2000 SUMMARY REPORT
of
FOREST LAKE

Lake County, Illinois

Prepared by the

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LAKE IDENTIFICATION AND LOCATION

Forest Lake is adjacent to the town of Hawthorne Woods in unincorporated Ela township (T43N, R10E, S10, 15). Old McHenry Road is to the north and Quentin road borders the west side of the lake. Forest Lake is a shallow, man-made impoundment with a surface area of 39.3 acres and a mean depth of 4.5 feet. Small sediment traps were dug (and aerators placed in the basins) in the northwestern portion of the lake, creating artificial holes 13 feet deep. However, the "natural" maximum depth of the lake is 9 feet. Lake volume is approximately 176.5 acre-feet (Lake Management Unit surface area x average depth). Forest Lake is part of the Indian Creek Watershed, a drainage basin of the Des Plaines River Watershed. One small, natural tributary drains into Forest Lake at the northwest end, and four stormwater outlets empty into the lake at various locations.
A 5 foot concrete overflow dam at the northeast end of the lake allows water to flow to Forest Lake Drain, the only outlet. The Drain flows north and enters Indian Creek near Windward Lake, eventually draining into the Des Plaines River.

BRIEF HISTORY OF FOREST LAKE

The lake was created in 1934 by dredging a wetland and flooding the surrounding area by damming the creek. Bottom ownership of Forest Lake primarily belongs to the Forest Lake Community Association, but several parcels on the southwest end of the lake are privately owned.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Four areas located around the lake provide year-round access to Forest Lake for Forest Lake residents and their guests (Figure 1). South Beach (Steinken Park Beach) is located at the southern end of the lake, Central Beach is located along the east-central shoreline, North Beach (Forest Lake Northeast Beach) is located at the northern tip of the lake, and West Beach (Erker Park Beach) is located on the northwest side of the lake. All four areas are owned and maintained by the Forest Lake Community Association, which meets one time per month. South and West Beaches have limited boat access, but North Beach serves as a storage space for rowboats and canoes belonging to community residents who do not have direct access to the lake. The lake's main uses are fishing and swimming. Rowboats and small boats with electric motors are the most common watercraft on the lake, as the lake association does not allow gas powered motors. Forest Lake's watershed is approximately 430 acres in size and is dominated by residential and agricultural uses. Similar to much of Lake County, the increased construction activity in recent years has shifted the land use from agricultural to residential. The shoreline of the lake is also dominated by single-family residences, and very little natural area is present around the lake.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples collected from Forest Lake were analyzed for a variety of water quality parameters (See *Appendix A* for methodology). Samples were collected at 3 foot and 7 foot depths from the deep hole location in the lake (Figure 1). Forest Lake did not thermally stratify in 2000. 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 by mid- summer. Forest Lake stayed mixed as a result of wind and wave action across the lake. The absence of stratification in Forest Lake was discovered by assessing the water quality data, which showed that concentrations of most parameters collected from shallow water samples, were similar to those same parameters collected from deep water samples. As a result, only data from the epilimnetic samples will be discussed. These parameters are discussed in detail in a document accompanying this report*: Interpreting Your Water Quality Data*. The complete data set for Forest Lake is located in Table 1. Below is a brief discussion of the analysis of the water quality data collected over the five month study of Forest Lake.

Phosphorus is a nutrient that can enter lakes through runoff or from the lake sediment, and high levels of phosphorus typically trigger algal blooms. Average phosphorus concentrations in Forest Lake (0.09 mg/l) were higher than the Lake County average (0.066 mg/l) (1995-2000), and were well above levels necessary to cause algae problems (0.05 mg/l) from June through September. As a result of these high phosphorus concentrations, lake wide blue-green algal blooms were present on Forest Lake from June through September and, subsequently, low Secchi depths were recorded in each of these months. Secchi depth is a direct indicator of water clarity and overall water quality and can be reduced by either algae or sediment in the water column. Secchi depth readings in Forest Lake were poor and well below the Lake County average of 5.0 feet from June-September. The Secchi depth declined from 4.3 feet in May to approximately 2.0 feet in June, and remained at 2.0 feet through September. This corresponded with a dramatic increase of algae in the lake from May to June.

Twelve grass carp (*Ctenopharyngodon idella* Val.) were stocked in Forest Lake on two different occasions (the last one occurring four years ago). The fixed stocking rate of grass carp is 10 fish per acre. It would appear, then, that Forest Lake was severely understocked (the lake is 39 acres). However, recent studies have shown that grass carp, like most animals, prefer some plants over others and that stocking rates should actually reflect plants palatability as well as percent plant cover in the lake. If a lake has a small plant infestation and the plants are very palatable, this fixed rate of 10 fish per acre will be much too high. If the plants being treated are unpalatable and cover a large percentage of the lake, this fixed rate may be too low. It is still assumed that Forest Lake was understocked with grass carp but that they are still inhabiting the lake, despite the absence of plants. Of greater concern is the presence of large numbers of common carp (*Cyprinus carpio*). Although grass carp are sterile (as required by law), common carp reproduce in large numbers and spawning typically occurs in June. Spawning activities will stir up bottom sediment, creating murky water conditions. Additionally, common carp naturally feed off the lake bottom, searching for insects, crustacean and small fish. Since plants stabilize bottom sediment, the absence of plants and the resuspension of sediment during carp feeding and spawning activities reduced water clarity and maintained turbid conditions in Forest Lake from June through September.

Besides decreasing Secchi depth, carp activities and lake-wide algal blooms negatively impacted other water quality parameters. Total suspended solids (TSS) increased from 5.6 mg/l in May to as high as 37.9 mg/l in July. Average TSS in 2000 was 15.6 mg/l, almost double the Lake County average of 8.6 mg/l (1995-2000 samples). Total volatile solids (TVS), which represents the amount of organic material in the water, was also well above the county average (129 mg/l) throughout the summer, reaching a level of 223 mg/l in June. This indicates that a large part of the material in the water column was algae (an organic material). Total dissolved solids (TDS) and conductivity, two closely related parameters, were elevated in May and June, but dropped dramatically in July and continued to fall through the rest of the summer. This is typical in most lakes within developed areas and is the result of road salt dissolved in spring runoff entering the lake from nearby roads and driveways.

