2001 SUMMARY REPORT
of
LAKE ELEANOR

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Lake Eleanor is a widening of the West Fork of the North Branch of the Chicago River located within the Village of Deerfield. The lake is privately owned, with residential lots surrounding the entire shoreline. The Lake County Health Department (LCHD) conducted a bathymetric survey of the lake in October 2001. Lake Eleanor has a volume of 41.33 acre-feet, a maximum depth of 5.5 feet, an average depth of 3.8 feet, with a surface area of 10.81 acres and a shoreline length of 1.19 miles.

Lake Eleanor has poor water clarity due to excessive sediment and algae in the water. The lake also has excessive concentrations of nutrients, particularly phosphorus, which cause algae problems. High conductivity readings were also found in the lake. These water quality problems are mainly from upstream sources including Interstate 94. Presence of carp exacerbate the sediment and nutrient problems.

Because it is a shallow flowage system, Lake Eleanor is fully oxygenated from the surface to the bottom. The aeration systems in the lake are not necessary from a dissolved oxygen perspective according to the data collected by LCHD. Some of the diffusers were not operating during much of the study.

The lake has poor plant diversity and very low plant coverage. Although the light availability through the water column offers the potential for 100% plant coverage across the bottom, heavy silt covering the few plants that were found may hinder plant growth.

The entire shoreline of Lake Eleanor is developed. The two largest shoreline types are seawall and lawn. A total of 72% or 4,535 feet of the shoreline is armored with either riprap (565 feet) or seawall (3,970 feet). The two shoreline types that were eroding most were seawall and lawn, which together comprised nearly 75% of the 1,868 feet of eroding shoreline. Fluctuating water levels aggravate shoreline erosion, especially along unstable shorelines such as manicured lawns or failing seawalls.

Because the area surrounding Lake Eleanor is highly residential/urban, there was a low variety of wildlife species recorded. Interestingly, black-crowned night herons, an Illinois endangered species, were spotted in the trees near the spillway during each monthly visit. The herons were probably nesting nearby, since two sightings included a juvenile bird.

LAKE IDENTIFICATION AND LOCATION

Lake Eleanor is a man-made lake located within the Village of Deerfield (T43N, R12E, Section 30, NE ¼). It is privately owned, with residential lots surrounding the entire shoreline. The Lake Eleanor Association (henceforth, the Association) owns the lake bottom, with access restricted to members of the association. It is part of the West Fork drainage basin of the Chicago River watershed. The river flows directly through Lake Eleanor, entering at the northwest corner, and exiting over a spillway at the southeast corner. The Lake County Health Department (LCHD) conducted a bathymetric survey of the lake in October 2001 (Figure 1 and Table 1). Lake Eleanor has a volume of 41.33 acre-feet, a maximum depth of 5.5 feet, an average depth of 3.8 feet, with a surface area of 10.81 acres, and a shoreline length of 1.19 miles.

BRIEF HISTORY OF LAKE ELEANOR

In 1964, Lake Eleanor was constructed by dredging and damming a small portion of the flood plain of the West Fork of the North Branch of the Chicago River. It was dredged in 1974 to remove some accumulated sediment. The plan was to dredge approximately 35,000 cubic yards of sediment in order to deepen the majority of the lake to six feet deep with a slope of 1:4. Two nine-foot deep holes were to be created in the north bay across from the inlet and in front of the large culvert on the west shore. These two deep holes were to act as a reservoir for incoming silt and to benefit the fishery. Because of its large urban/suburban watershed, the lake has been plagued with inputs of sediment and nutrients from the river and from other surrounding sources such as Interstate 94 which runs adjacent to the lake. The LCHD monitored stormwater quality at several sites draining into Lake Eleanor from 1997 to 2000. Although very high concentrations of many pollutants were entering the lake from Interstate 94 during rain events, the river contributed a higher pollutant load. LCHD also collected water quality samples from the lake in 1991. These data will be discussed in more detail later in the report.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Residents around Lake Eleanor use the lake for nonmotorized boating and aesthetics. The Association hires a consultant to periodically spot treat the lake with aquatic herbicides and algicides to control plants and algae. The Association also controls the Canada goose population by hiring a consultant to provide a pair of swans and also to periodically chase the geese away. The Association also runs three small aeration units and three air injectors. However, not all of these units were operating during 2001.

