

**2001 SUMMARY REPORT
of
LONG LAKE**

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Long Lake is a natural glacial lake located in unincorporated Lake County within both Grant and Avon Townships. The Long Lake drainage is large, encompassing 24,570 acres, seven municipalities, and 29 major lakes which drain into Long Lake. Its surface area is approximately 375.9 acres with a shoreline length of 5.1 miles and a maximum depth of approximately 28 feet. Long Lake has been an important part of the social and economic climate of the area for many years. However, past point source pollution has decreased the lake's water quality.

Water clarity, as measured by Secchi disk transparency readings, averaged 4.11 feet for the season, which is a significant increase from 1996 (2.44 feet) and 1991 (2.81 feet). Correlated with this increase in water clarity was a decrease of average total suspended solids from 23.6 mg/L (1991) to 13.92 mg/L (1996) to 9.7 mg/L (2001). Since 1991, average total phosphorus concentrations in the epilimnion water sample (3 foot depth) and in the hypolimnion (deep water) sample have remained relatively stable, with some fluctuations occurring primarily due to climatic influences. Long Lake experienced almost a doubling of the conductivity readings in the lake from 1996 to 2001 and had high levels of total dissolved solids throughout the season, most likely from the addition of road salt used on local roads during winter.

Long Lake strongly stratifies during the summer months. Anoxic conditions ($< 1\text{mg/L}$ dissolved oxygen) were found in deep waters in all months sampled (below 22 feet in May, 16 feet in June, 11 feet in July, 16 feet in August, and 24 feet in September).

Seven aquatic plant species were found in Long Lake in 2001. Only about 10% of the bottom of Long Lake had aquatic plant coverage and of that, Eurasian water milfoil, an exotic, dominates the plant species present.

Seawalls and rip-rap armor approximately 61% of the shoreline of Long Lake. Several areas around the lake were identified as having moderate (1,857 feet or 4.7% of the shoreline) or severe (455 feet or 1.1% of the shoreline) erosion.

Exotic plant species (buckthorn, purple loosestrife, and reed canary grass) were common along the shoreline of Long Lake. These plants should be removed and replaced with native vegetation.

Due to the size of Long Lake, it has the potential to be an important stop-over or staging area for migrating birds, particularly waterfowl. However, lack of aquatic plants coupled with the poor water clarity greatly reduces the potential uses of the lake for these birds and other wildlife.

LAKE IDENTIFICATION AND LOCATION

Long Lake (T45N, R9E, Section 13 and 24, R10E, Section 18) is located in unincorporated Lake County within both Grant and Avon Townships. It is between Illinois state highway 134 and Rollins Road (east-west) and Wilson and Fairfield Roads (north-south). It is classified as part of the Squaw Creek drainage of the Fox River watershed. The Long Lake drainage is large, encompassing 24,570 acres, seven municipalities, and 29 major lakes which drain into Long Lake.

Three inlets enter Long Lake: Eagle Creek from the north, Squaw Creek from the south, and the Round Lake Drain from the southeast. The lake has one outlet, Squaw Creek, located on the northwest side of the lake. Squaw Creek eventually drains into Fox Lake. A concrete dam at the outlet on Squaw Creek controls the water level of the lake. The U.S. Geological Survey Nippersink Road stream gage from 1990-1999 indicated that the Squaw Creek flow was 0.5-285 cubic feet per second (0.32-184 million gallons per day [MGD]).

A 1965 bathymetric (depth contour) map indicates the following statistics about Long Lake: surface area = 336 acres, maximum depth = 30 feet, average depth = 13.1 feet, volume = 4,400 acre-feet, shoreline length = 4.4 miles, elevation = 739 feet mean feet above sea level. In 2001, the maximum depth found was 28 feet. The 2000 aerial photography showed the surface area to be 375.9 acres and the shoreline length at 5.1 miles.

BRIEF HISTORY OF LONG LAKE

Long Lake is natural glacial lake resulting from the last glaciation several thousand years ago. The lake has been an important part of the lives of local people for many years. In C.F. Johnson's 1896 book Angling in the Lakes of Northern Illinois: How and Where To Fish Them (The American Field Publishing Company, Chicago, IL), Long Lake is described as an excellent fishing lake, with extensive aquatic plant beds. The map from his book (Figure 1) shows a large ring of emergent vegetation along the lake's shoreline. According to Johnson "it is no unusual thing for an angler to catch a string of a dozen fine bass weighting from two to four pounds each". A dam was constructed in approximately 1930 to control water levels. Prior to 1950, the lake was reported to be clear and weedy.

Historic sewage effluent from the Round Lake Sewage Treatment Plant (RLSTP), beginning in the 1950s, and the Lake Villa Sewage Treatment Plant (LVSTP) accelerated eutrophication of the lake. The lake changed from one with dense aquatic plant stands and clear water to a turbid lake with few aquatic plants and increased algae blooms. Fishkills were first reported in 1950s, including a severe kill in 1958. By 1967 the lake was quite turbid and carp dominated the fishery and total rehabilitation was recommended. In the early 1980s, the RLSTP was diverting its effluent away from Long Lake. During the same time period, sanitary sewers were installed around the lake,

Figure 1. 1896 C.F. Johnson's map of Long Lake.

replacing septic systems. The LVSTP stopped discharging effluent into Eagle Creek in 1991.

Several studies have been conducted on Long Lake in the past. The U.S. Environmental Protection Agency surveyed Long Lake in 1975 and concluded that the lake was eutrophic, ranked 29 out of 31 Illinois lakes, appeared to be limited by nitrogen, and that point sources contributed most of the phosphorus in the lake. This study concluded that the RLSTP contributed 82% of the total phosphorus (TP) or 44,000 pounds per year at 2.2 MGD and the LVSTP contributed 2.5% of the TP or 1,323 pounds per year at 0.3 MGD. Nonpoint source pollution was estimated in 1975 at 6,800 pounds of TP per year. A total of 53,736 pounds of TP per year from all sources entered Long Lake of which an estimated 63% remained in the lake.

Another more intensive survey by the Illinois EPA in 1979 concluded that Long Lake was turbid, had high algal production (mostly *Aphanizomenon*), and classified the lake as in poor condition. This report also stated that the major source of phosphorus and nitrogen was from the RLSTP. The Lake County Soil and Water Conservation District also published a planning report in 1986 on the Long Lake watershed.

The Lake County Health Department (LCHD) has conducted three other studies of Long Lake, excluding this one. In 1982 a significant lake study was completed. The conclusions of this study were similar to past studies, specifically, that Long Lake had high concentrations of nitrogen and phosphorus, algae blooms (again identified as mostly *Aphanizomenon*) were significant, and substantial amounts of nutrients were coming from Squaw Creek. Additional studies by LCHD were conducted in 1991 and 1996. Data from these studies will be discussed in more detail in the body of this report.

Currently, Baxter Healthcare Corporation (henceforth, Baxter Corp.) of Round Lake discharges its industrial wastewater into a ditch tributary which flows into Squaw Creek. Squaw Creek flows north into Mud Lake and then into Long Lake. Baxter Corp. operations result in an average discharge of 0.27 MGD. The load limits are 5.5 pounds per day (lbs/day) with a 6.3 lbs/day maximum for phosphorus, 38.5 lbs/day with a 75.1 lbs/day daily maximum for total suspended solids (TSS), and 8.13 lbs/day with a 18.77 lbs/day daily maximum (April – October) for ammonia nitrogen. Currently, Baxter Corp. is funding a one-year study (targeted completion date of July 2002) of the Long Lake Watershed. At seven monitoring stations (one at Baxter Corp., three on Squaw Creek before it enters Long Lake and one where the creek leaves the lake, one on the Round Lake Drain, and one on Eagle Creek) flow rates are continuously recorded and water quality samples taken weekly. However, results of this study were not available at the time of this report.

Several small treatment plants operate within the Long Lake Watershed. A small treatment plant at the Fremont School District 79 in Mundelin discharges its effluent into a tributary of Squaw Creek. Its average flow rate is 0.01 MGD with a design maximum flow of 0.04 MGD. TSS loads average one pound per day with a maximum of 4 lbs/day. Ammonia nitrogen loads average 0.1 lbs/day with a maximum of 0.4 lbs/day, April

through October. Another small treatment plant is operating at Camp Hickory in unincorporated Ingleside. It discharges its effluent into Squaw Creek. The average flow rate is 0.014 MGD with a permitted TSS concentration of 12 mg/L (monthly average). Although specific phosphorus loading from these plants are not monitored, a conservative estimate of the loading for each plant was calculated using 1.0 mg/L as the daily load being discharged. For the Fremont School plant, based on the 0.01 MGD flow rate, approximately 30.5 pounds of phosphorus, 365 pounds of TSS, and 36.5 pounds of ammonia nitrogen enter the Long Lake Watershed each year. For Camp Hickory, based on the 0.014 MGD flow rate, approximately 42.6 pounds of phosphorus and 59.7 pounds of TSS enter the watershed each year. Specific data on ammonia nitrogen for Camp Hickory was not available. Finally, Saddlebrook Farms operates a treatment plant in its mobile home park in Grayslake. The designed average flow is for this plant is 0.091 MGD. Its effluent, however, is discharged through spray irrigation.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Long Lake has been an important part of the social and economic climate of the area for a long time. Fish and wildlife were reported to be plentiful in and around the lake during European settlement of the area. It was likely important to native Indian cultures as well. Much of the documented uses of the lake begin in the late 1800's. Recreational activities such as fishing and boating have always been part of the lake usage. Annual fish stocking supplements any natural reproduction and is an important part of Long Lake management plan.