Typically, lakes are either phosphorus or nitrogen limited. This means that these nutrients are in short supply and that any addition of phosphorus or nitrogen to the lake will result in an increase of plant or algal growth. Other resources necessary for plant and algae growth, such as light or carbon, can be limiting, but this is rarely observed. 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 or equal to 10:1, but less than or equal to 15:1 indicate that there are enough of both nutrients to facilitate excess algal or plant growth. Forest Lake had a TN:TP ratio of 19:1. This indicates that it is phosphorus limited and reinforces the concern that high phosphorus levels (double the county average in July and September) are causing continuous algae blooms in Forest Lake throughout the summer.

The source of phosphorus in a lake can be either external or internal. External sources originate outside of the lake and can include fertilizer runoff, erosion, or failing septic systems. Internal sources originate from lake sediment. Internal sources are a common source of phosphorus in man-made lakes, which typically contain rich, organic sediment. Phosphorus can be released from oxic sediment through biological or mechanical processes, such as carp activities, macroinvertebrate burrowing, wind action, which disturb the sediments. This typically occurs in shallow lakes like Forest Lake that do not stratify, and released phosphorus can be easily distributed throughout the water column. In deeper lakes which do stratify, phosphorus can be released through chemical processes under anoxic conditions in the hypolimnion. This phosphorus will stay in the hypolimnion until the lake turns over in the fall, when it is mixed throughout the water column and can result in late season algal blooms. The source of phosphorus in Forest Lake appears to be internal. Phosphorus levels increased each month throughout the study. This increase did not coincide with similar increases in rainfall from month to month, as would be expected if the source of phosphorus was external. The increase occurred as phosphorus was released or resuspended from bottom sediment each month, accumulating in the water column. Forest Lake currently has two aerators. One pumps air to two areas in the northwest corner of the lake and one pumps air to two areas in the southwest bay. The aerators were installed in order to reduce sediment deposition, reduce algae blooms and, in the south bay, to reduce odors that resulted from a storm water inlet and a build-up of organic sediments. The aerator in the main lake is, likely, contributing to the high phosphorus levels (and low Secchi depths) in the lake by resuspending phosphorus-rich sediment into the water column on a daily basis. The aerator in the southwest bay is also resuspending sediment, but residents may have to decide between the negative aspects of sediment resuspension or odor problems.

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* 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 high TSI value indicates eutrophic (TSI=50-69) to hypereutrophic (TSI ≥70) lake conditions. Forest Lake has a phosphorus TSI value of 68.7, indicating borderline hypereutrophic conditions. This means that the lake is a highly productive system and has excessive nutrient (phosphorus) concentrations and algae growth. Dissolved oxygen concentrations could fall at certain times during the summer due to the high algae levels. Under these conditions, lake clarity will typically be poor. Although most man-made lakes in the county fall into the eutrophic and hypereutrophic categories, Forest Lake ranks 60th out of 86 lakes studied for water quality by the LCHD-LMU since 1988 (Table 2).

Most of the water quality parameters discussed can be used to analyze the water quality of Forest Lake based on use impairment indices established by the Illinois Environmental Protection Agency (IEPA). According to this index, Forest Lake has *Partial* overall use impairment due to low water clarity and elevated phosphorus levels. The lake provides *Full* aquatic life support, but only *Partial* swimming use support due to poor Secchi depth readings which prevent safe swimming. Additionally, Illinois Department of Public Health recommends at least 48” Secchi disk depth for safe swimming (Forest Lake’s average was 30”). There is also only *Partial* support for recreational use due to a high TSI value and high levels of suspended solids, which result in low visibility and contribute to an overall reduction in lake use.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant surveys were conducted every month for the duration of the study (See *Appendix A* for methodology). Shoreline plants of interest were also observed and recorded. However, no quantitative surveys were made of these shoreline species and all data are purely observational. Based on 1% light level, the depth at which plant growth could occur in Forest Lake differed on a monthly basis, but varied from the bottom (9 feet) in May to between 5 feet and 7 feet throughout the rest of the summer. However, only small sprigs of two plants (sago pondweed, *Potamogeton pectinatus*, and curly leaf pondweed, *Potamogeton crispus*) were observed at one location in the lake during the May survey. No other plant species were found during the 2000 survey. Purple loosestrife (*Lythrum saliarice*) was observed on several shorelines around the lake. A summary of plant data can be found in Table 3.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted at Forest Lake on May 10, 2000. The shoreline was assessed for a variety of criteria (See *Appendix A* for methodology). Based on these assessments, several important generalizations could be made. Virtually all of Forest Lake's shoreline (99.8%) is developed, and the majority of this developed shoreline (67.3%) is either comprised of seawall or rip-rap. Other major shoreline types included beach (12.7%) and manicured lawns (10.5%) (Figure 2). These four dominant types of shoreline are considered relatively undesirable for several reasons. Seawalls have a tendency to reflect wave action back into the lake, resuspending sediments and creating turbid conditions. They also provide poor wildlife habitat, as well as cause several other problems. If not properly installed, rip rap can be severely undercut by erosion, and beaches can be washed away into the lake year after year. Manicured lawns provide a poor shoreline-water interface due to the poor root structure of turf grasses. These grasses are incapable of stabilizing the shoreline and typically lead to erosion. More desirable shoreline, such as buffer strips and woodland area, was present in small quantities (6.5% and 3.1%, respectively) along Forest Lake. Despite the large amount of relatively undesirable shoreline present on Forest Lake, only 28% of the shoreline had slight to moderate erosion, and no shoreline areas were considered to be severely eroded. This low occurrence of erosion was due to the relatively gradual slope of the land as it nears the lake. Shoreline types that were likely to have eroded soils included wooded, poorly managed buffer strips and manicured lawns (Figure 3).