Figure 1

Table 1.

Figure 2.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were taken once a month, from May through September 2001, at the inflow and the outflow (Figure 2). Inflow samples were collected at the surface from the middle portion of the lake to represent the confluence of the river and the west inflow pipe from Interstate 94. The outflow sample was collected just in front of the spillway. All samples were analyzed for a variety of parameters, with the results listed in Table 2 in Appendix A. See Appendix B for water quality sampling and laboratory methods. The document "Interpreting Your Water Quality Data" explains these parameters in detail.

The water clarity in Lake Eleanor is poor, averaging 1.17 feet[1] deep during 2001, and 1.15 feet deep in 1991. In 2001, water clarity was highest in May (2.00 feet at the inflow) and declined as the season progressed. Water clarity readings in September were very poor (0.59 feet and 0.69 feet at the inflow and outflow, respectively). The reason for this poor clarity is due mostly to sediment in the water column. Evidence of this was seen in the ***extremely high*** total suspended solid (TSS) concentrations which, in 2001, averaged 36.3 mg/L at the inflow and 28.4 mg/L at the outflow. These concentrations have changed little since 1991 when the seasonal average TSS was 29.6 mg/L. Another set of water quality samples collected by Integrated Lakes Management had similar concentrations, ranging from 28 mg/L to 64 mg/L. Fifty percent of Lake County lakes had a TSS concentration of 5.7 mg/L or less[2]. Another parameter, non-volatile suspended solids (NVSS), was calculated to determine the inorganic composition of the suspended solids. The NVSS was very high at both sample locations, averaging 29.0 mg/L and 22.2 mg/L at the inflow and outflow, respectively. This illustrates that the TSS concentrations in the water column are comprised mostly of inorganic sediment, likely coming into the lake from upstream sources.

Other solid parameters in high concentrations during 2001 were total dissolved solids (TDS) and total solids.[3] TDS averaged 771 mg/L at the inflow, and 740 mg/L at the outflow. The 1150 mg/L TDS reading in May at the inflow area was the highest recorded in a lake by LCHD since 1995, at. This concentration decreased for the remainder of the season. The TDS concentrations influence the high conductivity readings in the lake, which averaged 1.250 milliSiemens/cm (inflow) and 1.220 milliSiemens/cm (outflow).[4] The Lake County average conductivity reading is 0.7557 milliSiemens/cm, and the average TDS concentration is 452 mg/L. Chlorides from the road salt used on Interstate 94 and other roads in the watershed are the main reason that both of these parameters are high[5]. Road salts can increase TDS concentrations and conductivity readings. Since most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts, we calculated the concentration of chloride in each water sample based on conductivity readings. The 2001 seasonal average for chloride in Lake Eleanor was calculated to be 276 mg/L at the inflow and 268 mg/L at the outflow. The Illinois

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[1] This is an average of the inflow and outflow measurements: 1.16 feet and 1.18 feet, respectively.
[2] This is the median value, or the point at which half of the lake samples have concentrations less than this value, and the other half have greater concentrations. Median and average values were calculated using results of lakes sampled by the LCHD from 1995 through 2001.
[3] Total solids, total dissolved solids and total volatile solids were not measured in 1991.
[4] Conductivity was not measured in 1991.
[5] Data from the 1997-2000 Tollway Water Quality Monitoring Project.

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.

The total phosphorus (TP) averages in Lake Eleanor were similar between the inflow (0.187 mg/L) and outflow (0.181 mg/L). This is nearly four times higher than the Lake County median of 0.047 mg/L. It was also noted that the average TP concentration had increased 56% since 1991. Possible explanations include differences in stormwater runoff occurrences before sampling or additional inputs from the watershed. The water quality samples collected by Integrated Lakes Management had similar concentrations, ranging from 0.11 mg/L to 0.26 mg/L.