Many agricultural uses were conducted around the lake in the early part of the 1900's. Summer cottages began appearing in the 1920's and '30s. These cottages were then converted and used as permanent summer homes shortly after World War II. Residential home building has continued to the point where the majority of the lake is surrounded by homes with the exception of the wetland on the southeastern side of the lake.

There are numerous bottom owners of the lake. However, it is managed by the Long Lake Improvement and Sanitation Association (LLISA). The association meets several times a year or as needed and holds an annual meeting in the spring.

All of the access points around the lake are privately owned. Boat launches can be found on the lake at Sabitini's Restaurant (fee charged), Pleasant Hill Subdivision (Pleasant Hill Association members only), Shaw Subdivision (Shaw Subdivision members only), the Squaw Creek Boat Dock (fee charged), and one located off of Forest Drive (no access). The boat lift on Squaw Creek is operated by the LLISA. A \$15 fee is charged to use this lift.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were taken monthly from May - September at the deep-hole location near the lake's center (Figure 2). See Appendix B for water sampling methods.

Long Lake's water quality is similar to many lakes in Lake County (Table 1, Appendix A). Most of the water quality parameters measured were near the averages of other Lake County lakes that the Health Department has monitored (1995-2001). Several important findings were noted.

Water clarity, as measured by Secchi disk transparency readings, averaged 4.11 feet for the season. While this is slightly below the county median (where 50% of the lakes are above and below this value) of 4.18 feet, it is a significant increase (68%) from 1996 (2.44 feet) and 1991 (2.81 feet). Correlated with this increase in water clarity was a decrease of total suspended solids (TSS) from 23.6 mg/L (1991) to 13.92 mg/L (1996) to 9.7 mg/L (2001). See Figure 3 for a comparison by year of Secchi and TSS. Solids suspended in the water reduce the depth at which the Secchi disk can be seen. In 2001, the best water clarity was in June when the Secchi depth was 5.61 feet, which correlated with the lowest TSS value of the season (6.3 mg/L). In months when Secchi readings were lower the TSS values were higher. Algae blooms during the year probably contributed to the higher TSS readings and reduced water clarity.

Total phosphorus (TP) levels in Long Lake have remained relatively stable since 1991. The 2001 epilimnion TP average was 0.092 mg/L, up slightly from the 1996 average of 0.086 mg/L and the 1991 average of 0.063 mg/L. Values above 0.03 mg/L are considered sufficient enough to cause nuisance algae blooms. The hypolimnion TP averages have slightly decreased (from 1996 to 2001). Much of this fluctuation may be attributed, in part, to climatic reasons, such as rain events or water temperature which influences the thermal stratification and subsequent turnover of the lake in the different years. External sources (i.e., point sources or non-point sources) entering the lake currently or in the past may be contributing to the elevated TP concentrations, however, more likely this phenomenon is due to internal recycling of TP, since most point sources have been eliminated or severely controlled. Additional TP may be coming from non-point sources including runoff from residential lots, agricultural fields, and construction sites. Because Long Lake has significant levels of nutrients (particularly phosphorus) and minimal aquatic plants (see **Limnological Data –Aquatic Plant Assessment**, below), algae is able to dominate the lake. Elevated TP concentrations will likely be a problem in Long Lake for years to come.

Concentrations of the three types of nitrogen measured showed a similar pattern from 1991 to 2001. Overall, Long Lake does not have significant problems with nitrogen. Noteworthy findings included the higher values of nitrate nitrogen in May and June in both the epilimnion and hypolimnion. These values were higher due to large amounts of nitrate nitrogen remaining after spring turnover and potentially from human sources such as residential and agricultural fertilizers. In the epilimnion in May and June, nitrate was

being utilized by algae, but sufficient quantities were still available in the water column. As the season progressed, fewer nitrates were available which resulted in the non-detectable readings in July through September. In the hypolimnion, the anoxic conditions (<1.0 mg/L dissolved oxygen) which occurred once the lake had stratified caused oxygen molecules to be stripped and converted to ammonia nitrogen. By July, most of the nitrate had been converted to ammonia. Additional ammonia was added to the hypolimnion through organic decomposition occurring under anoxic conditions. Similar patterns were noted in the data from 1991 and 1996.

The average ratio between total nitrogen and total phosphorus (TN:TP) for Long Lake was 15:1, indicating a phosphorus-limited system. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.) which are more difficult to control than sources of phosphorus. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon. The ratio was 23:1 in 1996 and 19:1 in 1991.

Long Lake strongly stratifies during the summer months. In 2001, the lake was weakly stratified by May and strongly stratified by June (at approximately the 12-14 foot depth). The thermocline (the depth where cool deep waters separate from warm upper waters) remained strong until September, when water temperatures throughout the water column began to become more similar. Turnover was beginning during the September sampling, although the thermocline was still present at approximately the 25-26 foot depth which was the depth at which the water sample was collected that month. The start of mixing (turnover) explains why some of the values in the hypolimnion (nitrogen and phosphorus in particular) were less than the values in August.

Dissolved oxygen (DO) concentrations in Long Lake did not indicate any significant problems in the upper waters. Generally concern arises when DO levels fall below 5 mg/L in the epilimnion. Anoxic conditions (where DO levels drop below 1 mg/L) did exist throughout the sampling season in the hypolimnion. This is a normal phenomenon in large, deep lakes that stratify. The anoxic boundary was at its shallowest in July at approximately 11 feet and deepest in September (during turnover) at approximately 23 feet. In order to determine if these DO conditions are a problem, the percent of volume at specific depths (preferably in one foot increments) is needed. While an old bathymetric (depth contour) map of Long Lake is available, the specific volumes at each depth are not known. Thus, an accurate assessment of the DO conditions cannot be made.

Water levels on Long Lake remained relatively stable throughout the season. The maximum change in water level was a 10.38-inch increase from May to June (as measured during monthly water sampling). Fluctuating water levels did not appear to be a problem in Long Lake in 2001. However, due to the large watershed of the lake, significant water fluctuations are probable. Fluctuating water levels can have a negative impact on shoreline erosion, water clarity, and aquatic plant growth.

The treatment plants at Fremont School District 79 and Camp Hickory likely contribute minimal amounts of nutrient loads into Long Lake, particularly when considering the size

Figure 2

Figure 3

of the lake's watershed. The effluent from Baxter Corp. may also have a minimal impact on the nutrient loading in the lake even though it discharges considerably more water and nutrients into the lake than the other plants. The Baxter Corp. discharge is very small when compared to the volume of water flowing through the Long Lake watershed each day. A more conclusive assessment of the Baxter Corp. discharge will be forthcoming pending the results of the watershed study which is being completed.

The 2001 conductivity readings in Long Lake were significantly higher than in 1996. In the epilimnion, the readings increased from 0.5222 milliSiemens/cm in 1996 to 0.9430 milliSiemens/cm in 2001. In the hypolimnion, the readings also increased from 1996 to 2001 (0.6006 milliSiemens/cm to 1.0348 milliSiemens/cm, respectively). Road salt from local roads within the watershed is a likely source of this increase. We calculated average chloride concentrations, based on average conductivity readings, in the epilimnion and hypolimnion. The calculated chloride concentrations were 169 mg/L in the epilimnion and 201 mg/L in the hypolimnion. The Illinois Environmental Protection Agency (IEPA) standard for chloride is 500 mg/L. Once values exceed this standard the water body is deemed to be impaired, thus impacting aquatic life. However, the long-term impacts of high conductivity readings are unknown.

Rain events probably contributed additional sediment or nutrients (like phosphorus) to the lake, which may have influenced the water sample results. Rain occurred within 48 hours prior to water sampling in June (0.21 inches), July (0.46 inches), August (0.6 inches) and September (0.06 inches) as recorded at the Lake County Stormwater Management Commission rain gage at Old Mill Creek.

Based on data collected in 2001, standard classification indices compiled by the IEPA were used to determine the current condition of Long Lake. A general overall index that is commonly used is called a trophic state index or TSI. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich productive). This index is calculated using total phosphorus values obtained at or near the surface. The TSI for Long Lake classified it as a eutrophic lake. Eutrophic lakes are the most common types of lakes throughout the lower Midwest, and they are particularly common among man-made lakes. See Table 2 in Appendix A for a ranking of average TSI values for Lake County lakes (Long Lake is currently #74). This ranking is only a relative assessment of the lakes in the county. The current rank of a lake is dependent upon many factors including lake origin, water source, nutrient loads, and morphometric features (volume, depth, substrate, etc.). Thus a small, shallow, manmade lake with high nutrient loads could not expect to achieve a high ranking even with intensive management.