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

The most recent fish survey performed on Forest Lake by the Illinois Department of Natural Resources (IDNR-formerly the Illinois Department of Conservation (IDOC)) was in 1985. Electroshocking and gill nets were used to collect the data. White crappie and bluegill dominated the sport fish populations, which also included large mouth bass, pumpkinseed, warmouth, black crappie, northern pike, and yellow perch. Golden shiners dominated the commercial/forage fish population, which also included a small number of common carp and blunt-nose minnows. It was concluded that Forest Lake had a relatively good quality sport fishery, with growth and condition of most fish being good. Stocked northern pike were thriving, but numbers of yellow perch had declined due to heavy predation by the successful pike population. Only seven older carp were found in 1985, and it was concluded that they posed no problem to the fishery. IDNR recommendations to maintain and improve the fishery included (1) a 14 inch size limit and catch limit on large mouth bass, (2) the continuation of northern pike stocking and

(3) the maintenance of an aquatic weed control program as necessary. One hundred northern pike are stocked every year for carp and bluegill predation. However, it is emphasized by the IDNR that, to date, no biological control shows promise to restore “balance” among the fish species inhabiting artificial lakes. Stocking of predators such as northern pike, tiger muskie, and/or walleye to control undesirable fish numbers has proven ineffective. This is primarily due to the stocked fish being unable to compete with excessive numbers of undesired fish already present. These species cannot reliably maintain self-sustaining populations in man-made lakes. Two hundred pounds of flathead minnow are also stocked each year to provide food for bass and pike. Without the minnow stocking, the bass and pike would, most likely, be quite stunted and in poor health. Approximately two dozen grass carp have been stocked in the lake over the past 8-10 years with resultant plant eradication. A fish kill involving black crappie occurred during May 2000. The LCHD-Lakes Management Unit examined this fish kill and determined that it was probably caused by a disease specific to black crappie, and not by oxygen depletion.

Wildlife observations were made on a monthly basis during water quality and plant sampling activities (See *Appendix A* for methodology). All observations were visual and several types of waterfowl were observed over the course of the study (Table 4). Poor wildlife habitat was found along Forest Lake. Several mature trees and a few dead trees were present. Dead trees can serve as excellent habitat for birds like herons and cormorants. In addition, once a tree falls into the water, it provides excellent habitat for many wildlife species (i.e., turtles, fish, birds). However, there are many areas around Forest Lake in which habitat can be improved to facilitate more bird and waterfowl nesting. Purple loosestrife (*Lythrum saliaria*), an invasive plant species, was observed along the shoreline. This plant is seldom used by wildlife for food or shelter and can easily displace other native, more desirable plant species. Actions should be taken to control or eliminate purple loosestrife around Forest Lake. Additionally, shoreline habitat should be improved and should include buffer strips and more naturalized shoreline areas. See *Objective V: Wildlife Habitat Improvement* (p. 21).

Table 4: Observed Wildlife Species on Forest Lake, May-September 2000

<u>*Birds*</u>	
Double Crested Cormorant	*Phalacrocorax auritus*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
American Coot	*Fulica americana*
Great Blue Heron	*Ardea herodias*

EXISTING WATER QUALITY PROBLEMS

- *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. Morphometric data obtained in the creation of a bathymetric map is necessary for calculation of equations for correct application of these types of treatments.

- *Poor Plant Diversity/Density*

One key to a healthy lake is a healthy aquatic plant community. Forest Lake is devoid of plants. Lack of quality aquatic plants and subsequent reduction of water quality is the result of low light penetration caused by lake-wide algae blooms which began in late spring and continued into early fall. The negative impacts associated with the absence of aquatic plants are wide spread and include those on water quality and fishery health.

- *Poor Water Clarity*

As a result of the absence of aquatic plants, which provide sediment stability, reduce sediment resuspension, and compete with algae for light and resources, the water column of Forest Lake is filled with algae and suspended sediments. This keeps water clarity low and prevents any aquatic plants from growing. As mentioned before, high algae densities are the result of high nutrient levels, and the resuspension of bottom sediments into the water column is the result of the lack of sediment stabilizing plants and increased carp activity. Poor water clarity reduces the aesthetics of recreational activities such as swimming and fishing. Swimming becomes unsafe and fish species decrease in size and number as it becomes more difficult to find prey in murky waters.

- *High Nutrient Levels and Algae Blooms*

Algae blooms were wide-spread and continuous in Forest Lake from mid-May through September. The blooms largely consisted of planktonic blue-green algae and were caused by high phosphorus levels. It was determined that phosphorus is probably originating from resuspended bottom sediment in the lake and that external sources of phosphorus may be less important. Increases in alga blooms over the course of the summer lead to a dramatic decrease in water clarity, a decrease in light penetration, and an increase in TSS. As mentioned before, with a decrease in light levels, aquatic vegetation is no longer able to grow in the lake and the benefits they provide are lost.

- *Sediment Resuspension via Aerators*

Two aerators were installed into Forest Lake primarily to reduce sediment deposion. The aerator in the southwest bay was also meant to reduce algae and the odors associated with it. However, in keeping bottom sediment suspended, these aerators are contributing to the poor water clarity and absence of plants observed in the lake in 2000. The water column is turbid due to suspended sediment and algae. The aerators are leading to low water clarity directly through sediment resuspension and indirectly by providing a source of phosphorus (through resuspended sediments) to the algae in the lake. According to homeowners, sediment deposition is not a significant problem in the main part of the lake. It is, therefore, recommended that the aerator in the main lake be removed in order to reduce sediment resuspension and phosphorus release. Because sediment deposition is more significant and odors are persistent in the south bay, we suggest aeration continue there and that the aerator no longer needed in the main body of the lake be used to supplement the aerator in the south bay. This would provide double the amount of horsepower needed to oxygenate and circulate this area of the lake, and may eliminate algae and odor problems in the bay altogether.

- *Presence of Common Carp and Grass Carp*

Twenty-four grass carp were stocked in Forest Lake to help in plant control when the lake did contain plants. Although these fish are sterile, their feces are very high in phosphorus and their feeding activities (in the absence of plants) will disturb bottom sediments. Common carp are present in the lake in very high densities. This carp species does reproduce at a high rate and their spawning and feeding activities disturb bottom sediments in a similar manner as grass carp. The presence of these two fish species is contributing to low Secchi depths and further hampering any chance for plant growth in Forest Lake.