Ammonia nitrogen concentrations were above the detection limits during two sampling events in 1991 and one sampling event in 2001. Rainfall occurred just prior to two of the sampling dates. The input of stormwater is the most probable reason ammonia nitrogen was elevated at these times. Nitrate nitrogen concentrations averaged 0.142 during 1991, but were below the 0.05 mg/L detection limit for all of the sampling dates in 2001. The ratio of total nitrogen[6] (TN) to TP in the lake indicates if phosphorus or nitrogen would limit algae and/or plant growth in the lake. Lakes with TN:TP ratios of more than 15:1 are usually limited by phosphorus. Those with ratios less than 10:1 are usually limited by nitrogen. The seasonal TN:TP ratio of Lake Eleanor during 2001 was 7:1, which indicates it is limited by nitrogen. This explains why soluble reactive phosphorus (SRP) concentrations were found at detectable levels in all of the months sampled (except May) at both locations, since plants and algae could not use all of the SRP without sufficient nitrogen. SRP is the type of phosphorus that is readily available to be utilized by plants and algae. Most lakes throughout Lake County are phosphorus limited, which is not the case with Lake Eleanor. Nutrients, like phosphorus and nitrogen, enter Lake Eleanor from the watershed and by internal loading, through resuspension of sediment from wind, wave and carp activity.

One positive aspect to the water quality results in Lake Eleanor is that concentrations were similar at both sample sites, indicating that near equal amounts of nutrients and solids were entering and leaving the lake. This may mean a low net gain in these concentrations and that sedimentation in the lake may not be as rapid as first suspected. However, residents have expressed concern over this issue and are interested in the possibility of dredging part or all of the lake. This issue is discussed in more detail, including a conceptual plan and estimated costs, in **Objective I: Dredging and Wing Dam**.

The trophic condition of a lake indicates the overall level of nutrient enrichment. Most lakes in Lake County are eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae and fish. Hypereutrophic lakes are those that have excessive nutrients. Lakes with nuisance algae growth reminiscent of "pea soup" are often labeled hypereutrophic, and usually have poor water clarity. Higher total phosphorus concentrations are linked to more algae in the water and hence, lower water clarity. Although the water color in Lake Eleanor was reminiscent of high sediment loading instead of nuisance algae blooms, the condition of Lake Eleanor in terms of its phosphorus concentrations during 2001 and 1991 was hypereutrophic. Lake Eleanor ranked #88 out of 103 Lake County lakes based on average total phosphorus concentrations (See Table 3 in Appendix A).

[6] Total nitrogen consists of the organic forms of nitrogen plus nitrate nitrogen.

Because this lake is so shallow and is a flow-through system, oxygen levels did not reach anoxic conditions (<1 mg/L) at any time during either the 2001 or 1991 sampling seasons. The Association has three 1/3 horsepower, low pressure, rotary vane aeration units. These operate on Gast compressors at 5 psi, delivering 3.7 cfm. Each compressor supplies air to one diffuser, which is set on the bottom. These are supposed to operate throughout the summer season, but LCHD staff only noticed their operation in June 2001. The units were disturbing the sediment on the bottom, causing turbid water in a six-foot diameter ring around the aerators. Because the oxygen concentrations were sufficient down to the bottom throughout the entire season, these aeration systems are not necessary, and in fact, are causing more turbidity in the immediate area. The Association also has three air injectors (two are Aquamaster, one is Kasco). These are basically inverted fountains that operate on a 2-horsepower motor that turns a propeller in order to create water flow. They are set just off the bottom in four feet of water. These are set in the northwest bay, the east bay in the main body of the lake, and at the inlet to the lake. The injectors were installed to move the water in these areas out toward the main body of the lake to avoid stagnation in these areas. The injector at the inlet to the lake was not in operation during 2001. However, the inlet does have flow, so the injector at that location is unnecessary.

