 6.0 and 11.9 feet, respectively. The lake receives water directly from two roof drains and the C-dock sump pump. Non-point sources of pollution include water from the golf course to the south, from soccer and baseball fields to the west, a fire station to the southeast and a residential neighborhood to the south.

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. Willow Lake was mixed and stratified intermittently throughout the summer, and epilimnetic oxygen concentrations remained relatively high. The epilimnetic total phosphorus (TP) concentration was slightly lower than county median, but increased substantially throughout the summer. It appears that the TP concentrations are related to the amount of rainfall and subsequent lake level changes, as well as movement of phosphorus from bottom waters to surface waters. Total suspended solids (TSS) levels were high all summer (over twice the county median value) and, as a result, Secchi depths (water clarity) were lower than the county median every month during the summer. Conductivity was much higher than the county median and is also thought to be related to the amount of rainfall and evaporation in the lake. Very little rain fell in the latter half of the summer, and lake levels decreased accordingly. This caused an increase in conductivity as dissolved solids were concentrated into a smaller volume of water. These elevated conductivity levels are cause for some concern, but there may not be much that lake managers can do to reduce them.

Aquatic plants were completely absent in Willow Lake, but a large number of emergent wetland plants and upland plant and shrub species were present along the shoreline. Buffer and prairie dominated the shoreline. Despite the high degree of beneficial shoreline type, 28% of the shoreline exhibited erosion. Most of the erosion was occurring along unmaintained buffer or shrubby shoreline. Buffer and shrub shorelines should be improved and maintained as much as possible. Invasive plant and tree species, including common buckthorn, purple loosestrife, honeysuckle, reed canary grass, bull thistle, and Queen Anne's lace were present along 59.3% of the shoreline. Steps should be taken to rid the lake of these plant species, as they do not provide quality wildlife habitat or erosion control.

Despite the residential and commercial dominance of land use around the lake, a relatively high number of wildlife species were observed around Willow Lake. It is very important that the buffer and wetland areas are improved and maintained to provide habitat for birds and other animals into the future.

LAKE IDENTIFICATION AND LOCATION

Willow Lake is located in the Village of Grayslake, Avon Township, on the campus of College of Lake County (T 44N, R 11E, S 19, 20). Willow Lake has a surface area of 11.43 acres with an estimated mean and maximum depth of 5.95 feet and 11.9 feet, respectively. It has an estimated volume of 68 acre-feet and a shoreline length of 0.66 miles. The watershed of Willow Lake is approximately 190 acres and includes the Lake County Forest Preserve District golf course to the south. The lake directly receives water from two roof drains to the north and a C-dock sump pump to the east. All other inflow to the lake moves through a newly constructed wetland buffer zone before it reaches the lake (Figure 1). The lake is located in the Mill Creek sub basin, within the Des Plaines River watershed.