- *Poor Natural Shoreline Conditions*

Virtually all of the shoreline of Forest Lake is developed by single-family residences, and nearly all of this developed shoreline consists of rip rap, seawalls, manicured lawns or beaches. These types of shorelines do not provide quality wildlife habitat. In addition, severe erosion is typical on shorelines consisting of manicured lawns.

POTENTIAL OBJECTIVES FOR FOREST LAKE MANAGEMENT PLAN

I. Create a Bathymetric map, Including a Morphometric Table
II. Establish Better Aquatic Plant Management Techniques and Aquatic Revegetation
III. Establish a Better Algae Management Plan
IV. Eliminate Common and Grass Carp
V. Wildlife Habitat Improvement
VI. Eliminate or Control Exotic Species

ALTERNATIVES FOR ACHIEIVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Create a Bathymetric Map, Including a Morphometric Table

A bathymetric (depth contour) map is an essential tool in effective lake management since it provides information on the morphometric features of the lake, such as depth, surface area, volume, etc. The knowledge of this morphometric information would be necessary if lake management treatments such as fish stocking, dredging, alum application or aeration were part of the overall lake management plan. Forest Lake does have a bathymetric map. However, it is outdated (1990), may not accurately represent the lake features, and does not include morphometric data (which are pertinent for certain calculations). Maps can be created by the Lake County Health Department – Lake Management Unit or other agencies for costs that vary from $3,000-$10,000, depending on lake size.

Objective II: Establish Better Aquatic Plant Management Techniques and Aquatic Revegetation

All aquatic plant management techniques have both positive and negative characteristics. If used properly, they can all be beneficial to a lake's well being. If misused or abused, they all share similar outcomes - negative impacts to the lake. Putting together a good aquatic plant management plan should not be rushed. Plans should consist of a realistic set of goals well thought out before implementation. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. For an aquatic plant management plan to achieve long term success, follow-up is critical. A good aquatic plant management plan considers both the short and long-term needs of the lake. An association or property owner should not always expect immediate results, as a quick fix of the vegetation problems may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly solve the problem. The management option covered below involves the pros and cons of revegetation of the plant community in a lake.

Option 1: No Action

Under a no action management plan for lake revegetation, no plants would be planted in Forest Lake. The current status of the plant community would remain the same and water clarity would not change. The fish community would continue to be stunted and sediment resuspension would continue to be a problem.

Pros

There are few pros to the overall lake water quality with this option. However, there would be no costs associated with this option and no threat of excessive plant growth in the lake would be realized. Boats could continue to navigate the lake freely and anglers and swimmers would not have to worry about getting lines or legs caught up in dense plant stands.

Cons

Taking no action to reestablish a plant community in Forest Lake will maintain or increase the poor water quality due to the high levels of nutrients and sediment in the water column. Aquatic plants serve many purposes in a lake, including sediment stabilization, nutrient uptake and fish habitat. A healthy plant community will increase water clarity, reduce algal abundance, improve fishery and wildlife populations and improve the overall aesthetics of the lake. With the no action plan, none of these benefits will be available.

Costs

No costs would be incurred with this option.

Option 2: Reestablishing Native Aquatic Vegetation

Because Forest Lake has poor clarity due to excessive algal growth and turbidity, these problems must be addressed before a revegetation plan is undertaken. Without adequate light penetration, revegetation will not work. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

There are two methods by which reestablishment can be accomplished. The first involves the use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake are allowed to naturally expand into adjacent areas. If native plants were to re-emerge as water clarity is increase, this could be an option for Forest Lake. Another technique utilizing existing plants is to transplant vegetation from one area to another. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 5 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are aquatic shoreline vegetation (rushes, cattails, etc) and deeper water plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

Pros

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

Cons

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

Costs

See Table 5 for pricing

Objective III: Establish a Better Algae Management Plan

The growth of nuisance or excessive algae can cause a number of problems. Excessive algal growth can cause decreases in water clarity and light penetration. This can lead to several major problems such as loss of aquatic plants, decline in fishery health, and interference with recreational activities. Health hazards, such as swimmer's itch and other skin irritations have been linked to excessive algal growth. Normally, excessive algae growth is a sign of larger problems such as excessive nutrients and/or lack of aquatic plants. Some treatment methods, such as copper sulfate, are only quick remedies to the problem. Solving the problem of excessive algal growth involves treating the factors that cause the excessive growth, not the algae itself. Long term solutions typically include an integrated approach such as alum treatments, revegetation with aquatic plants, and limiting external sources of nutrients. Interestingly enough, these long-term management strategies are seldom used, typically because of their high initial costs. Instead, the cheap, quick fix of using copper sulfate, though temporary, is much more widely used. However, the costs of continually applying copper sulfate over years, even decades, can far exceed the costs of a slower acting, more effective, integrated approach.

As with aquatic plant management techniques, algae management practices have both positive and negative characteristics. If used properly, they can be beneficial to a lake's well being. If misused or abused, they will result in negative impacts to the lake. The plan should be based on the management goals of the lake and involve usage issues (beaches, boat ramps, etc.), habitat maintenance/restoration issues, and nutrient levels. As with a plant revegetation plan, for an algal management plan to achieve long term success, follow-up is critical. The management of the lake's algae problem does not end once the blooms and/or mats have been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and treat as necessary. Sometimes the best solutions take several seasons to properly address the problem. The management options covered below are coming into wider acceptance, and have been used in Lake County. There are other algae management options that are not covered below as they not are very effective or are too experimental to be widely used.

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

With a no action management plan, nothing would be done to control the nuisance algae, regardless of type and extent. Nuisance algae, planktonic and/or filamentous, could continue to grow until epidemic proportions are reached. Growth limitations of the algae and the characteristics of the lake itself (light penetration, nutrient levels) will dictate the extent of infestation. Unlike aquatic plants, algae are not normally bound by physical factors such as substrate type. The areas in which filamentous and thick surface planktonic blooms (scum) occur can be affected by wind and wave action if strong enough. However, under normal conditions, with no action, both filamentous and planktonic algal blooms can spread to cover 100% of the lake surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

Pros

There are positive aspects associated with the no action option for nuisance algae management. The first, and most obvious, is that there is no cost. However, if an active management plan for algae control were eventually needed, the cost would be substantially higher than if the no action plan had been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, no introduction of any chemical or organisms would take place. Use of the lake would continue as normal unless blooms worsened. In this case, activities such as swimming might have to be suspended due to an increase in health risks.