The IEPA has assessment indices to classify Illinois lakes for their ability to support aquatic life, swimming, or recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations and aquatic plant coverage. Lake Eleanor partially supports aquatic life according to these guidelines. Lake Eleanor is impaired for swimming uses because of the high phosphorus concentrations and low water clarity. In addition, LCHD historic records of fecal coliform counts in Lake Eleanor are high after rain events. This, with its hypereutrophic condition, places Lake Eleanor in the nonsupport category for swimming uses. The lake was placed in the nonsupport category for recreational uses also, for its hypereutrophic conditions and poor water clarity. The overall use support category for Lake Eleanor is that of nonsupport.

Staff measured the water elevation at the spillway each month, and found very little fluctuation throughout the season. The largest elevation difference was when the water level was one inch higher in July than in June. However, give the large urban/suburban watershed, there is potential for significant water fluctuations during rain events. Residents have reported water elevations well over the spillway during rain events. To monitor water level fluctuations it is recommended that a staff gage be installed at a location that it can be easily seen and maintained.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Staff randomly sampled locations in Lake Eleanor each month for aquatic plants. Because of the high concentrations of total suspended solids in the water, few plants were found. Only four species were identified: coontail, curlyleaf pondweed, duckweed and sago pondweed (Table 4). The few plants that were seen were coated with silt. Table 5 in Appendix A lists the plant species and the frequency that they were found. Duckweed and curlyleaf pondweed were most often seen, at 23% and 22% of the sample sites respectively. Sago pondweed was located at 19% of the total sample sites.

Table 4. Aquatic and shoreline plants of Lake Eleanor, May – September, 2001.

<u>*Aquatic Plants*</u>	
Coontail	*Ceratophyllum demersum*
Duckweed	*Lemna* spp.
Curlyleaf Pondweed	*Potamogeton crispus*
Sago Pondweed	*Stuckenia pectinatus*
<u>*Shoreline Plants*</u>	
Purple loosestrife	*Lythrum salicaria*
Reed Canary Grass	*Phalaris arundinacea*
Buckthorn	*Rhamnus* spp.

Water clarity, depth, and sediment type are the major limiting factors in determining the maximum depth at which aquatic plants will grow. Aquatic plants will not photosynthesize in water depths with less than 1% of the available sunlight. In Lake Eleanor, the 1% light level reached the bottom throughout the season, but only about 3% of the lake bottom had plant coverage. Although there is the possibility of 100% plant coverage based on available light levels, silt covering the plants may hinder growth or the bottom sediment may be unsuitable for plant stabilization. To maintain a healthy fishery, the Illinois Department of Natural Resources suggests that plants cover 20% to 40% of the lake bottom. Native aquatic plants should be encouraged to grow. Lake Eleanor would also benefit from the establishment of emergent vegetation along the shoreline.

Floristic quality index is a measurement designed to evaluate the closeness of the flora (plants species) of an area to that with 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 floating and submersed plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). These numbers are then used to calculate the floristic quality index (FQI). A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake, and better plant diversity. Nonnative species are included in the FQI calculations for Lake County lakes. The FQI scores of 64 lakes measured in 2000 and 2001 ranges from 0 to 37.2, with an average of 14. Lake Eleanor has a floristic quality of 7.5, indicating poor aquatic plant diversity based on the 64 lakes measured.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

In early July 2001, LCHD staff assessed the shoreline of Lake Eleanor. See Appendix B for a discussion of the methods used. The entire shoreline of Lake Eleanor is developed. A total of

72% or 4,535 feet of the shoreline is armored with either riprap (565 feet) or seawall (3,970 feet) (Figure 3). Twenty-two properties had seawalls that were in fair to poor condition. The second largest shoreline type is lawn, which was 15.1% of the total shoreline. Other shoreline types were riprap (9%), beach (8.1%), shrub (3.2%) and buffer (2.8%). Approximately 25% or 1,578 feet of the shoreline is slightly eroding, and 4.6% or 290 feet of the shoreline is moderately eroding (Figure 4). The two shoreline types that were eroding most were seawall and lawn, which together comprised nearly 75% of the 1,868 feet of eroding shoreline. Fluctuating water levels aggravate shoreline erosion, especially along unstable shorelines such as manicured lawns. Approximately half of the seawalls that are in fair to poor condition have eroding shorelines. Because of their unstable conditions, they can no longer adequately protect the shoreline from further erosion. Options for addressing shoreline erosion can be found in **Objective III: Shoreline Erosion Control**.