BRIEF HISTORY OF WILLOW LAKE

Willow Lake is a man-made lake, created at approximately the same time as the College of Lake County (CLC) was built in 1968 by dredging and damming a low-lying area. The lake is entirely contained on the grounds of the college and is surrounded by large upland and wetland buffer areas and some manicured lawn. The lake is not open to the public, but is used occasionally for fishing and by several different Environmental Biology and Field Study classes. Currently, the lake is managed by the college, but no management techniques have been carried out in the lake in the recent past. In 2000, construction began on two new detention basins on the CLC campus. The college hired Hey and Associates to oversee the permitting process through the Army Corp of Engineers and also to monitor for siltation during the project. A new spillway was installed in Willow Lake and was intended to control water levels for the new, enhanced wetland area on the south side of the lake. The wetland is serving as mitigation for other wetland areas destroyed during the new construction. When water reached the top of the spillway, the south shore of the lake was to be under three inches of water. This is currently not occurring and it was determined that the south wetland area was not graded to a proper elevation. The problem should be rectified next year.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Access to Willow Lake, as controlled by the CLC, is closed to the public and only students are allowed access to the lake. Its main use is fishing and providing educational opportunities. Students can fish from the shore, and small canoes and johnboats are launched by students for collection of water samples. No other boats are allowed on the lake. Currently, the management concerns on Willow Lake include the fish community, shoreline erosion, exotic shoreline species and water level.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples collected from Willow Lake were analyzed for a variety of water quality parameters (See Appendix B for methodology). Samples were collected at 3 foot and 7-8 foot depths (depending on water level) from the deep hole location in the lake (Figure 2). Willow Lake was weakly stratified in June and July at a depth between seven and eight feet and in August at a depth between nine and ten feet. 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 in nutrient enriched lakes, the hypolimnion typically becomes anoxic (dissolved oxygen= 0 mg/l) by mid-summer. A lake that remains thermally stratified all summer is considered dimictic. Conversely, a polymictic lake stratifies and destratifies many times during the summer. Stratification may occur after several calm, hot days. However, this stratification may be broken by a storm or high wind event and the lower water layer will mix with the upper water layer. This may result in changes in phosphorus concentrations in the epilimnion that affect many aspects of water quality. The surface waters of Willow Lake were well oxygenated during the summer, and dissolved oxygen (DO) concentrations did not fall below 5.0 mg/l (a level below which many aquatic organisms become stressed) at any time during the study period.

Phosphorus is a nutrient that can enter lakes through runoff or be released from lake sediment, and high concentrations of phosphorus typically trigger algal blooms or produce high plant density. The average epilimnetic phosphorus concentration in Willow Lake was 0.046 mg/l, slightly lower than the Lake County median of 0.059 mg/l (Table 1, Appendix A). Total phosphorus (TP) concentrations remained relatively stable until August, when the average epilimnetic concentration increased 62% over July's average. It appears that the TP concentrations are related to the amount of rainfall and subsequent lake level changes. Willow Lake has a small watershed (191.4 acres), and a relatively small watershed to lake ratio (16.7:1). This can be both beneficial and detrimental to lake water quality. Having a small watershed means that it is easier to control the quality and amount of runoff from surrounding roads and parking lots, which 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 summer of 2003 were relatively large in Willow Lake. The lake dropped nearly one foot between July and September, reducing lake volume by approximately 16%. This most likely led to the increase in TP concentrations, as nutrients were concentrated into a smaller volume of water. Additionally, it appears that the thermal stratification occurring at eight feet was broken in August and that only water below eight feet was hypoxic. This would have resulted in phosphorus-rich water from near the lake bottom mixing with surface water and increasing the TP concentration in the epilimnion.

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 epilimnetic TSS concentration in Willow Lake (19.4 mg/l) was over twice the median value for Lake County lakes (7.5 mg/l). Although not highly correlated from May-July, TSS and TP concentrations both rose dramatically in August indicating that as TSS increased, TP increased, and visa versa (Figure 3). In many lakes, this indicates that the source of TSS is algae. An increase in TP will cause an algae bloom, which causes an increase in TSS. However, in Willow Lake, total volatile solids (TVS, a measure of organic matter, such as algae, in the water column) concentrations were not strongly correlated with TSS concentrations, and 74% of the TSS was made up of non-volatile suspended solids (NVSS). This indicates that organic material did not make up much of the TSS in the water column. The relationship between TP and TSS may indicate that an increase in clay particles with attached phosphorus (P) may have caused the increased TSS concentrations in August and September. In response to decreasing water levels and polymixis, phosphorus attached to the TSS was probably resuspended into the water column due to wind and wave action.

As a result of the increases in TP and TSS concentrations throughout the summer, Secchi depth (water clarity) on Willow Lake was lower than the county median (3.41 feet) every month during the summer of 2003, and reached a minimum of 1.08 feet in September (Figure 4) (Table 1, Appendix A). The combination of high TSS and low Secchi depth resulted in an absence of aquatic plants in Willow Lake. A diverse community of aquatic plants is beneficial to a lake in many ways, including stabilizing sediment to prevent resuspension, causing soil particles entering the lake through non-point runoff to settle out more quickly, competing with planktonic algae for resources and providing habitat and a food base for a healthy fish community. Without adequate plant coverage, there were likely more sediment particles in the water column during the summer. As a result, Secchi depth and light levels in the lake were very low, and plants were unable to become established, which then resulted in more resuspension of sediment into the water column, and the cycle continued.