Cons

Under the no action option, if nuisance algae becomes wide spread and able to reach epidemic proportions, there will be many negative impacts on the lake. The fishery of the lake may become stunted due the to lack of quality forage fish habitat and reduced predation. This will cause an explosion in the small fish population and, with food resources not increasing, growth of fish will be reduced. Fish kills can result from toxins released by some species of blue-green algae. Blue-green algae can also produced toxins that are harmful to other algae, allowing blue-green algae to quickly dominate a body of water. Decreased dissolved oxygen levels, due to high biological oxygen demand from the excessive algae growth, will also have negative impacts on the aquatic life. Wildlife populations will also be negatively impacted by dense growths of algae. Birds and waterfowl will have difficulty in finding quality plants for food or in locating prey within the turbid green waters. Additionally, some algae species are poor sources of food for zooplankton and fish.

Water quality could also be negatively impacted with the implementation of a no action option. Decomposition of organic matter and release of nutrients upon algal death is a probable outcome. Large nutrient release with algae die back could lead to lake-wide increases of internal nutrient load. This could, in turn, increase the frequency or severity of other blooms. In addition, decomposition of massive amounts of algae will lead to a depletion of dissolved oxygen in the lake. This can cause fish stress, and eventually, if stress is frequent or severe enough, fish kills.

In addition to ecological impacts, many physical lake uses will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick mats of filamentous algae. Swimming could also become increasingly difficult and unsafe due to thick mats and reduction in visibility by planktonic blooms. Fishing could become more and more exasperating in thick mats with stunted fish populations. In addition, the aesthetics of the lake will decline due to large green mats and the odors that may develop as a result. The combination of above events could cause property values on the lake to suffer. Property values on lakes with algae problems have been shown to decrease by as much as 15-20%.

Costs

No cost will be incurred by implementing the no action management option.

Option 2: Algicides

Algicides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate ($CuSO_4$) and chelated copper products are the two main algicides in use. These two compounds are sold by a variety of brand names by a number of different companies. They all work the same and act as contact killers. This means that the product has to come into contact with the algae to be effective. Algicides come in granular and liquid forms. Granular herbicides are spread by hand or machine over an affected area. They can also be placed in a porous bag (such as a burlap sack) and dragged though the water in order to dissolve and disperse the product. Granular algicides are mainly used on filamentous algae where they are spread over the mats. As the granules dissolve, they kill the algae. Liquid algicides, which are much more widely used, are mixed with a known amount of water to achieve a known concentration. The mixture is then sprayed onto/into the water. They can be used on both filamentous and planktonic algae and are often mixed with herbicides and applied together to save on time and money. When applying an algicide, it is imperative that the label is completely read and followed. If too much of the lake is treated at any one time an oxygen crash may occur and decomposition of the treated algae may cause fish kills. Additionally, treatments should never be made when blooms/mats are at their fullest extent. It is best to divide the lake into at least two sections, depending on the size of the lake, and treat one section at a time, allowing at least two weeks between treatments. Furthermore, application of algicides should never be done in extremely hot weather (>90^{o}F). This will help lessen the likelihood of an oxygen crash and resulting fish kills. When possible, treatments should be made as early in the season as possible. It is best to treat in spring or when the blooms/mats start to appear so that the algae is killed before it becomes a problem.

Pros

When used properly, algicides can be a powerful tool in management of nuisance algae growth. A properly implemented plan can often provide season-long control with minimal applications. Another benefit of using algicides is the low costs. The fisheries and waterfowl populations of the lake would greatly benefit by a decrease in nuisance algal blooms. By reducing the algae, clarity would increase. This, in turn, would allow the native aquatic plants to return to the lake, improving spawning habitat and food source availability for fish. Waterfowl population would also greatly benefit from increases in quality food sources, such as large-leaf pondweed (*Potamogeton amplifolius*) and sago pondweed (*Potamogeton pectinatus*). Additionally, copper products, at proper dosages, do not affect aquatic vascular plants or wildlife.

By implementing a good management plan, usage opportunities for the lake would increase. Activities such as boating and swimming would improve due to the removal of thick blooms and/or mats of algae, and health risks associated with excessive algae growth (toxins, reduced visibility, etc.) would be reduced. The quality of fishing may recover with improved habitat and feeding opportunities. In addition to increased usage opportunities, overall aesthetics of the lake would improve, potentially increasing property values.

Cons

The most obvious drawback of using algicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error and overuse can make them unsafe and bring about undesired outcomes. By continually killing particular algal species, lake managers may unknowingly be creating a larger problem. In many instances, over use of copper is leading to selection of species tolerant to copper. As the algae are continuously exposed to copper, some species are becoming more and more tolerant. This results in the use of higher concentrations in order to achieve adequate control, which can be unhealthy for the lake. In other instances, by eliminating one type of algae, lake managers are finding that other, more problematic species are filling the empty gaps. Additionally, excessive use of copper products can lead to a build up of copper in lake sediments. This can cause problems for activities such as dredging which would require special permits and disposal methods for dredged sediment with high copper concentrations.

Costs

Copper sulfate, used to treat microscopic and filamentous algae, is applied at a rate of 2.7 gal./acre-foot at a cost of $7.50/gal. Since copper is not usually used as a like-wide treatment, specific areas of Forest Lake should be targeted. Shallow, undisturbed areas of the lake would benefit most from the treatment since plants would be more likely to grow in these areas as water clarity increased. Approximately half of the lake could be treated with copper sulfate for around $400.00 plus applicator's fees. Chelated copper (Cleargate, Cutrine Plus) is also a copper-based product for treatment of microscopic and filamentous algae. It differs from copper sulfate in that it is coated with an organic molecule that prevents the copper from binding with other ions in the water. This makes the product more effective, but also more expensive. With Cleargate, at an application rate of 2-5 gal/acre-foot and a cost of $45/gal, half of Forest Lake could be treated for $3,150.00 plus applicator's fees. With Cutrine Plus, at an application rate of 0.5-1.0 gal/acre-foot and a cost of $35/gal, the lake could be treated for $700 plus applicator's fees. These approximate costs cover one application only. Typically, copper treatments do not last an entire summer and may need to be repeated as often as every month.