LCHD staff also noted aggressive, invasive shoreline plants at several locations around Lake Eleanor. One is a shrub - buckthorn, and two were herbaceous plants – purple loosestrife and reed canary grass. These aggressive exotics can crowd out native, beneficial plants. The removal of these species is recommended. Alternatives for their removal can be found within **Objective IV: Eliminate or Control Exotic Species**.

LIMNOLOGICAL DATA –WILDLIFE ASSESSMENT

Because the area surrounding Lake Eleanor is highly residential/urban, there was a low diversity of wildlife species recorded. Interestingly, black-crowned night herons, an Illinois endangered species, were spotted in the trees near the spillway during each monthly visit. The herons were probably nesting nearby, since two sightings included a juvenile bird. Table 6 lists the wildlife species reported on Lake Eleanor.

Wildlife habitat around Lake Eleanor was poor, since most of the area around the lake consists of residential homes with manicured lawns to the water's edge. Marginal habitat is located along the narrow channels where the river enters and leaves Lake Eleanor.

Carp were noted during the season and are likely the dominant fish in the lake, although no fish surveys were completed by LCHD in 2001. Carp are partly responsible for the poor water clarity and high concentrations of nutrients and solids since their actions cause resuspension of bottom sediment. Removal would likely be short-term as carp would repopulate the lake from upstream sources.

Figure 3

Figure 4

Table 6. Wildlife species observed on Lake Eleanor, May – September, 2001.

Birds	
Double-crested Cormorant	*Phalacrocorax auritus*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Green Heron	*Butorides striatus*
Black-crowned Night Heron*	*Nycticorax nycticorax*
Spotted Sandpiper	*Actitis macularia*
Solitary Sandpiper	*Tringa solitaria*
Mourning Dove	*Zenaida macroura*
Downy Woodpecker	*Picoides pubescens*
Tree Swallow	*Iridoprocne bicolor*
Rough-wing Swallow	*Stelgidopteryx ruficollis*
American Crow	*Corvus brachyrhynchos*
House Wren	*Troglodytes aedon*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*
Song Sparrow	*Melospiza melodia*

Amphibians, Mammals, and Reptiles
None noted.

*** Endangered in Illinois**

EXISTING LAKE QUALITY PROBLEMS

- *Poor Water Quality*

  Lake Eleanor's poor water quality is a result of internal resuspension of sediment mostly from carp activity, inputs from the West Fork of the North Branch of the Chicago River and from other areas of the lake's large watershed, including inflows from Illinois Highway 94. High concentrations of phosphorus, total dissolved solids, and total suspended solids were also found. The shallow nature of the lake compounds the poor water clarity issue. Due to its poor water quality, Lake Eleanor does not support recreational uses or swimming uses according to the Illinois Environmental Protection Agency's Use Impairment Guidelines.

- *Shoreline Erosion*

  Approximately 1,868 feet of shoreline is eroding, mostly on shorelines classified as either lawn or seawall. Approximately 25% or 1,578 feet of the shoreline is slightly eroding, and 4.6% or 290 feet of the shoreline is moderately eroding. Although none of the shoreline was listed as severely eroding, residents may still want to curtail damaged shorelines before their condition worsens.

  Installing buffer strips and encouraging or planting emergent vegetation would help control shoreline erosion and potentially improve water quality.

- *Lack of Aquatic Vegetation*

  Lake Eleanor has poor diversity and coverage of aquatic plant life. Because of the poor water clarity, only four species were noted in small scattered beds. Heavy silt covered the plants that were found, which likely inhibited plant growth. Establishing native emergent vegetation could help improve water quality, prevent shoreline erosion, and provide habitat for fish and wildlife.

- Carp

  Numerous carp were seen during the season in Lake Eleanor. Carp likely contribute to many of the water quality problems in the lake, particularly by resuspending bottom sediment. Total elimination of carp is unlikely since upstream sources exist, however, reducing carp numbers may help improve water quality.