In Long Lake, the IEPA aquatic life impairment index was low, indicating a full degree of support for all aquatic organisms in the lake. The swimming index indicated a partial degree of support based primarily on poor Secchi disk readings. Due to high nutrient levels (particularly phosphorus) and poor water clarity, the recreation use index showed a

partial impairment. LCHD did not test for bacteria or other harmful pathogens on Long Lake in 2001.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Long Lake were assessed monthly from May through September 2001 (see Appendix B for methods). Seven aquatic plant species and several emergent shoreline plants were found (see Table 3, below).

Plants were found primarily near the shoreline. The maximum depth at which plants were found was 6.3 feet. This corresponds with the 1% light levels (the point where plant photosynthesis ceases) which ranged from a depth of 5.25 feet (May) to 7 feet (July). It was estimated that only 10% of the lake bottom had any plants, most of them were scattered around the lake. The Illinois Department of Natural Resources recommends 25-40% aquatic plant coverage to maintain ideal fish habitat conditions.

Eurasian water milfoil (EWM) was the dominant plant in the lake (Table 4 in Appendix A). It was first seen in Long Lake in the 1980's. This is an undesirable exotic species that has caused problems in many lakes throughout North America. Since Long Lake has several boat launches, it is recommended that signage be erected at each launch notifying users of the presence of this exotic species in the lake, so it is not introduced into other lakes which do not already have it. The Exotic Species Advisory signs are available for \$13.50 each to homeowner associations from the Illinois-Indiana Sea Grant Program at their internet site <http://www.iisgcp.org/outrch/br/sign.htm> or by calling 217-333-0240.

The other aquatic plants found were scattered around the lake, often in the bays and channels. Limited light penetration coupled with carp activity, and wave action from wind and boat activity are the probable causes for the poor aquatic plant presence and distribution in Long Lake.

Historical records indicate that Long Lake was clear and weedy prior to 1950. While this situation may be difficult to achieve again, the improvement of water clarity will help in increasing plant beds. Due to the depth of the lake and current light penetration, plant growth will be limited to the near shore areas as well as the bays and channels. Because EWM is present and the dominant plant at this time, a “hands-off” policy may only result in the spread of this exotic and is a reason that an active plant management plan should be developed. An increase in the native aquatic plant coverage in the lake is recommended.

During the plant sampling LCHD staff found the milfoil weevil (*Euhrychiopsis lecontei*) on several EWM plants. This weevil attacks the tip and stem of the plant and is currently being used as a biological control for EWM in many lakes in the Midwest. The weevils are found naturally in many lakes. The EWM in the lake did show signs of weevil damage but overall the impact in 2001 was minimal.

Floristic quality index (FQI; Swink and Wilhelm 1994) is an assessment tool designed to evaluate the closeness that the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). The FQI was calculated for all floating and submersed aquatic plants found in the lake. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were counted in the FQI calculations for Lake County lakes. In 2001, Long Lake had a FQI of 13.6. The average FQI of lakes studied by LCHD in 2000-2001 was 14.0.

Table 3. Aquatic and shoreline plants on Long Lake, May - September 2001.

<i>Aquatic Plants</i>	
Coontail	<i>Ceratophyllum demersum</i>
Small Duckweed	<i>Lemna minor</i>
Eurasian Water Milfoil	<i>Myriophyllum spicatum</i>
White Water Lily	<i>Nymphaea tuberosa</i>
Large Duckweed	<i>Spirodella polyrhiza</i>
Sago Pondweed	<i>Stuckenia pectinatus</i>
Watermeal	<i>Wolffia columbiana</i>
<i>Shoreline Plants</i>	
Spikerush	<i>Eleocharis</i> sp.
Honey Locust	<i>Gelditsia triacanthos</i>
Honeysuckle	<i>Lonicera</i> sp.
Purple Loosestrife	<i>Lythrum salicaria</i>
Reed Canary Grass	<i>Phalaris arundinacea</i>
Cottonwood	<i>Populus deltoides</i>
Buckthorn	<i>Rhamnus cathartica</i>
Cattail	<i>Typha</i> sp.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted in 2001 to determine the condition of the lake shoreline (see Appendix B for methods). Of particular interest was the condition of the shoreline at the water/land interface.

The shoreline of Long Lake is approximately 80% developed. The wetland located along the southeastern shore comprised most of the 20% of the shoreline that was classified as

Figure 4

Figure 5

Figure 6

undeveloped. Several different shoreline types were identified. The most common shoreline type was seawall (36%) followed by riprap (25%), shrub (13%), wetland (8%), beach (6%), lawn (6%), woodland (3%), and buffer (3%; see Figure 4). Buffer habitat is a strip of unmowed grass or native vegetation located along the water's edge. The seawalls included wood, concrete, and steel construction. The condition of seawalls varied considerably, from poorly deteriorated to excellent condition.

Erosion on Long Lake was minimal. However several areas were identified as having moderate or severe erosion. Approximately 1,857 feet (4.7%) of the shoreline was classified as having moderate erosion (see Figure 5). These areas should be addressed in the near future, as they are prone to increased deterioration and may cause more problems later. Severe erosion was found at approximately 455 feet (1.1%) of the shoreline. This severe erosion comprised of two locations: a 371 foot section owned by the Lake County Forest Preserve along the northern shoreline and a 85 foot privately owned section on the southern shoreline of the Squaw Creek outlet adjacent to the Wilson Road bridge. These two erosion areas should be addressed immediately.

Exotic plant species were common along the shoreline of Long Lake. The most common exotic plants were buckthorn, purple loosestrife, and reed canary grass. Loosestrife and buckthorn are particularly problematic as they outcompete native plants and offer little value in terms of shoreline stabilization or wildlife habitat. Plants should be removed and replaced with native shoreline plants.

In addition to shoreline plants, emergent vegetation should be planted or encouraged to grow. These plants (arrowhead, bulrushes, spikerushes, etc.) help stabilize the shoreline by buffering wind and wave action. Similarly, buffer strips should be installed between the water and manicured lawns to reduce nutrient-rich runoff into the lake. Both emergent vegetation and buffer strips also provide habitat for fish and wildlife that use the lake. More information can be found in the section **Objective IV: Shoreline Erosion Control**.

The potential loss of the wetland area located at the southeastern section of the lake was identified as an area of concern by several lake residents. Field inspection of this area in 2001 showed no visible signs of severe erosion or loss of wetland. In addition, a comparison of aerial photographs from 1993 and 2000 showed minimal differences in this wetland (< 0.5 acre loss over this time; see Figure 6), however differences may have been masked by variations in the aerial photographs. Wetland systems like this one are dynamic and often shift in response to fluctuating water levels or wave action. Areas of cattails are likely continuously building up in some areas and breaking away or eroding in others.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Good numbers of wildlife, particularly birds, were noted on and around Long Lake. See Appendix B for methods. Several of the species listed in Table 5 (below) were seen during spring or fall migration and were assumed not to be nesting around the lake.

Most of the habitat around Long Lake is in the form of residential lots. Although mature trees along the shoreline of these lots provide good habitat for many species, the habitats under the trees, namely lawns, are poor habitats for many wildlife species. Several areas around the lake are undeveloped and have a good mix of mature trees and understory vegetation. Unfortunately, much of the understory in these areas consists of exotic plants such as buckthorn, purple loosestrife, honeysuckle, or reed canary grass.

Due to the size of Long Lake, it has the potential to be an important stop-over or staging area for migrating birds, particularly waterfowl. However, lack of aquatic plants coupled with the poor water clarity greatly reduces the potential uses of the lake for these birds. Improvements to the habitats in and around the lake could help increase wildlife presence. Native aquatic plants and shoreline buffer strips will aid in the improvement of wildlife habitats around Long Lake.

LCHD did not conduct any fish surveys in 2001. However, the Illinois Department of Natural Resources did conduct a fish survey in August of 2001 and found 15 species, with bluegill (23%), yellow perch (10.5%), channel catfish (10.5%), and yellow bass (10%) being the most abundant. The DNR's recommendations were to 1) monitor submergent aquatic vegetation and control if vegetation exceeds 20-40% of the lake area, 2) establish a 15 inch minimum length limit and 1 per day catch limit on largemouth bass and initiate a 3 year supplemental stocking program, 3) establish a 16 inch minimum length limit and 3 per day creel limit on walleye and stock fingerlings annually, and 4) promote harvest of carp and yellow bass.

Table 5. Wildlife species observed on Long Lake, May – September 2001.