Option 3: Alum Treatment

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus in the water column. One way that Forest Lake can do this is to discontinue the use of the aerator, which is contributing to phosphorus release through sediment resuspension in the main body of the lake. Reduction of phosphorus can also be accomplished by using aluminum sulfate (alum). Alum does not directly kill algae as copper sulfate does. Instead, alum binds phosphorus, making it unavailable to algae, thus reducing algal growth. Alum is sprayed as a liquid onto the water surface. It then binds phosphorus in the water column as it forms a solid flocculent layer that settles on the bottom. This layer can then also prevent sediment bound phosphorus from being released from the sediment and entering the water column. Phosphorus inactivation using alum has been in use for 25 years. However, cost and unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds, and its use in larger lakes is increasing. Alum treatment typically lasts 1 to 20 years depending on various parameters. Lakes with low mean depth to surface area are good candidates, and lakes that are thermally stratified experience longer inactivation than non-stratified lakes due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited. Alum treatments must be carefully planned and carried out by an experienced professional. If not properly performed, there may be many detrimental side effects. Regardless, a good bathymetric map is essential before any alum treatment can be carried out.

Pros
Phosphorus inactivation is a possible long-term solution for controlling nuisance algae and increasing water clarity. Alum treatments can last as long as 20 years. This makes alum more cost effective in the long-term as compared to continual treatment with algaecides. Studies have shown reductions in phosphorus concentrations by 66% in spring and 68% in summer. Chlorophyll *a*, a measure of algal biomass, was reduced by 61%. Reduction in algal biomass caused an increase in dissolved oxygen and a 79% increase in Secchi disk readings. Effects of alum treatments can be seen in as little as a few days. The increase in water clarity can have many positive effects on the lake's ecosystem. With increased clarity, plant populations could expand or become reestablished. This, in turn, would improve fish habitat and provide improved food sources for other organisms. Recreational activities such as swimming and fishing would be improved due to increased water clarity and healthy plant populations. Typically, there is a slight invertebrate decline immediately following treatment but populations recover fully by the following year.

Cons
There are several drawbacks to alum. External nutrient inputs must also be reduced or eliminated for alum to provide long-term effectiveness. With larger watersheds this could prove to be physically and financially impossible. Phosphorus inactivation may be shortened by excessive plant growth or carp activity, which can disturb the flocculent layer and allow phosphorus to be released. Also, lakes that are shallow, non-stratified, and wind-blown typically do not achieve long term control due to disruption of the flocculent layer. If alum is not properly applied, toxicity problems may occur. Typically aluminum toxicity occurs if the pH of the water is below 6 or above 9. Forest Lake is in this range, but special precautions must still be taken when applying alum. By adding the incorrect amounts of alum, pH of the lake could drastically and quickly change. Due to these dangers, it is highly recommended that a lake management professional plans and administers the alum treatment.

Costs
Cost for an alum treatment based on volume and phosphorus concentrations in Forest Lake would be approximately $20,000. This is based on full lake volume. A water drawdown would decrease the costs proportionally. Drawdown could be easily carried out on Forest via the spillway. Additionally, rotenone treatment. See *Objective IV: Eliminate Common and Grass Carp* (p. 17) of the lake for carp could also be carried out during draw down to save money. These costs are approximate and include labor. When doing an alum treatment it is best to hire an *experienced* applicator. If alum treatments are not properly done, the alum may be ineffective and/or bring about several unwanted effects.

Option 4: Revegetation With Native Aquatic Plants
A healthy native plant population can reduce algal growth. Many lakes with long-standing algal problems have a very sparse plant population or none at all. This is due to

reduction in light penetration brought about by years of excessive algal blooms and/or mats. Revegetation should only be done when existing nuisance algal blooms are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. Without adequate light penetration, revegetation will not work. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis. If aquatic herbicides are being used to control what vegetation does exist their use should be scaled back or abandoned altogether. This will allow the vegetation to grow back, helping to control the algae.

The two methods by which reestablishment can be accomplished, and the pro and cons of these methods have already been discussed and can be referred to under *Objective II: Establish Better Aquatic Plant Management Techniques and Aquatic Revegetation* (p. 9).

Objective IV: Eliminate Common and Grass Carp

A frequent problem that plagues many of the lakes in the County is the presence of common carp (*Cyprinus carpio*). Common carp were first introduced into the United States from Europe in the early 1870's, and in Illinois river systems in 1885, to improve commercial fishing. The carp eventually made their way into many inland lakes and are now so wide spread that many people do not realize that they are not native to the U.S.

Carp prefer warm waters in lakes, streams, ponds, and sloughs that contain high levels of organic matter. This is indicative of many lakes in Lake County. Carp feed on insect larvae, crustaceans, mollusks, and even small fish by rooting through the sediments. Immature carp feed mainly on small crustaceans. Because their feeding habits cause a variety of water quality problems, carp are very undesirable in lakes. Rooting around for food causes resuspension of sediments and nutrients, which can lead to increased turbidity. Additionally, spawning, which occurs in shallow water, can occur from late April through June. The spawning activities of carp can be violent, further contributing to turbidity problems. Adult carp can lay between 100,000 –500,000 eggs, which hatch in 5-8 days. Initial growth is rapid with young growing 4 ¾" to 5" in the first year. Adults normally range in size from 1-10 lbs., with some as large as 60 lbs. The average carp lifespan is 7-10 years, but they may live to be as old as 15.

There are several techniques to remove carp. However, rarely does any technique eradicate carp from a lake. Typically, once a lake has carp, it has carp forever. However, it is up to the management entity to dictate how large the problem is allowed to become. Rotenone is the only reliable piscacide (fish poison) on the market at this time, but it kills all fish that is comes into contact with. Currently, there is a rotenone-laced baiting system that can selectively remove carp. While the process is a step in the right direction, several factors still need to be worked out in order for it to be a viable alternative to the whole lake treatment. Until this baiting technique is further developed and produces consistent results, it is not recommended.