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 conductivity in Willow Lake (1.1280 mS/cm) was much higher than the county median of 0.7503 mS/cm. Conductivity increased from May-June, decreased in July and then increased from July-September. It appears that the increase in conductivity levels in Willow Lake is related to evaporation and a decrease of water volume. Conductivity somewhat related to increases

and decreases in rainfall, with levels falling after a large rain event flushes the system and rising after periods of very little rain. Conductivity changes also appear to be related to the polymictic nature of the lake. Conductivity increased in the bottom waters and decreased in surface waters during July, when the lake was most strongly stratified. In August, when stratification was broken at eight feet, conductivity increased in the epilimnion as a result of the mixing of bottom water into surface water (Table 1, Appendix A). Although the high conductivity levels are cause for concern, there may not be much that can be done about them. Non-point runoff, such as that which picks up road salt and enters the lake during rain events, is very difficult to control. Additionally, the polymictic nature of the lake and changes in water levels that reduce total water volume will continue to contribute to fluctuating conductivity levels.

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. Willow Lake had an average TN:TP ratio of 32:1. This indicates that the lake is phosphorus limited and that an increase in phosphorus concentrations in the epilimnion could result in algae blooms in the future.

Phosphorus levels can also be used to indicate the trophic state (productivity level) of a lake. The Trophic State Index (TSI) uses phosphorus levels, chlorophyll *a* (algae biomass) levels and Secchi depth to classify and compare lake trophic states using just one value. The TSI is set up so that an increase in phosphorus concentration is related to an increase in algal biomass and a corresponding decrease in Secchi depth. A moderate TSI value (TSI=40-49) 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 $\geq$70) lake conditions, typically characterized by high nutrient concentrations, high algal biomass, low DO levels, a rough fish population, and low water clarity. Willow Lake had an average phosphorus TSI (TSIp) value of 59.5, indicating eutrophic conditions. This means that the lake is an enriched system with relatively poor quality. The lake ranked 52nd out of 130 lakes studied in Lake County since 2000. Although this is a moderate ranking, it is not unusual for a man-made lake in Lake County. Most man-made lakes in this region fall into the eutrophic and hypereutrophic categories, while many of the glacial lakes and borrow pits rank higher (Table 2, Appendix A).

Most of the water quality parameters just discussed can be used to analyze the water quality of Willow Lake based on use impairment indices established by the Illinois Environmental Protection Agency (IEPA). According to this index, Willow Lake provides *Full* support of aquatic life and *Partial* support of swimming and recreational use activities (such as boating) as a result of high TP and nonvolatile suspended solids (clay particles) in the water column, and low plant coverage. The lake provides *Partial* 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 one-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. If a quality bathymetric map exists, this information can be used to determine how much of the lake has the potential to support aquatic plant growth. Based on 1% light level, Willow Lake could have supported plants to a depth of 3.25-7.25 feet, depending on the month (Appendix C). However, due mostly to the hard, rock and clay substrate that makes up the lake bottom, no true aquatic plants are present in Willow Lake. *Chara*, a macroscopic algae species, was observed at one site in July and one site in September. Despite the absence of aquatic plants in Willow Lake, a large number of upland plant and tree species were observed along the shoreline. These plants and trees were planted and are maintained as part of a wetland mitigation project, and provide valuable habitat for a large number of birds and other wildlife species. They should be preserved and maintained as much as possible.

Table 3. Shoreline plants on Willow Lake, May-September 2003.