Birds

Double-crested Cormorant	<i>Phalacrocorax auritus</i>
Canada Goose	<i>Branta canadensis</i>
Mallard	<i>Anas platyrhynchos</i>
Ring-billed Gull	<i>Larus delawarensis</i>
Great Blue Heron	<i>Ardea herodias</i>
Spotted Sandpiper	<i>Actitis macularia</i>
Belted Kingfisher	<i>Megasceryle alcyon</i>
Common Flicker	<i>Colaptes auratus</i>
Downy Woodpecker	<i>Picoides pubescens</i>
Eastern Kingbird	<i>Tyrannus tyrannus</i>
Purple Martin	<i>Progne subis</i>
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>
Barn Swallow	<i>Hirundo rustica</i>
Tree Swallow	<i>Iridoprocne bicolor</i>
Chimney Swift	<i>Chaetura pelagica</i>
American Crow	<i>Corvus brachyrhynchos</i>
Blue Jay	<i>Cyanocitta cristata</i>

Table 5. Wildlife species observed on Long Lake, May – September 2001 (cont'd).

American Robin	<i>Turdus migratorius</i>
Cedar Waxwing	<i>Bombycilla cedrorum</i>
Warbling Vireo	<i>Vireo gilvus</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Common Grackle	<i>Quiscalus quiscula</i>
Northern Oriole	<i>Icterus galbula</i>
House Sparrow	<i>Passer domesticus</i>
Northern Cardinal	<i>Cardinalis cardinalis</i>
House Finch	<i>Carpodacus mexicanus</i>
American Goldfinch	<i>Carduelis tristis</i>
Song Sparrow	<i>Melospiza melodia</i>

Mammals

Eastern Chipmunk	<i>Tamias striatus</i>
Muskrat	<i>Ondatra zibethicus</i>

Amphibians and Reptiles

None noted.

Insects

Cicadas
Dragonfly
Damselfly

EXISTING LAKE QUALITY PROBLEMS

- *Lack of a Quality Bathymetric Map*

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, 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. Currently, an old map exists (1978) for Long Lake, but it has no volumetric calculations.

- *Poor Water Clarity and Elevated Phosphorus Concentrations*

Poor water clarity, measured by low Secchi disk transparency readings and high total suspended solid values, was found in Long Lake in 2001. While improvements in water clarity have taken place since the 1990's, the lake continues to have nuisance algae blooms and turbid water. Phosphorus levels have remained relatively stable since 1991. Internal recycling of phosphorus will likely continue for years to come.

- *Shoreline Erosion*

Several areas of the Long Lake shoreline were classified as eroding either moderately or severely. Approximately 1,857 feet were moderately eroding and 455 feet severely eroding. This erosion may be the result of many factors, but likely is due to wind and wave action and boat activity. Much of the shoreline is dominated by exotic plant species which can also exacerbate erosion. Shoreline remediation could improve these areas aesthetically as well as providing protection from future erosion. When possible, reestablishing native shorelines is preferred, including emergent vegetation in the shallow water areas. Buffer strips between the water and manicured lawns are also recommended.

- *Invasive Shoreline Plant Species*

Several exotic invasive plants were found along the shoreline of Long Lake. The most numerous and problematic are buckthorn, purple loosestrife, honeysuckle, and reed canary grass. All these plants outcompete native vegetation and may exacerbate shoreline erosion and offer limited habitat for fish and wildlife. Control or elimination of these plants with subsequent replanting of native plants is recommended.

- *Minimal Aquatic Vegetation and Presence of Eurasian Water Milfoil*

Only about 10% of the bottom of Long Lake has aquatic plant coverage and of that Eurasian water milfoil (EWM) dominates the plant species present. An increase of the plant communities in the lake is recommended. However, control of EWM should be a high priority. At this time, it is not a problem but has the potential to become one. Since Long Lake has several boat launches, it is recommended that signage be erected at each launch notifying users of this presence of exotic species in the lake, so it is not spread to other lakes that do not already have it. The Exotic Species Advisory signs are available for \$13.50 each to homeowner associations from the Illinois-Indiana Sea Grant Program by calling 217-333-0240 or visiting their internet site <http://www.iisgcp.org/outrch/br/sign.htm>.

Native plants will help improve the water quality of the lake and utilize the abundant nutrients as well as increased habitat for fish and wildlife. Emergent plants (like arrowheads and bulrushes) will also help buffer wave action that causes erosion.

- *High Conductivity and Total Dissolved Solids*

Long Lake experienced almost a doubling of the conductivity readings in the lake from 1996 to 2001 and had high concentrations of total dissolved solids throughout the season. The most likely reason for this increase is winter road salt that is applied to the miles of roads in the Long Lake watershed. The impacts of these values to organisms in the lake are unknown.

POTENTIAL OBJECTIVES FOR THE LONG LAKE MANAGEMENT PLAN

- I. Bathymetric Map
- II. Aquatic Plant Management Options
- III. Nuisance Algae Management Options
- IV. Shoreline Erosion Control
- V. Control Exotic Plant Species
- VI. Enhance Wildlife Habitat Conditions

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Bathymetric Map

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, 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.

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: Aquatic Plant Management Options

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. The management of the lake's vegetation does not end once the nuisance vegetation has been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and remove as necessary. An association or property owner should not always expect immediate results. 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 options covered below are commonly used techniques that are coming into wider acceptance and have been used in Lake County. There are other plant management options that are not covered below as they are not very effective, unreliable, or are too experimental to be widely used.

For Long Lake, the primary recommendation is to increase the aquatic plant coverage to 20-40% with native aquatic plants. However, due to the presence of Eurasian water milfoil continued management of the plant communities will be needed. Most of the plant growth will be from the shoreline out to about 6-8 feet due to the current water clarity of the lake. Infringement of recreational boating will be minimal since much of the surface area of the lake will be free of plants. The following options could be incorporated into the lake management plan.

Option 1: No Action

If the lake is dominated by *native, non-invasive* species, the no action option could be ideal. Under these circumstances native plant populations could flourish and keep nuisance plants from becoming problematic. However, if a no action aquatic plant management plan in a lake with non-native, invasive species, nothing would be done to control the aquatic plant population of the lake regardless of the type and extent of the vegetation. Nuisance vegetation could continue to grow until epidemic proportions are reached. Growth limitations of the plant and the characteristics of the lake itself (light penetration, lake morphology, substrate type, etc.) will dictate the extent of infestation. Rooted plants, such as curly leaf pondweed (*Potamogeton crispus*) and elodea (*Elodea canadensis*), will be bound by physical factors such as substrate type and light availability. Plants such as Eurasian watermilfoil and coontail, which can grow unrooted at the surface regardless of water depth, could grow to cover 100% of the water's 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 plant management. The first, and most obvious, is that there is no cost. However, if an active management plan for vegetation control were eventually needed, the cost would be substantially higher than if the no action plan had not been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, no chemicals, mechanical alteration, or introduction of any organisms would take place. This is important since studies have shown that nuisance plants are more likely to invade disrupted areas. If the lake contains native, non-invasive plant species, expansion of the native plant population would increase the overall biodiversity and health of the lake. Habitat, breeding areas, and food source availability would greatly improve. Use of the lake would continue as normal and in some cases might improve (fishing) if native plants keep “weedy” plants under control.

An additional benefit of the no action option is the possible improvement in water quality. Turbidity could decrease and clarity should increase due to sediment stabilization by the plant’s roots. Algal blooms could be reduced due to decreased resource availability and sediment stabilization. However, the occurrence of filamentous algae may increase/remain stable due to their surface growth habitat. The lake’s fishery could improve due to habitat availability, which in turn would have numerous positive effects on the rest of the lake’s ecosystem.

Cons

Under the no action option, if nuisance vegetation is dominant in the lake and were uninhibited and able to reach epidemic proportions, there will be many negative impacts on the lake. By their weedy nature, the nuisance plants would out-compete the more desirable native plants. This could eventually, drastically reduce or even eliminate the native plant population of the lake and reduce the lake’s biodiversity. The fishery of the lake may become stunted due to lack of quality forage fish habitat and reduced predation. Predation will decrease due to the difficulty of finding prey in the dense stands of vegetation. This will cause an explosion in the small fish population and with food resources not increasing, growth of fish will be reduced. Decreased dissolved oxygen levels, due to high biological oxygen demand from the excessive vegetation, will also have negative impacts on the aquatic life. Wildlife populations will also be negatively impacted by these dense stands of vegetation. Birds and waterfowl will have difficulty finding quality plants for food or in locating prey within the dense plant stands.

Water quality could also be negatively impacted with the implementation of the no action option. Deposition of large amounts of organic matter and release of nutrients upon the death of the massive stands of vegetation is a probable outcome of the no action option. These dead plants will contribute to the sediment load of the lake and could accelerate its filling in. The large nutrient release when the plants die back in the fall could lead to lake-wide algae blooms and an overall increase of the internal nutrient load. In addition, the decomposition of the

massive amounts of vegetation will lead to a depletion of the lakes dissolved oxygen. This can cause fish stress, and eventually, if the stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake's ecosystem.

In addition to the ecological impacts, many physical uses of the lake will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick stands of plants. Swimming could also become increasingly difficult due to thick vegetation that would develop at beaches. Fishing could become more and more exasperating due in part to the thick vegetation and also because of stunted fish population. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by tangled mats of vegetation and the odors that will develop when they decay. The combination of the above events could cause property values on the lake to suffer. Property values on lakes with weedy plant/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. However, if in the future a management plan was initiated, costs might be significantly higher since a no action plan was originally followed.