Option 1: No Action

By following a no action management approach, nothing would be done to control the carp population of the lake. Populations would continue to expand and reach epidemic proportions if they do not already exist.

Pros

There are very few positive aspects to following a no action management plan for excessive carp populations. The only real advantage would be the money saved by taking no action.

Cons

There are many negative aspects to a no action management plan for carp management. The feeding habits of carp cause most of the associated problems. As carp feed they root around in the lake sediment, causing resuspension of sediment and nutrients. Increased nutrient levels can lead to increased algal blooms, which, combined with resuspended sediments, lead to increased turbidity. A subsequent decrease in light penetration along with the rooting action of the carp causes both indirect and direct disruption of aquatic plants. Loss of aquatic plants can further aggravate sediment and nutrient loads in the water column due to loss of sediment stabilization provided by the plants. Additionally, the fishery of the lake may decline and/or become stunted due to predation issues related to decreased water clarity and loss of habitat. Other wildlife, such as waterfowl, which commonly forage on aquatic plants and fish, would also be negatively impacted by the decrease in vegetation.

The loss of aquatic plants and an increase in algae will drastically impair recreational use of the lake. Swimming could be adversely affected due to the increased likelihood of algal blooms. Swimmers may become entangled in large mats of filamentous algae, and blooms of planktonic species, such as blue-green algae, can produce harmful toxins and noxious odors. Fishing would also be negatively affected with the decreased health of the lake's fishery. The overall appearance of the lake would suffer from an increase in unsightly algal blooms, having an unwanted effect on property values.

Costs

There is no cost associated with the no action option.

Option 2: Rotenone

Rotenone is a piscacide that is naturally derived from the stems and roots of several tropical plants. Rotenone is approved for use as a piscacide by the USEPA and has been used in the U.S. since the 1930's. It is biodegradable (breaks down into CO_2 and H_20) and there is no bioaccumulation. Because rotenone kills fish by chemically inhibiting the use of oxygen in biochemical pathways, adult fish are much more susceptible than fish eggs (carp eggs are 50 times more resistant). Other aquatic organisms are less sensitive to rotenone, but some organisms are affected enough to reduce populations for several months. In the aquatic environment, fish come into contact with the rotenone by a different method than other organisms. With fish, the rotenone comes into direct contact with the exposed respiratory surfaces (gills), which is the route of entry. In other organisms this type of contact is minimal. More sensitive nonfish species include frogs and mollusks, but these organisms typically recover to pretreatment levels within a few months. Rotenone has low mammalian and avian toxicity. For example, if a human consumed fish treated with normal concentrations of rotenone, approximately 8,816 lbs. of fish would need to be eaten at one sitting in order to produce toxic effects in humans. Furthermore, due to its unstable nature, it is unlikely that the rotenone would still be active at the time of consumption, and warm-blooded mammals have natural enzymes that would break down the toxin before it had any effects.

Rotenone is available in 5% and 2.5% concentrations. Both concentrations are available as synergized formulations. The synergist (piperonal butoxide) is an additive that inhibits fish detoxification of rotenone, making the rotenone more effective. Rotenone has varying levels of toxicity on different fish species. Some species of fish can detoxify rotenone quicker than it can build up in their systems. Unfortunatly, concentrations to remove undesirable fish, such as carp, bullhead and green sunfish, are high enough to kill more desirable species such as bass, bluegill, crappie, walleye, and northern pike. Therefore, it is difficult to selectively remove undesirable fish while leaving desirable ones. Typically, rotenone is used at concentrations from 2 ppm (parts per million) – 12 ppm. For removal of undesirable fish (carp, bullhead and green sunfish) in lakes with alkalinities in the range found in Lake County, the target concentration should be 6 ppm. Sometimes concentrations will need to be increased based on high alkalinity and/or high turbidity since excessive algae blooms or high sediment suspension will have the effect of neutralizing 50-90% of the rotenone applied. Rotenone is most effectively used when waters are cooling down (fall) not warming up (spring) and is most effective when water temperatures are $<50^{o}$F. Under these conditions, rotenone is not as toxic as in warmer waters but it breaks down slower and provides a longer exposure time. If treatments are done in warmer weather, they should be done before spawn or after hatch as fish eggs are highly tolerant to rotenone.

Rotenone rarely kills every fish (normally 99-100% effective). Some fish can escape removal, and rotenone retreatment needs to occur about every 10 years. At this point in time, carp populations will have become reestablished through reintroduction and reproduction by fish that were not removed during the previous treatment. To ensure the best results, precautions can be taken to assure a higher longevity. These precautions include banning live bait fishing (minnows bought from bait stores can contain carp minnows) and making sure every part of the lake is treated (i.e., cattails, inlets, and harbored shallow areas). Restocking of desirable fish species may occur about 30-50 days after treatment, when the rotenone concentrations have dropped to sub-lethal levels. Since it is best to treat in the fall, restocking may not be possible until the following spring. To use rotenone in a body of water over 6 acres a *Permit to Remove Undesirable Fish* must be obtained from the Illinois Department of Natural Resources (IDNR), Natural Heritage Division, Endangered and Threatened Species Program. Furthermore, only an IDNR fisheries biologist licensed to apply aquatic pesticides can apply rotenone in the state of Illinois as it is a restricted use pesticide.

Pros
Rotenone is one of the only ways to effectively remove undesirable fish species. This allows for rehabilitation of the lake's fishery, which will allow for improvement of the aquatic plant community, and overall water quality. By removing carp, sediment will be left largely undisturbed. This will allow aquatic plants to grow and help further stabilize the sediment. As a result of decreased carp activity and increased aquatic plant coverage, fewer nutrients will be resuspended, greatly reducing the likelihood of nuisance algae blooms. Additionally, reestablishment of aquatic plants will have other positive effects on lake health and water quality, providing increases in fish habitat and food source availability for wildlife such as waterfowl.