Shoreline Plants	
White Yarrow	*Achillea millefolium*
Marsh Milkweed	*Asclepaias incarnuta*
Nightshade	*Atropa belladonna*
Sedge	*Carex* sp.
Ox-eye Daisy	*Chrysanthemum leucanthemum*
Canada Thistle^	*Cirsium arvense*
Bull Thistle^	*Cirsium vulgare*
Queen Anne's Lace^	*Daucus carota*
Purple Coneflower	*Echinacea purpurea*
Daisy Fleabane	*Erigeron annuus*
Joe-Pye Weed	*Eupatorium maculatum*
Purple Loosestrife^	*Lythrum salicaria*
White Sweet Clover^	*Melilotus alba*
Catnip	*Nepeta cataria*
Reed Canary Grass^	*Phalaris arundinacea*
Black Eyed Susan	*Rudbeckia serotina*
Goldenrod species	*Solidago* sp.

^Exotic plant or tree species

Table 3. Shoreline plants on Willow Lake, May-September 2003 (cont'd).

Shoreline Plants	
Three Square Bulrush	*Scirpus pungens*
Softstem Bulrush	*Scirpus validus*
Common Cattail	*Typha latifolia*
Great Mullein	*Verbascum thapsus*
Blue Vervain	*Verbena hastate*
Wild Grape	*Vitis* sp.
Trees/Shrubs	
Serviceberry^	*Amelanchier canadensis*
Redosier Dogwood	*Cornus sericea*
Ash	*Fraxinus* sp.
Honeysuckle^	*Lonicera* sp.
Cottonwood	*Populus deltoids*
Common Buckthorn^	*Rhamnus cathartica*
Sandbar Willow	*Salix interior*
Elderberry	*Sambucus* sp.
Northern White Cedar	*Thuja occidentalis*

^Exotic plant or tree species

Although it appears that there is enough light penetrating the water column to support plant growth, we can speculate that the absence of a seed bank and the hard sediment is preventing the establishment of submersed aquatic plants. However, it is only speculation, and there may be some value in attempting to establish both emergent and submersed plant species in the lake. It is recommended that this serve as a pilot project for the biology class at the college. Tables 5 and 6, Appendix A provide a list of appropriate native plants that could be considered, along with the contact information for local nurseries that provide these plants. Our staff could recommend the specific species to be planted based on past experience, as well as provide information on the design and maintenance of the project.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted at Willow Lake on July 15, 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 84% of Willow Lake's shoreline is developed (only the shoreline around the island is considered undeveloped), comprised of buffer (58.7%) and prairie (25.2%) (Figure 6). The undeveloped shoreline consists of shrub and lawn. Despite the high degree of natural shoreline, approximately 28% of the shoreline around the lake was slightly eroded. Typically, buffer and shrub are ideal shoreline types because they can prevent shoreline erosion, as well as provide wildlife habitat. However, if the shoreline is not properly maintained, and exotic plant or tree species such as buckthorn are allowed to colonize, buffered and shrubby shorelines can succumb to erosion. Thirty eight percent of the shrub and 41% of the buffer shoreline around Willow Lake had slight erosion (Figure 7). These shorelines should be improved and maintained as much as possible with re-grading and removal of the exotic plant and tree species.

Dramatic water level fluctuation can increase shoreline erosion, especially if the fluctuations occur over short periods of time. As mentioned previously, the water level in Willow Lake dropped nearly one foot throughout the summer. Erosion occurs when water levels drop and newly exposed soil, which may not support emergent plant growth, is subjected to wave action.

Invasive plant and tree species, including Canada thistle, purple loosestrife, Queen Anne's lace, honeysuckle, white sweet clover, reed canary grass and buckthorn were present along 59.3% of the shoreline. These plants and trees are extremely invasive and exclude native plants from the areas they inhabit. Buckthorn and honeysuckle provide poor shoreline stabilization and may lead to increasing erosion problems in the future. Reed canary grass and purple loosestrife inhabit wetland areas and can easily outcompete native plants. Additionally, they do not provide the quality wildlife habitat or shoreline stabilization that native plants provide. Purple loosestrife beetles were released in 2002 in an attempt to naturally reduce the plant's density. It may be several years before the full results of this release can be accurately determined. Steps to eliminate other invasive plant and tree species should be carried out in order to reduce competition with native species being planted, and enhance the wildlife habitat already present around Willow Lake.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

A fish survey by the Illinois Department of Natural Resources (IDNR) has never been conducted on Willow Lake and no fish stocking of any kind has been carried out.