- *Limited Wildlife Habitat*

  Because of the highly residential setting, Lake Eleanor has limited habitat to support wildlife, except for the narrow areas where the river enters and leaves the lake. LCHD staff identified black-crowned night herons, an Illinois state endangered species, at the spillway location each month. Improvements could be made around the lake to increase wildlife species diversity.

POTENTIAL OBJECTIVES FOR LAKE ELEANOR MANAGEMENT PLAN

I. Dredging and Wing Dam
II. Aquatic Plant Management Options
III. Shoreline Erosion Control
IV. Eliminate or Control Exotic Species
V. Enhance Wildlife Habitat Conditions

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Dredging and Wing Dam

Lake Eleanor was created by widening and damming the West Fork of the North Branch of the Chicago River. It experiences poor water quality due, in part, to the fact that it is shallow (maximum depth of 5.5 feet, average depth 3.8 feet) and large volumes of water flow through the lake. Water flowing into the lake via the river or from runoff from Interstate 94 also contains large amounts of sediment. Increases in sedimentation over time may have detrimental effects on the lake's ecosystem. The lake was dredged previously, in 1974, with the removal of approximately 35,000 cubic yards of sediment.

Residents around Lake Eleanor have expressed interest in dredging the lake again to improve water quality and to improve use of the lake for recreational activities. Dredging may help improve fish habitat and improve water quality. A bathymetric map, created in October 2001 by the LCHD was used to calculate the amount of sediment (and hence the approximate cost) that would need to be removed from the lake to achieve a desired average depth or volume. We based calculations on several assumptions. The lake would be dredged so that approximately 25% of the lake would be greater than 10 feet deep. This is a standard recommendation that has been determined to have the maximum benefit for a small lake such as Lake Eleanor. We also assumed the deepening of the lake would be conducted by hydraulic dredging and not mechanical, since the later usually requires lake drawdown and thus increases the costs and lengthens the duration of the dredging. Costs for hydraulic dredging were estimated at $5 –15 per cubic yard. Costs are higher if dewatered dredge material has to be trucked to a disposal site. Based on these assumptions, approximately 32,000 cubic yards of sediment could be dredged in Lake Eleanor at an approximate cost of $160,000 – $480,000 (see Figure 5 and Table 7, below). This would increase the volume of the lake from 41.33 acre-feet to 61.09 acre-feet. The average depth would increase from 3.8 feet to 5.7 feet.

In addition to the dredging, LCHD proposes a wing dam be built near the inlet as seen in Figure 5. The purpose of this dam would be to direct the river flow into the main body of the lake and thus eliminating sediment and other material from stagnating in the northeastern bay. This wing dam would be approximately 80 feet in length and consist of large rip-rap, ideally protruding one or two feet above normal water levels. Costs for this wing dam would be approximately $4,800 - $8,000, based on $60 - $80 per linear foot.

Figure 5

Table 7

Objective II: Aquatic Plant Management

Lake Eleanor has few aquatic plants, mainly the result of poor water clarity and siltation, which inhibit plant growth. It may be best to initially revegetate with emergent species for this reason. If water clarity improves, submergent plant populations may increase. It is important to manage the plant populations to minimize the amount of nuisance exotic plants and maximize the growth of native plants.

Option 1: Reestablishing Native Aquatic Vegetation

Revegetation should only be done when existing nuisance vegetation, such as Eurasian water milfoil, are under control using hand-pulling or aquatic herbicides. 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 8 in "Objective III: Shoreline Erosion Control" 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 8 for plant pricing. Additional costs will be incurred if a consultant/nursery is contracted for design and labor.

Objective III: 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. In Lake Eleanor, the fluctuating water levels threaten the shoreline, and are the reason several seawalls have begun to fail.

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. Because of the fluctuating water levels that occur in Lake Eleanor, seawalls or riprap are most likely the best choice of shoreline protection.

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. The cost to install a seawall along the moderately eroded areas along Lake Eleanor would be approximately $18,880 – 23,200 for steel and $20,300 – 29,000 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). Due to the gentle shoreline slopes on Lake Eleanor, gabions would not be needed. Because of the fluctuating water levels that occur in Lake Eleanor, seawalls or riprap are most likely the best choice of shoreline protection.