Cons
There are no negative impacts associated with removing excessive numbers of carp from a lake. However, in the process of removing carp with rotenone, other desirable fish species will also be removed. The fishery can be replenished with restocking and quality sport fishing normally returns within 2-3 years. Other aquatic organisms, such as mollusks, frogs, and invertebrates (insects, zooplankton, etc.), are also negatively impacted. However, this disruption is temporary and studies show that recovery occurs within a few months. Furthermore, the IDNR will not approve application of rotenone to waters known to contain threatened and endangered fish species. Another drawback to rotenone is the cost. Since the whole lake is treated and costs per gallon range from $50.00-$75.00, total costs can quickly add up. This can be off-set with lake draw down to reduce treatment volume. Unfortunately, draw down is not an option on all lakes.

Costs
As with most intensive lake management techniques, a good bathymetric map is needed so that an accurate lake volume can be determined. To achieve a concentration of 6 ppm, which is the rate needed for most total rehabilitation projects (remove carp, bullhead and green sunfish), 2.022 gal/AF is required. So, with that in mind……

(176.5 acre-feet)(2.022 gallons) = 357 gallons of rotenone needed to treat the lake.

(357 gallons)($50-$75/gallon of rotenone) = $17,850-$26,775

In waters with high turbidity and/or planktonic algae blooms, the ppm may have to be higher. An IDNR fisheries biologist will be able to determine if higher concentrations will be needed.

Objective V: Wildlife Habitat Improvement

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

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

In all cases, the best wildlife habitats are ones consisting of native plants. Unfortunately, non-native plants dominate many of our lake shorelines. Many of them escaped from gardens and landscaped yards (i.e., purple loosestrife) while others were introduced at some point to solve a problem (i.e., reed canary grass for erosion control). Wildlife species prefer native plants for food, shelter, and raising their young. In fact, one study showed that plant and animal diversity was 500% higher along naturalized shorelines compared to shorelines with conventional lawns (University of Wisconsin – Extension, 1999).   More information about non-native (exotic) plants can be found under *Objective VI: Eliminate or Control Invasive Species* (p. 26).

<u>Option 1: No Action</u>
This option means that the current land use activities will continue. No additional techniques will be implemented. Allowing a field to go fallow or not mowing a manicured lawn would be considered an action.

> *Pros*
> Taking no action may maintain the current habitat conditions and wildlife species present, depending on environmental conditions and pending land use actions. If all things remain constant there will be little to no effect on lake water quality and other lake uses.
>
> *Cons*
> If environmental conditions change or substantial land use actions occur (i.e., development) wildlife use of the area may change. For example, if a new housing

development with manicured lawns and roads is built next to an undeveloped property, there will probably be a change in wildlife present.

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

Costs

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

Option 2: Increase Habitat Cover

This option can be incorporated with Option 3 (see below). One of the best ways to increase habitat cover is to leave a minimum 25 foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see Table 5 for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species outcompete native plants and provide little value for wildlife.

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

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

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

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

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

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

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

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

Option 3: Increase Natural Food Supply

This can be accomplished in conjunction with Option 2. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates, that live on or are attracted to the plants. Plants found in Table 5 should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily, sago pondweed, largeleaf pondweed, and wild celery to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

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

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

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

Pros

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

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

Cons

Feeding wildlife can have adverse consequences if populations become dependent on hand-outs or populations of wildlife exceed healthy numbers. This frequently happens when people feed waterfowl like Canada geese or mallard ducks. Feeding these waterfowl can lead to a domestication of these animals. As a result, these birds do not migrate and can contribute to numerous problems, such as excess feces, which is both a nuisance to property owners and a significant contribution to the lake's nutrient load. Waterfowl feces are particularly high in phosphorus. Since phosphorus is generally the limiting factor for nuisance algae growth in many lakes in the Midwest, the addition of large amounts of this nutrient from waterfowl may exasperate a lake's excessive algae problem. In addition, high populations of birds in an area can increase the risk of disease for not only the resident birds, but also wild bird populations that visit the area.

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

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

Option 4: Increase Nest Availability
Wildlife are attracted by habitats that serve as a place to raise their young. Habitats can vary from open grasslands to closed woodlands (similar to Options 2 and 3). Standing dead or dying trees provide excellent habitat for a variety of wildlife species. Birds such as swallows, woodpeckers, and some waterfowl need dead trees to nest in. Generally, a cavity created and used by a woodpecker (e.g., red-headed or downy woodpecker, or common flicker) in one year, will in subsequent years be used by species like tree swallows or chickadees. Over time, older cavities may be large enough for waterfowl, like wood ducks, or mammals (e.g., flying squirrels) to use. Standing dead trees are also favored habitat for nesting wading birds, such as great blue herons, night herons, and double-crested cormorants, which build stick nests on limbs. For these birds, dead trees in groups or clumps are preferred as most herons and cormorants are colonial nesters.

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

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

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

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

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

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

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

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

Objective VI: 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 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 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. Table 5 lists several native plants that can be planted along shorelines.

Cons

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

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

Costs

Costs with this option are initially zero. 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 beetles (*Galerucella pusilla* and *G. calmariensis*) and two weevils (*Hylobius transversovittatus* and *Nanophyes marmoratus*) have offered some hope to control purple loosestrife by natural means. These insects feed on either the leaves or juices of purple loosestrife, eventually weakening or killing the plant. In large stands of loosestrife, the beetles and weevils naturally reproduce and in many locations, significantly retard 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.

Pros

Control of exotics by a natural mechanism is preferable to chemical treatments. Insects, being part of the same ecological system as the exotic (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 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 Department of Natural Resources at Cornell University (607-255-2821) sells overwintering adult beetles (which will lay eggs the year of release) for $2 per beetle and new generation beetles (which will lay eggs beginning the following year) at $0.25 per beetle. Some beetles may be available for free by contacting the Illinois Natural History Survey (217-333-6846).

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 excavated. 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 impractical (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

Glyphosate (Eagre, Rodeo) is commonly used to treat purple loosestrife at an application rate of 1 gal/acre for a cost of $200-$220/gal. Only a slight loosestrife infestation was observed on several properties around Forest Lake. One to two gallons, shared among homeowners, would be sufficient to treat around Forest Lake. A Hydrohatchet®, a hatchet that injects herbicide through the bark, is about $300.00. Another injecting devise, E-Z Ject® is $450.00. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40.