Wildlife observations were made on a monthly basis during water quality and plant sampling activities (See Appendix B for methodology). As a result of the dominance of buffer and prairie around Willow Lake, a fair number wildlife species were observed (Table 4). It is, therefore, very important that the buffer areas around the lake be improved and maintained to provide the appropriate habitat for birds and other animals into the future.

Table 4. Wildlife species observed at Willow Lake, May-September 2003.

Birds	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Ring-billed Gull	*Larus delawarensis*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Killdeer	*Charadrius vociferus*
Solitary Sandpiper	*Tringa solitaria*
Red-tailed Hawk	*Buteo jamaicensis*
Belted Kingfisher	*Megacerlye alcyon*
Common Flicker	*Colaptes auratus*
Catbird	*Dumetella carolinensis*
Cedar Waxwing	*Bombycilla cedrorum*
Yellow Warbler	*Dendroica petechia*
Red-winged Blackbird	*Agelaius phoeniceus*
Starling	*Sturnus vulgaris*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Insects	
Tiger Swallowtail Butterfly	

EXISTING LAKE QUALITY PROBLEMS

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

  In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection agency (Illinois EPA) to gather fundamental information on Illinois inland lakes, and to provide an educational program for citizens. Annually, 165 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 300 citizen volunteers. The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake. The establishment of a VLMP on Willow Lake would provide valuable historical data and enable lake managers to create baseline information and then track the improvement or decline of lake water quality over time. This program could be initiated and carried out by professors in the Environmental Biology department at the college, who already use Willow Lake for many of their classes.

- *Lack of a Quality Bathymetric Map*

  A bathymetric (depth contour) map is an essential tool in effective lake management, especially if the long term lake management plan includes intensive treatments, such as fish stocking, dredging, chemical application or alum application.

- *Lack of Aquatic Vegetation*

  One key to a healthy lake is a healthy aquatic plant community. Poor substrate for plant growth and relatively low water clarity contribute to the complete absence of plants in Willow Lake. The absence of plants, in turn, reduces the water clarity even further because sediment stabilization is not provided. Plants provide many benefits to a lake ecosystem, including stabilizing bottom sediment, providing habitat for fish, and competing with algae for resources. Without plants, Willow Lake is relatively turbid and may not support a diverse and healthy sport fish population. Despite these observations, there may be enough light penetrating the water column to support plant growth, and the inability of the substrate to support plants is only speculation. There may be some value in attempting to establish both emergent and submersed plant species in the lake. It is recommended that this serve as a pilot project for the biology class at the college. It might be worthwhile to attempt emergent or aquatic plant revegetation with plants such as arrowhead, blue flag iris and pickerelweed. Table 5 (Appendix A) lists plants specific to different areas of the littoral zone, and includes prices for seeds and plant plugs and rates of application. Table 6 (Appendix A) provides a list of companies and nurseries in the vicinity of Lake County that sell the types of plants listed in Table 5. Residents on Lake Linden in Lindenhurst have had very good success in planting emergent plant species along several areas of shoreline.

Through correspondence with one of the residents there, it was determined that the cost for building 10 cages to protect the plants was $300. Mesh cloth was purchased at $18 per 50 feet and 4x8 foot cages were built. Posts to which the cloth was attached cost $1 per post and were placed every four feet along the shoreline. The residents at Lake Linden chose to plant arrowhead, blue flag iris and pickerelweed and paid $3.50 per potted plants and $170 per seed bag. Despite using cages, there has still been some disturbance by raccoons and muskrats and the Lake Linden residents have found that there is less predation on blue flag iris than on arrowhead or pickerelweed. The above-mentioned prices are to serve merely as an estimate of cost as prices may differ depending on plant species, the choice of seed or age of plant material and the vendor used.