Option 2: Aquatic Herbicides

Aquatic herbicides are the most common method to control nuisance vegetation/algae. When used properly, they can provide selective and reliable control. Products can not be licensed for use in aquatic situations unless there is less than a 1 in 1,000,000 chance of any negative effects on human health, wildlife, and the environment. Aquatic herbicides are not allowed to be environmentally persistent, bioaccumulate, or have any bioavailability. Prior to herbicide application, licensed applicators should evaluate the lake's vegetation and, along with the lake's management plan, choose the appropriate herbicide and treatment areas, and apply the herbicides during appropriate conditions (i.e. low wind speed, D.O. concentration, temperature).

There are two groups of herbicides: contact and systemic. Contact herbicides, like their name indicates, kill on contact. These herbicides affect only the above ground portion of the plant that they come into contact with and therefore do not kill the root system. An example of a contact herbicide is diquat. Systemic herbicides are taken up by the plant and disrupt cellular processes, which in turn cause plant death. These herbicides kill both the above ground portions of the plant as well as the root system. An example of a systemic herbicide is fluridone. Both types of herbicides are available in liquid or granular forms. Liquid forms are concentrated and need to be mixed into water to obtain the desired concentration. The solution is then sprayed on the water's surface or injected into the water in the treatment areas. Granular herbicides are broadcast in a known rate over the treatment area where they sink to the bottom. Some granular products slowly release the herbicide, which is then taken up by the plant. These are referred to as SRP formulations (Slow Release Pellet). Other granular herbicides come in crystal form and

dissolve as they come in contact with water. This is typical of herbicides such as copper sulfate. Many herbicides come in both liquid and granular forms to fit the management needs of the lake. Herbicide applications can either be done as whole lake treatments or as more selective spot treatments. Multiple herbicides are often mixed and applied together. This is called a tank mix. This is done to save time, energy, and cost.

Aquatic herbicides are best used on actively growing plants to ensure optimal herbicide uptake. For this reason, herbicides are normally applied mid to late spring when water temperatures are above 60⁰F. This is the time of year when the plants are most actively growing and before seed/vegetative propagule formation. Follow up applications should be done as needed. When choosing an aquatic herbicide it is important to know what plants are present, which ones are problematic, which plants are beneficial, and how a particular herbicide will act upon these plants. The herbicide label is very important and should always be read before use. There may be more than one herbicide for a given plant. As with other management options, proper usage is the key to their effectiveness, benefits, and disadvantages.

In Long Lake, aquatic herbicides are not needed at this time. However, if EWM becomes problematic, spot treatments of an herbicide such as 2,4-D (granular) may be necessary. This herbicide works well on dicots such as EWM while minimizing damage to monocots such as the native pondweeds. Applications could be initialized in the spring (early April) before many of the native plants begin to grow.

Pros

When used properly, aquatic herbicides can be a powerful tool in management of excessive vegetation. Often, aquatic herbicide treatments can be more cost effective in the long run compared to other management techniques. A properly implemented plan can often provide season long control with minimal applications. Ecologically, herbicides can be a better management option than using mechanical harvesting or grass carp. When properly applied, aquatic herbicides may be selective for nuisance plants such as Eurasian watermilfoil but allow desirable plants such as American pondweed (*Potamogeton nodosus*) to remain. This removes the problematic vegetation and allows native and more desirable plants to remain and flourish with minimal manipulation.

The fisheries and waterfowl populations of the lake would benefit greatly due to an increase in quality habitat and food supply. Dense stands of plants would be thinned out and improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed (*Potamogeton amplifolius*). Another environmental benefit of using aquatic herbicides over other management options is that they are organism specific. The metabolic pathways by which herbicides kill plants are plant specific which humans and other organisms do not carry out. Organisms such as fish, birds, mussels, and zooplankton are generally unaffected.

By implementing a good management plan with aquatic herbicides, usage opportunities of the lake would increase. Activities such as boating and swimming would improve due to the removal of dense stands of vegetation. The quality of fishing may improve because of improved habitat. In addition to increased usage opportunities, the overall aesthetics of the lake would improve, potentially increasing property values on the lake.

Cons

The most obvious drawback of using aquatic herbicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error can make them unsafe and bring about undesired outcomes. If not properly used, aquatic herbicides can remove too much vegetation from the lake. This could drastically alter biodiversity and ecological. Total or over-removal of plants can cause a variety of problems lake-wide. The fishery of the lake may decline and/or become stunted due predation issues related to decreased water clarity. Other wildlife, such as waterfowl, which commonly forage on aquatic plants, would also be negatively impacted by the decrease in food supply.

Another problem associated with removing too much vegetation is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. The increase in turbidity can cause a decrease in light penetration, which can further aggravate the aquatic plant community. The resuspension of nutrients will contribute to the overall nutrient load of the lake, which can lead to an increased frequency of noxious algal blooms. Furthermore, the removal of aquatic vegetation, which compete with algae for resources, can directly contribute to an increase in blooms.

After the initial removal, there is a possibility for regrowth of vegetation. Upon regrowth, weedy plants such as Eurasian watermilfoil and coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiversity. Additionally, these dense stands of nuisance vegetation can lead to an overpopulation of stunted fish due to a decrease in predation of forage species by predatory fish. This disruption in the fisheries can have negative impacts throughout the ecosystem from zooplankton to higher organisms such as waterfowl and other wildlife. Additionally, some herbicides have use restrictions regarding their use in relation to fish, swimming, irrigation, etc.

Overremoval, and possible regrowth of nuisance vegetation that may follow will drastically impair recreational use of the lake. Swimming could be adversely affected due to the likelihood of increased algal blooms. Swimmers may become entangled in large mats of filamentous algae. Blooms of planktonic species, such as blue-green algae, can produce harmful toxins as well produce noxious odors. If regrowth of nuisance vegetation were to occur, motors could become entangled making boating difficult. Fishing would also be negatively impacted due to the

decreased health of the lake's fishery. The overall appearance of the lake would also suffer due to an increase in unsightly algal blooms and massive stands of vegetation. This in turn could have an unwanted effect on property values. Studies have shown that problematic algal blooms can decrease property values by 15-20%.

Costs

To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's aquatic plant management plan. 2,4-D granular is generally applied at 100 pounds per surface acre at a cost of \$350-425 per surface acre.

Option 3: Mechanical Harvesting

Mechanical harvesting involves the cutting and removal of nuisance aquatic vegetation by large specialized boats with underwater cutting bars. Plants are cut below the water at a level that will restore use of the lake. Typically, problematic areas are harvested and other areas are left alone. However, some management plans call for more widespread harvesting, especially when nuisance plants such as Eurasian watermilfoil become dominant. The total removal or over removal (neither of which should never be the plan of any management entity) of plants by mechanical harvesting should never be attempted. To avoid complete or over removal, the management entity should have a harvesting plan that determines where and how much vegetation is to be removed.

Pros

Mechanical harvesting can be a selective means to reduce stands of nuisance vegetation in a lake. Typically, plants cut low enough to restore recreational use and limit or prevent regrowth. This practice normally improves habitat for fish and other aquatic organisms. Some plant species such as curlyleaf pondweed, if harvested at the right time, do not grow back to nuisance proportions after harvesting. Plant clippings are high in nutrients and can be used as fertilizer or compost. Additionally, use of the lake is uninterrupted while harvesting is occurring.

By removing large quantities of plant biomass the overall quality of the lake may improve in many ways. The decrease in vegetative biomass will reduce the dissolved oxygen (D.O.) demand on the lake. This will cause increased dissolved oxygen levels. Some nuisance vegetation such as coontail have extremely high oxygen demands. Dense stands of these plants can quickly deplete a lake of D.O. during certain periods of the day. This can cause fish stress. Additionally, a decrease in plant density will improve the lake's fishery of the lake by creating better opportunities for predation, which is essential in creating a balanced fish population. By removing nuisance vegetation, recreational uses of the lake will improve. The quality of activities such as boating, swimming, and fishing would greatly improve. By removing dense stands of vegetation the possibility of entanglement will decrease thereby increasing opportunities for boating and swimming. Paths cut by the harvester will open fishing areas especially if

networks of fish “cruising lanes” are created.

Cons

Once widespread, mechanical harvesting is becoming a less attractive management technique for a variety of reasons. Many applicators that regularly employed mechanical harvesting no longer use or even offer this service due to low public demand. In addition, high initial investment, extensive maintenance, and high operational costs have also led to decreased use. Since many applicators no longer offer harvesting services, a lake association would have to purchase and maintain their own harvester. Many associations do not even have the financial resources to cover the maintenance and operational cost involved with owning a harvester. Harvester costs can range from \$50,000-\$150,000. Beside the financial limitations there are also physical limitations. Mechanical harvesters cannot be used in less than 2-4 ft of water (depending on draft of the harvester) and can not maneuver well in tight places. The harvested plant material must be disposed of properly to a place that can accommodate large quantities of plants and prevent any from washing back into the lake. Fish, mussels, turtles and other aquatic organisms are commonly caught in the harvester and injured or even removed from the lake in the harvesting process.