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. To install rip-rap along the moderately eroded areas of Lake Eleanor would cost approximately $8,700 – 13,050. Costs for gabions are approximately $20-30 per linear foot, and approximately $60-100 per linear foot when filled with rocks. 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 resprout and begin establishing a deep root structure that secures the soil. If the shoreline is highly erodible, willow posts may have to be used in conjunction with another erosion control technique such as biologs, A-Jacks ®, or rip-rap.

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or rip-rap. However, in the case of Lake Eleanor, the fluctuating water levels may make this option very difficult to succeed. On the other hand, emergent vegetation in front of shoreline stabilization such as a seawall or riprap could enhance the shoreline by offering further protection along with wildlife benefits. Native emergent vegetation can be either hand planted or allowed to become established on its own over time. Some plants, such as native cattails (*Typha* sp.), quickly spread and help stabilize shorelines, however they can be aggressive and may pose a problem later. Other species, such as those listed in a table 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.

Table 8

Option 5: Install A-Jacks â

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. To install A-Jacks® along the moderately eroded shoreline of Lake Eleanor would cost approximately $11,600 – 21,750, plus permits.

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.

Objective IV: Eliminate or Control Exotic Plant Species

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. 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 species that was introduced as a shoreline stabilizer. It is found on lakeshores, streambanks, marshes and exposed moist ground. Although it does serve to stabilize shorelines to some extent, it has low food value and does not provide winter habitat for wildlife. It is very successful in taking over disturbed areas and, if left unchecked, will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

Presence of exotic species along a lakeshore is by no means a death sentence for the lake or other plant and animal life. If controlled, many exotic species can perform many of the original functions that they were brought here for. For example, reed canary grass was imported for its erosion control properties. It still contributes to this objective (offering better erosion control than commercial turfgrass), but needs to be isolated and kept in control. Many exotics are the result of garden or ornamental plants escaping into the wild. One isolated plant along a shoreline will probably not create a problem by itself. However, problems arise when plants are left to spread, many times to the point where treatment is difficult or cost prohibitive. A monitoring program should be established, problem areas identified, and control measures taken when appropriate. This is particularly important in remote areas of lake shorelines where the spread of exotic species may go unnoticed for some time.

Around the shores of Lake Eleanor, three invasive species were noted scattered in small numbers: purple loosestrife, buckthorn and reed canary grass. Most of the buckthorn can be seen at the spillway. Because these plants are in small numbers, it may be simplest to hand remove the purple loosestrife and reed canary grass. In some areas, the buckthorn can be removed by cutting them down, but in areas such as the spillway, some people may chose to girdle the trunks or even use herbicides.

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: 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 3: Herbicide Treatment

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

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

Pros

Herbicides provide a fast and effective way to control or eliminate nuisance vegetation. Unlike other control methods, herbicides kill the root of the plant, which prevents regrowth. If applied properly, herbicides can be selective. This allows for removal of selected plants within a mix of desirable and undesirable plants.

Cons

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

Costs

Two common herbicides, triclopyr (sold as Garlon™) and glyphosate (sold as Rodeo®, Round-up™, Eagre™, or AquaPro™), cost approximately $100 and $65 per gallon, respectively. Only Rodeo® is approved for water use. A Hydrohatchet®, a hatchet that injects herbicide through the bark, is about $300.00. Another injecting device, E-Z Ject® is $450.00. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40.

Objective V: 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).

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

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

Pros

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

Cons

If environmental conditions change or substantial land use actions occur (i.e., development) wildlife use of the area may change. For example, if a new housing development with manicured lawns and roads is built next to an undeveloped property, there will probably be a change in wildlife present.

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

Costs
The financial cost of this option 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 place at least 10 feet away from the shoreline to prevent any debris from washing into the lake.

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

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

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

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

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

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

Option 3: Increase Natural Food Supply
This can be accomplished in conjunction with Option 2. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Plants found in 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.

<u>Option 4: Increase Nest Availability</u>

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

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

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

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

Pros

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

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

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

Cons

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

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

Costs

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