- *Shoreline Erosion*

Approximately 28% of the shoreline along Willow Lake was exhibiting slight erosion that was mostly concentrated along unmaintained shrub and buffer areas. As mentioned above, buffered and shrubby shorelines are typically ideal shoreline types with regard to wildlife habitat and erosion prevention. However, if these areas are not maintained properly, erosion can occur. Shrubs, especially buckthorn present along these shorelines can have very large roots that are unable to stabilize soil. Buckthorn also contains a chemical that restricts the growth of other plants in the vicinity. This can result in bare, exposed soil and subsequent erosion. Additionally, with the fluctuating water level in Willow Lake, if buffered areas are not maintained, more of this type of shoreline will begin to exhibit erosion.

- *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. Purple loosestrife is responsible for the “sea of purple” seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. 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. A relatively large number of exotic species, including purple loosestrife, reed canary grass, Canada thistle, honeysuckle and buckthorn are present along 59.3% of the shoreline of Willow Lake and attempts should be made to control their spread.

POTENTIAL OBJECTIVES FOR THE WILLOW LAKE MANAGEMENT PLAN

I. Create a Bathymetric Map, Including a Morphometric Table
II. Participate in the Volunteer Lake Monitoring Program
III. Control Shoreline Erosion
IV. Eliminate or Control Exotic Species
V. Conduct a Fisheries Assessment

Objective I: Create a Bathymetric Map Including a Morphometric Table

A bathymetric map (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. A bathymetric map does not currently exist for Willow Lake. Maps can be created by agencies like the Lake County Health Department - Lakes Management Unit or other companies. Costs vary, but can range from $3,000-10,000 depending on lake size.

Objective II: Participate in the Volunteer Lake Monitoring Program

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

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

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

Currently the number of volunteers in the six county northeast Illinois region has reached its limit with regard to how many volunteers NIPC can handle. New lakes wishing to be part of the VLMP will be taken on and trained by the Lake County Health Department Lakes Management Unit (LMU). If you would like to be placed on this training list or would simply like more information, contact the Lakes Management Unit Local Coordinator:

LMU Local Coordinator:	VLMP Regional Coordinator:
Mary Colwell	Holly Hudson
3010 Grand Ave.	Northeast Illinois Planning Commission
Waukegan, IL 60085	222 S. Riverside Plaza, Suite 1800
(847) 377-8009	Chicago, IL 60606
mcolwell@co.lake.il.us	(312) 454-0400

Objective III: 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.

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. A table in 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.

A technique that is sometimes implemented along shorelines is the use of willow posts, or live stakes, which are harvested cuttings from live willows (*Salix* spp.). They can be planted along the shoreline along with a cover crop or native seed mix. The willows will resprout and begin establishing a deep root structure that secures the soil. If the shoreline is highly erodible, willow posts may have to be used in conjunction with another erosion control technique such as biologs, A-Jacks ®, or rip-rap.

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 a Table 5, Appendix A should be considered for native plantings.

Much of Willow Lake's shoreline is already buffered by wetland plant species and shrubby areas. However, several parts of the shrubby shoreline are currently exhibiting erosion because the larger root systems of the shrubs, as well as invasion of these areas by buckthorn, are resulting in the instability of soils there. It is recommended that these areas be cleared of buckthorn, re-graded and re-planted with native emergent plant species.

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. Approximately 1,250 feet of shoreline was exhibiting slight erosion in 2003. The cost to create a buffer strip could $12,500, without the cost of permits or willow posts.

<u>Option 3: Install Biolog, Fiber Roll, or Straw Blanket with Plantings</u>

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Once established, a buffer strip of native plants can be planted along side or on top of the roll (depending if rolls are made of synthetic or natural fibers). They are most effective in areas where plantings alone are not effective due to already severe erosion. In areas of severe erosion, other techniques may need to be employed or incorporated with these products. Those with natural fibers could also provide a substrate base in order to reestablish some native emergent plants.

Pros

Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from terrestrial sources. These factors help improve water quality in the lake by reducing the amount of nutrients available for algae growth and by reducing the sediment that flows into a lake.