After the initial removal, there is a possibility for vegetation regrowth. Upon regrowth, weedy plants such as Eurasian watermilfoil and coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiversity. Additionally, these dense stands of nuisance vegetation may lead to an overpopulation of stunted fish due to a decrease in predation of forage species by predatory fish. This disruption in the fishery will have negative impacts throughout the ecosystem from zooplankton to higher organisms such as waterfowl.

If complete/over removal does occur several problems can result. One problem is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. The increase in turbidity can cause a decrease in light penetration, which can further aggravate the aquatic plant community. The resuspension of nutrients will also contribute to overall nutrient load of the lake, which can lead to increased frequency of algal blooms. Furthermore, the removal of aquatic vegetation, which competes with algae for resources with algae, can directly contribute to an increase in algal blooms. Removal of plants may lead to increased turbidity and decreased clarity. The fishery of the lake may decline and/or become stunted due changes in predation related to decreased water clarity. Other organisms, such as waterfowl, which commonly forage on native aquatic plants, would also be negatively impacted by the removal of these plants.

Another problem with mechanical harvesting, even if properly done, is that it can be a nonselective process. In the areas where harvesting is being conducted, one plant can not be removed and another left. All the plants are removed from that area. After the initial removal, regrowth of desirable plants does not typically

occur in these harvested areas. Due to their weedy nature, plants such as Eurasian water milfoil, are able to grow more quickly than native plants and become more established in harvested areas. This will create a monoculture of nuisance vegetation. This causes an overall decrease in plant biodiversity, which can have detrimental effects to the entire ecosystem. Depending on the plant species, frequent harvesting might be required (typically 2-4 times per season). Along with this increased harvesting frequency come increased operational costs (labor, gas, maintenance, etc.). Nuisance plants such as coontail and Eurasian watermilfoil can spread by vegetative fragments that may escape collection during the harvesting process and spread to uninfested parts of the lake. In addition to the release of plant fragments, as the plants are cut, there is a possibility of plant associated nutrients being released into the lake. This could cause an increase in algal blooms whenever harvesting is conducted. Short-term turbidity may also be created by the harvester paddle wheels stirring up sediment in harvested area.

Costs

Depending on the type of harvester (cutting width, payload capacity, hull material, HP of the motor, trailer options, etc) prices range from \$50,000 to \$150,000. Operational and maintenance costs typically range from \$161.00-\$445.00/acre.

Option 4: Hand Removal

Hand removal of excessive aquatic vegetation is a commonly used management technique. Hand removal is normally used in small ponds/lakes and limited areas for selective vegetation removal. Areas surrounding piers and beaches are commonly targeted areas. Typically tools such as rakes and cutting bars are used to remove vegetation. These are easily obtainable through many outdoor supply catalogs or over the internet. Some rakes are equipped with tines as well as cutting edges. Tools can also be hand made by drilling a hole in the handle of a heavy-duty garden rake and tying it to a length of rope. Weights may be needed in order to provide forceful contact with the plants. In many instances, homeowners on lakes with near shore vegetation problems simply cut swaths through the weeds to create pathways to open water. Due to the limited amount of biomass removed, harvested plant material is often used as fertilizer and compost in gardens.

Hand removal around piers and boat launches may be an option once significant plant beds become established on Long Lake. Small channels could also be created to permit boating or other recreational activities.

Pros

Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. Hand removal is an activity in which all lake residents could participate. The work involved in removing plants can provide a rewarding sense of accomplishment. By removing excess vegetation, use of beaches and piers would be improved. Many of the improved water quality benefits of a well-executed herbicide program or harvesting program are also shared by hand

removal. Wildlife habitat, such as fish spawning beds, could be greatly improved. This in turn would benefit other portions of the lake's ecosystem.

Cons

There are few negative attributes to hand removal. One negative implication is labor. Depending on the extent of infestation, removal of large amount, of vegetation can be quite tiresome. Another drawback can be disposal. Finding a site for numerous residents to dispose of large quantities of harvested vegetation can sometimes be problematic. However, individual homeowners would be removing limited quantities of plant material so there would not be much to dispose of. Another drawback is possible nonselective removal by hand harvesting. By throwing a rake blindly into the depths, it is impossible to determine what plants are removed and which ones are not until the rake is pulled up. Even in shallow depths, untrained persons might mistakenly remove desirable vegetation and/or disrupt valuable habitat (fish spawning beds). Over removal could also be a problem but is not normally a concern with hand removal.

Costs

Plant removal rakes can range in price from \$50-150 and cutting tools commonly range in price from \$50-200. Both are available from numerous catalogs and from the internet. A homemade rake would cost about \$20-40.

Option 5: Water Milfoil Weevil

Euhrychiopsis lecontei (*E. lecontei*) is a biological control organism used to control Eurasian water milfoil (EWM). *E. lecontei* is a native weevil, which feeds exclusively on milfoil species. It was originally discovered while investigating declines of EWM in a Vermont lake in the early 1990s. It was discovered in northeastern Illinois lakes by 1995. It was found in Long Lake in 2001. Another weevil, *Phytobius leucogaster*, also feeds on EWM but does not cause as much damage as *E. lecontei*. Therefore, *E. lecontei* is stocked as a biocontrol and is commonly referred to as the Eurasian water milfoil weevil. Currently, the LCHD-Lakes Management Unit has documented weevils (*E. lecontei* and/or *P. leucogaster*) in 16 Lake County lakes. Many of these lakes have seen declines in EWM densities in recent years. It is highly likely that *E. lecontei* and/or *P. leucogaster* occurs in all lakes in Lake County that have excessive EWM growth.

Weevils are stocked in known quantities to achieve a density of 1-4 weevils per stem. As weevil populations expand, EWM populations may decline. After EWM declines, weevil populations decline and do not feed on any other aquatic plants and die back. When EWM starts to grow again in the spring, the weevil populations respond by keeping the increasing milfoil under control before it becomes a problem. Once the weevil is established, EWM should no longer reach nuisance proportions and begins to become more sparse. Best results are achieved in lakes that have shallow EWM infestations in areas where it is undisturbed by recreational and management activities. Weevils need proper overwintering habitat such as leaf litter and mud, which are typically found on naturalized shorelines or shores with good buffer strips. Additionally, water temperatures need to be 68-70°F for maximum weevil activity. For this reason, weevils are typically

stocked in late spring/early summer. Currently only one company, EnviroScience Inc., has a stocking program (called the MiddFoil[®] process). The program includes evaluation of EWM densities of current weevil populations (if any), stocking, monitoring, and restocking as needed.

In Long Lake, the weevil appeared to damage a significant portion of the EWM beds around the lake. How much of an impact this insect will have on controlling EWM in Long Lake remains to be seen. Long Lake has limited overwintering habitat for the weevil since a large portion of the shoreline is armored with seawall or riprap.

Pros

The milfoil weevil can provide long-term control of EWM. Typically, by the end of June EWM stands are starting to decline due to weevil damage. In many situations, EWM beds might not reach the surface before weevil damage causes declines. *E. lecontei* is also a selective means to control EWM. Studies have shown that *E. lecontei* has a strong preference for EWM and the only other plant it possibly will feed on is northern water milfoil. Since milfoil weevils are found to naturally occur in several lakes in Lake County, weevil stocking would be an augmentation rather than an introduction, making it a more natural control option.

If control with milfoil weevils were successful, the quality of the lake would be improved. Native plants could then start to recolonize. Fisheries of the lake would improve due to more balanced predation and higher quality habitat. Waterfowl would benefit due to increased food sources and availability of prey. Recreational activities such as fishing, swimming, and boating would be easier and more enjoyable with the removal of inhibiting stands of EWM.

Cons

Use of milfoil weevils does have some drawbacks. Control using the weevil has been inconsistent in many cases. EWM has been reduced one year, only to be unaffected the next. Reasons for these inconsistencies are under investigation. One possible explanation is lack of suitable overwintering habitat. The highly developed, manicured shorelines of many lakes in the County are not suitable habitat for weevil overwintering. Another possible explanation is cooler than normal summer water temperatures. Studies have shown that cooler water temperatures reduce weevil feeding and egg production.

Milfoil control using weevils may not work well on plants in deep water. Plants are able to compensate for weevil damage on upper portions of the plant by increasing growth on lower portions where weevil does not feed. Furthermore, weevils do not work well in areas where plants are continuously disturbed by activities such as powerboats and swimming, harvesting or herbicide use. In areas where weevils are to be stocked, activity should be reduced as much as possible. This may either limit the extent to which the weevils can be used or limit recreational use of the lake.