Cons

These products may not be as effective on highly erodible shorelines or in areas with steep slopes, as wave action may be severe enough to displace or undercut these products. On steep shorelines grading may be necessary to obtain a 2:1 or 3:1 slope or additional erosion control products may be needed. If grading or filling is needed, the appropriate permits and surveys will have to be obtained.

Costs

Costs range from $25 to $35 per linear foot of shoreline, including plantings. This does not include the necessary permits and surveys, which may cost $1,000 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed. Approximately 1,250 feet of shoreline was exhibiting slight erosion in 2003. The cost to install a biolog, fiber roll or straw blanket with plantings could range from $31,250-$43,750, without permit cost.

Objective IV: 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.

Purple loosestrife is responsible for the “sea of purple” seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. Due in part to an extensive root system, large seed production (estimates range from 100,000 to 2.7 million seeds per plant), and high seed germination rate, purple loosestrife spreads quickly. 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. This is particularly important in remote or undeveloped areas of lake shorelines where the spread of exotic species may go unnoticed for some time.

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

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

Pros

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics when possible. Tables 5 and 6, Appendix A lists several native plants that can be planted along shorelines and local greenhouses that sell these plants.

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: Biological Control

Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase.

Recently two leaf beetles (*Galerucella pusilla* and *G. calmariensis*) and two weevils, one a root-feeder (*Hylobius transversovittatus*) and one a flower-feeder (*Nanophyes marmoratus*) have offered some hope to control purple loosestrife by natural means. These insects feed on the leaves, roots, or flowers of purple loosestrife, eventually weakening and killing the plant or, in the case of the flower-feeder, prevent seeding. In large stands of loosestrife, the beetles and weevils naturally reproduce and in many locations, significantly reduce plant densities. The insects are host specific, meaning that they will attack no other plant but purple loosestrife. Currently, the beetles have proven to be most effective and are available for purchase. There are no designated stocking rate recommendations, since using bio-control insects are seen as an inoculation and it may take 3-5 years for beetle populations to increase to levels that will cause significant damage. Depending on the size of the infested area, it may take 1,000 or more adult beetles per acre to cause significant damage. CLC stocked beetles for purple loosestrife in 2002 and are continuing to monitor the effect of this stocking.

Pros

Control of exotics by a natural mechanism is preferable to chemical treatments. Insects, being part of the same ecological system as the exotic plant (i.e., the beetles and weevils and the purple loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while bio-control measures target specific plant species. This technique is beneficial to the ecosystem since it preserves, even promotes, biodiversity. As the exotic plant dies back, native vegetation can reestablish the area.

Cons

Few exotics can be controlled using biological means. Currently, there are no bio-control techniques for plants such as buckthorn, reed canary grass, or a host of other exotics. One of the major disadvantages of using bio-control is the costs and labor associated with it.

Use of biological mechanisms to control plants such as purple loosestrife is still under debate. Similar to purple loosestrife, the beetles and weevils that control it are not native to North America. Due to the poor historical record of introducing non-native species, even to control other non-native species, this technique has its critics.

Costs

The New York Department of Natural Resources at Cornell University (email: bb22@cornell.edu, 607-255-5314, or visit the website: www.invasiveplants.net) sells overwintering adult leaf beetles (which will lay eggs the year of release) for $1 per beetle and new generation leaf beetles (which will lay eggs beginning the following year) at $0.25 per beetle. The root beetles are sold for $5 per beetle. Some beetles may be available for free by contacting the Illinois Natural History Survey (INHS; 217-333-6846). The INHS also conducts a workshop each spring at Volo Bog for individuals and groups interested in learning how to rear their own beetles.

Option 3: Control by Hand

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Some exotics, such as purple loosestrife and reed canary grass, can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is removed. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored. 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 4: 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. 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® or Round-up™), cost approximately $100 and $65 per gallon, 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.

Objective V: Conduct a Fisheries Assessment

Many lakes in Lake County have a fish stocking program in which fish are stocked every year or two to supplement fish species already occurring in the lake or to introduce additional fish species into the system. However, very few lakes that participate in stocking check the progress or success of these programs with regular fish surveys. Lake managers should have information about whether or not funds delegated to fish stocking are being well spent, and it is very difficult to determine how well stocked fish species are surviving and reproducing or how they are affecting the rest of the fish community without a comprehensive fish assessment. Willow Lake has not been stocked by the College of Lake County (CLC), but there is interest in a possible fish stocking program in the future. In order to determine what species of fish might be appropriate to stock in the lake, it is highly recommended that a fish assessment is carried out.

A simple, inexpensive way to derive direct information on the status of a fishery is to sample anglers and evaluate the types, numbers and sizes of fish caught by anglers actively involved in recreational fishing on the lake. Such information provides insight on the status of fish populations in the lake, as well as a direct measure of the quality of fishing and the fishing experience. However, the numbers and types of fish sampled by anglers are limited, focusing on game and large, catchable-sized fish. Thus, in order to obtain a comprehensive assessment of the fish community status, including non-game fish species, more quantitative methods must be employed. These include gill netting, trap netting, seining, trawling, angling (hook and line fishing) and electroshocking. Each method has its advantages and limitations, and frequently multiple gear and approaches are employed. The best gear and sampling methods depend on the target fish species and life stage, the types of information desired and the environment to be sampled. The table below lists examples of suitable sampling gear for collecting adults and young of the year (YOY) of selected fish species in lakes.

Typically, fish populations are monitored at least annually. The best time of year depends on the sampling method, the target fish species and the types of data to be collected. In many lakes and regions, the best time to sample fish is during the fall turnover period after thermal stratification breaks down and the lake is completely mixed because (1) YOY and age 1+ (one year or older) fish of most target species should be present and vulnerable to most standard collection gear, including seines, trap nets and electroshockers; (2) species that dwell in the hypolimnion during the summer may be more vulnerable to capture during fall overturn; and (3) lower water temperatures in the fall can help reduce sampling-related mortality. Sampling locations are also species-, life stage-, and gear-dependent. As with sampling methods and time, locations should be selected to maximize capture efficiency for the target species of interest and provide the greatest gain in information for the least amount of sampling effort.

The Illinois Department of Natural Resources (IDNR) will perform a fish survey at no charge on most public and some private water bodies. In order to determine if your lake is eligible for a survey by the IDNR, contact Frank Jakubecik, Fisheries Biologist at (815) 675-2319. If a lake is not eligible for an IDNR fish survey, or if a more comprehensive survey is desired, two known consulting firms have previously conducted fish surveys in Lake County: EA Engineering, Deerfield, IL, (847) 945-8010 and Richmond Fisheries, Richmond, IL, (815) 675-6545.

		GEAR[a]	
TAXON	**FISH LIFE STAGE**	**STANDARD**	**SUPPLEMENTAL**
Trout, salmon, whitefish, char (except lake trout)	YOY	Electrofishing	Gill nets, trawls, seine
	Adult	Trap nets	Gill nets, electrofishing (F)
Lake trout	YOY	Electrofishing (F)	Seine (F), trawls
	Adult	Trap nets (F)	
Pike, pickerel, muskellange	YOY	Seine (Su)	
	Adult	Trap nets (S), gill nets (S,F)	
Catfish, bullheads	YOY	Seine	Baited traps
	Adult	Gill nets, trap nets[b]	Slat nets, angling
Bass, sunfish, crappie	YOY	Seine, electrofishing	
	Adult	Electrofishing	Trap nets, angling
Minnows, carp, dace, chub, shiners	YOY	Electrofishing	Seine
	Adult	Electrofishing	Seine
Yellow perch	YOY	Seine (Su), electrofishing	Trawls (S)
	Adult	Gill net, trap net	
Walleye	YOY	Seine (S), electrofishing	Trawls (S)
	Adult	Trap nets (S), gill nets (S, F), electrofishing (S, F)	

[a]Letter codes indicate seasonal restrictions on gear use to the spring (S), summer (Su), or fall (F).
[b]Bullheads only.