One of the most prohibitive aspects to weevil use is price. Typically weevils are stocked to achieve a density of 1-4 weevils per stem. This translates to 500-3000 weevils per acre. At a cost of \$1 per weevil plus labor, a EWM management program using weevils can be expensive. Additionally, there is no guarantee that weevils will provide long term control or even produce any results at all. At this time stocking of weevils into Long Lake is not recommended.

Costs

Since the weevil is naturally found in Long Lake, the purchase and stocking of weevils is not needed at this time.

Option 6: Reestablishing Native Aquatic Vegetation

Revegetation should only be done when existing nuisance vegetation, such as Eurasian water milfoil, 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.

There are two methods by which reestablishment can be accomplished. The first is 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 thereby filling the niche left by the nuisance plants. 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 6 in Appendix A lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

Pros

By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. Once established, expanded native plant populations will help to control growth of nuisance vegetation. This provides a more natural approach as compared to other management options. In addition, using established native plants to control excessive invasive plant growth can be less expensive in the long run than other options. Expanded native plant populations will also 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 can lead 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 and the suppression of weedy species.

Cons

There are few negative impacts to revegetating a lake. One possible 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 is used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

Costs

See Table 6 in Appendix A for plant pricing. Additional costs will be incurred if a consultant/nursery is contracted for design and labor.

Objective III: Nuisance Algae Management Options

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 nuisance algae growth. Normally, excessive/nuisance algae growth is a sign of larger problems such 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 nuisance algal growth involves treating the factors that cause the growth not the algae it self. 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 eventually far exceed the costs of a slower acting, eventually 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 all share similar outcomes - negative impacts to the lake. Putting together a good 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 (beaches, boat ramps, etc.), habitat maintenance/restoration issues, and nutrient levels. 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. An association or property owner should not always expect immediate results. A quick fix of the algal problem may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly address the problem. The management options covered below are commonly used techniques and those that 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 are not very effective, unproven, unfounded, or are too experimental to be widely used.

In Long Lake, nuisance algae blooms were noted in 2001. Due to the high levels of nutrients (particularly phosphorus) in the lake, and the minimal aquatic vegetation present, algae blooms can be expected to be a problem for some time to come. The following options may help with the algae management on Long Lake.

Option 1: No Action

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 growth. 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 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, chemicals or introduction of any organisms would not 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. Other problems such as strong odors (blue-green algae) might also increase in frequency.

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 such as some blue-green algae. Blue-green algae can also produced toxins that are harmful to other algae. This allows 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 finding quality plants for food or in locating prey within the turbid green waters. Additionally, some species, such as blue-green algae, 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, could increase the frequency or severity of other blooms. In addition, decomposition of massive amounts of algae, filamentous and planktonic, 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. All of the impacts above could in turn have negative impacts on numerous aspects of the lake's ecosystem.

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 due in part to the thick mats and stunted fish populations. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by large green mats and/or blooms of algae and the odors that may develop, such as with large blue-green blooms. 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 (CuSO₄) 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 two forms, granular and liquid. Granular herbicides are spread by hand or machine over an effected area. They can also be placed in a porous bag (such as a burlap sack) and dragged through 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. Liquid algicides are used on both filamentous and planktonic algae. Liquid algaecides are often mixed with herbicides and applied together to save on time and money. The effectiveness of some herbicides are enhanced when mixed with an algicide. 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. This may cause fish kills due to decomposition of treated algae. 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. Larger lakes will need to be divided into more sections. Then treat the lake 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°F) or when D.O. concentrations are low. 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 when temperature and D.O. concentrations are adequate. It is best to treat in spring or when the blooms/mats starts to appear there by killing the algae before they become 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 are their low costs. The fisheries and waterfowl populations of the lake would greatly benefit due to 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. Newly established stands of plants would improve spawning habitat and food source availability for fish. Waterfowl population would 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, are selective in the sense that they do not affect aquatic vascular plants and 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. Health risks associated with excessive algae growth (toxins, reduced visibility, etc.) The quality of fishing may recover due to 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. 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 species that are even more problematic are filling the empty gap. These species that fill the gap can often be more difficult to control due to an inherent resistance to copper products. Additionally, excessive use of copper products can lead to a build up of copper in lake sediment. This can cause problems for activities such as dredging. Due to a large amount of copper in the sediment, special permits and disposal methods would have to be utilized.

Costs

To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's management plan. Chelated copper products vary with regard to application rate and price, but generally range from 0.5 to 5 gallons per acre foot at a cost of \$35-45 per gallon.

Option 3: Alum Treatment

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum does not directly kill algae as copper sulfate does. Instead, alum binds phosphorus making it unavailable, thus reducing algal growth. Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom. This floc layer can then prevent sediment bound phosphorus from entering the water column. Phosphorus inactivation using alum has been in use for 25 years. However, cost and sometimes unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds and small lakes, 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 ratio are good candidates. This encompasses many lakes within Lake County. 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 done, there may be many detrimental side effects.

Due to the large size of the Long Lake watershed, an alum treatment may not be very effective or long lasting. It should only be considered after other options are assessed.

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 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 clarity can have many positive effects on the lake's ecosystem. With increased clarity, plant populations could expand or reestablish. This in turn would improve fish habitat and provide improved food/habitat 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 motorboat traffic, 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 pH is below 6 or above 9. Most of Lake County's lakes are in this safe range. However, at these pHs, special precautions must be taken when applying alum. By adding the incorrect amounts of alum, pH of the lake could drastically change. Due to these dangers, it is highly recommended that a lake management professional plans and administers the alum treatment.

Costs

To treat Long Lake with alum would cost approximately \$450,000. This is based on a lake volume of 4,400 acre-feet and the phosphorus levels recorded in 2001.

Option 4: Revegetation With Native Aquatic Plants

This is identical to Option 6 in **Objective II: Aquatic Plant Management Options** above.

Objective IV: Shoreline Erosion Control

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.

Several areas of the Long Lake shoreline were classified as eroding either moderately or severely. Approximately 1,857 feet were moderately eroding and 455 feet severely eroding. This erosion may be the result of many factors, but likely is due to wave action due to wind and boat activity and due to the fact that much of the shoreline is dominated by exotic plant species. Shoreline remediation is recommended along these areas. When possible, reestablishing native shorelines is preferred, including emergent vegetation in the shallow water areas.

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: Install a Steel or Vinyl Seawall

Seawalls are designed to prevent shoreline erosion on lakes in a similar manner they are used along coastlines to prevent beach erosion or harbor siltation. Today, seawalls are generally constructed of steel, although in the past seawalls were made of concrete or wood (frequently old railroad ties). Concrete seawalls cracked or were undercut by wave action requiring routine maintenance. Wooden seawalls made of old railroad ties are not used anymore since the chemicals that made the ties rot-resistant could be harmful to aquatic organisms. A new type of construction material being used is vinyl or PVC. Vinyl seawalls are constructed of a lighter, more flexible material as compared to steel. Also, vinyl seawalls will not rust over time as steel will.

Pros

If installed properly and in the appropriate areas (i.e. shorelines with severe erosion) seawalls provide effective erosion control. Seawalls are made to last numerous years and have relatively low maintenance.

Cons

Seawalls are disadvantageous for several reasons. One of the main disadvantages is that they are expensive, since a professional contractor and heavy equipment are needed for installation. Any repair costs tend to be expensive as well. If any fill material is placed in the floodplain along the shoreline, compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain. Permits and surveys are needed whether replacing and old seawall or installing a new one (see costs below).

Wave deflection is another disadvantage to seawalls. Wave energy not absorbed by the shoreline is deflected back into the lake, potentially causing sediment disturbance and resuspension, which in turn may cause poor water clarity and problems with nuisance algae, which use the resuspended nutrients for growth. If seawalls are installed in areas near channels, velocity of run-off water or channel flow may be accelerated. This may lead to flooding during times of high rainfall and run-off, shoreline erosion in other areas of the lake, or a resuspension of sediment due to the agitation of the increased wave action or channel flow, all of which may contribute to poor water quality conditions throughout the lake. Plant growth may be limited due to poor water clarity, since the photosynthetic zone where light can penetrate, and thus utilized by plants, is reduced. Healthy plants are important to the lake's overall water clarity since they can help filter some of the incoming sediment, prevent resuspension of bottom sediment, and compete with algae for nutrients. However, excessive sediment in the water and high turbidity may overwhelm these benefits.

Finally, seawalls provide no habitat for fish or wildlife. Because there is no structure for fish, wildlife, or their prey, few animals use shorelines with seawalls. In addition, poor water clarity that may be caused by resuspension of sediment from deflected wave action contributes to poor fish and wildlife habitat, since sight feeding fish and birds (i.e. bass, herons, and kingfishers) are less successful at catching prey. This may contribute to a lake's poor fishery (i.e. stunted fish populations).

Costs

Depending on factors such as slope and shoreline access, cost of seawall installation ranges from \$65-80 per linear foot for steel and \$70-100 per linear foot for vinyl. To install a seawall along the moderately eroded shoreline (1,857 feet) of Long Lake would cost approximately \$120,705 – 148,560 for steel and \$129,990 – 185,700 for vinyl. The severely eroded sections (455 feet) would cost approximately \$29,575 – 36,400 for steel and \$31,850 – 45,500 for vinyl. A licensed contractor installs both types of seawall. Additional costs may occur if the shoreline needs to be graded and backfilled, has a steep slope, or poor accessibility. Price does not include the necessary permits required. Additional costs will be incurred if compensatory storage is needed. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained. For seawalls, a site development permit and a building permit are needed. Costs for permits and surveys can be \$1,000-2,000 for installation of a seawall. Contact the Army Corps of Engineers, local municipality, or the Lake County Planning and Development Department.

Option 3: Install Rock Rip-Rap or Gabions

Rip-rap is the term for using rocks to stabilize shorelines. Size of the rock depends on the severity of the erosion, distance to rock source, and aesthetic preferences. Generally, four to eight inch diameter rocks are used. Gabions are wire cages or baskets filled with rock. They provide similar protection as rip-rap, but are less prone to displacement. They can be stacked, like blocks, to provide erosion control for extremely steep slopes. Both rip-rap and gabions can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the rip-rap or gabions, fill will probably be needed to cover the rocks and provide an acceptable medium for plants to grow on. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained (see costs below).

Pros

Rip-rap and gabions can provide good shoreline erosion control. Rocks can absorb some of the wave energy while providing a more aesthetically pleasing appearance than seawalls. If installed properly, rip-rap and gabions will last for many years. Maintenance is relatively low, however, undercutting of the bank can cause sloughing of the rip-rap and subsequent shoreline. Areas with severe erosion problems may benefit from using rip-rap or gabions. In all cases, a filter fabric should be installed under the rocks to maximize its effectiveness.

Fish and wildlife habitat can be provided if large boulders are used. Crevices and spaces between the rocks can be used by a variety of animals and their prey. Small mammals, like shrews can inhabit these spaces in the rock above water and prey upon many invertebrate species, including many harmful garden and lawn pests. Also, small fish may utilize the structure underwater created by large boulders for foraging and hiding from predators.

Cons

A major disadvantage of rip-rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip-rap or gabions and must be acquired prior to work beginning. If any fill material is placed in the floodplain along the shoreline, compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain.

While rip-rap and gabions absorb wave energy more effectively than seawalls, there is still some wave deflection that may cause resuspension of sediment and nutrients into the water column.

Small rock rip-rap is poor habitat for many fish and wildlife species, since it provides limited structure for fish and cover for wildlife. As noted earlier, some small fish and other animals will inhabit the rocks if boulders are used. Smaller rip-rap is more likely to wash away due to rising water levels or wave action. On the other hand, larger boulders are more expensive to haul in and install.

Rip-rap may be a concern in areas of high public usage since it is difficult and possibly dangerous to walk on due to the jagged and uneven rock edges. This may be a liability concern to property owners.

Costs

Cost and type of rip-rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately \$30-45 per linear foot. Costs for gabions are approximately \$20-30 per linear foot, and approximately \$60-100 per linear foot when filled with rocks. To install riprap along the moderately eroded shoreline (1,857 feet) of Long Lake would cost approximately \$55,710 – 83,565. The severely eroded sections (455 feet) would cost approximately \$13,650 – 20,475 for vinyl. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be \$1,000-2,000 for installation of rip-rap or gabions, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

Option 4: 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 sprout 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 Table 5 in Appendix A should be considered for native plantings.

Pros

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

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

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

Many fish and wildlife species prefer the native shoreline vegetation habitat. This habitat is an asset to the lake's fishery since the emergent vegetation cover may be used for spawning, foraging, and hiding. Various wildlife species are even dependent upon shoreline vegetation for their existence. Certain birds, such as marsh wrens (*Cistothorus palustris*) and endangered yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) nest exclusively in emergent vegetation like cattails and bulrushes. Hosts of other wildlife like waterfowl, rails, herons, mink, and frogs to mention just a few, benefit from healthy stands of shoreline vegetation. Dragonflies, damselflies, and other beneficial invertebrates can be found thriving in vegetation along the shoreline as well. Two invertebrates of particular importance for lake management, the water-milfoil weevils (*Euhrychiopsis lecontei* and *Phytobius leucogaster*), which have been shown to naturally reduce stands of exotic Eurasian water-milfoil (*Myriophyllum spicatum*). Weevils need proper over wintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Many

species of amphibians, birds, fish, mammals, reptiles, and invertebrates have suffered precipitous declines in recent years primarily due to habitat loss. Buffer strips may help many of these species and preserve the important diversity of life in and around lakes.

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.

Option 5: Install A-Jacks

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a child's playing jacks. These structures are installed along the shoreline and covered with soil and/or an erosion control product. Native vegetation is then planted on the backfilled area. They can be used in areas where severe erosion does not justify a buffer strip alone.

Pros

The advantage to A-Jacks® is that they are quite strong and require low maintenance once installed. In addition, once native vegetation becomes established the A-Jacks® can not be seen. They provide many of the advantages that both rip-rap and buffer strips have. Specifically, they absorb some of the wave energy and protect the existing shoreline from additional erosion. The added benefit of a buffer strip gives the A-Jacks® a more natural appearance, which may provide wildlife habitat and help filter run-off nutrients, sediment, and pollutants. Less run-off entering a lake may have a positive effect on water quality.

Cons

The disadvantage is that installation cost can be high since labor is intensive and requires some heavy equipment. A-Jacks® need to be pre-made and hauled in from the manufacturing site. These assemblies are not as common as rip-rap, thus only a limited number of contractors may be willing to do the installation.

Costs

The cost of installation is approximately \$40-75 per linear foot, but does not include permits and surveys, which can cost \$1,000-2,000 and must be obtained prior to any work implementation. Additional costs will be incurred if compensatory storage is needed. On Long Lake, the cost to install A-Jacks® along the moderately eroded sections (1,857 feet) would be approximately \$74,280 – 139,275. The severely eroded areas (455 feet) would cost approximately \$18,200 – 34,125.

Option 6: Install Biolog, Fiber Roll, or Straw Blanket with Plantings

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.

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.

Option 7: Establish a “No Wake” Zone, Boat Horsepower Limit, or Boat Speed Limit

Establishing a “No Wake” zone, boat horsepower limit, or boat speed limit will not solve erosion problems by itself. However, since shoreline erosion is generally not caused by one specific factor, these techniques can be effective if used in combination with one or more of the techniques described above.

Pros

These techniques can reduce wave activity along shorelines susceptible to erosion. Limiting boat activity, particularly near shorelines, may also have an additional benefit by improving water quality since less sediment will be disturbed and resuspended in the water column. Disturbed sediment contribute to poor water clarity, which can negatively effect sight feeding fish and wildlife and limit the available light needed for plant growth. Nuisance algae also benefit from disturbed sediment since this action makes available nutrients in the sediment that otherwise would stay settled on the bottom.

Less motorboat disturbance will benefit wildlife and may encourage many species to use the lake both during spring and fall migration and for summer residence. This may add to the lake’s aesthetics and increasing recreational opportunities for some lake users.

Cons

Enforcement and public education are the primary obstacles with these techniques. Public resistance to any regulation change may be strong, particularly if the lake is open to the public and has had no similar regulations in the past. Depending on the regulations implemented, there may be some loss of recreational use for some users, particularly powerboating. However, if the lake is large enough, certain parts of the lake (i.e., the middle or deepest) may be used for this activity without negatively influencing other uses.

Costs

Costs are limited to purchase and placement of signs and enforcement. No wake or speed limit buoys cost approximately \$30-150 each.

Objective V: 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 (*Alliaria 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.

Option 1: No Action

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. A table in Appendix A lists several native plants that can be planted along shorelines.

Cons

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

Recreational activities, especially wildlife viewing, may be hampered by such monocultures. Access to lake shorelines may be impaired due to dense stands of non-native plants. Other recreational activities, such as swimming and boating, may not be 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 beetles (*Galerucella pusilla* and *G. californiensis*) 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

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 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 VII: Enhance Wildlife Habitat Conditions

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

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

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

Option 1: No Action

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

Pros

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

Cons

If environmental conditions change or substantial land use actions occur (i.e., development) wildlife use of the area may change. For example, if a new housing

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

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

Costs

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

Option 2: Increase Habitat Cover

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

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

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

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

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

Pros

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

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

Cons

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

Costs

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

Option 3: Increase Natural Food Supply

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

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

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

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

Pros

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

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

Cons

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

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

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

Costs

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

Option 4: Increase Nest Availability

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

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

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

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

Pros

Providing places 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 the entire lake ecosystem.

Cons

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

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

Costs

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

Option 5: Limit Disturbance

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

Pros

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

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

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

Cons

One of the strongest oppositions to this option would probably be from the powerboat users and water skiers. However, this problem may be solved if a significant portion of the daylight hours and the use of the middle part of the lake (assuming the lake is deep enough) are allowed for powerboating. For example, powerboating could be allowed between 9 AM and 6 PM within the boundaries established by “no wake” restricted area buoys.

Costs

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