2003 SUMMARY REPORT
of
FLINT LAKE

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Flint Lake is a private lake encompassing approximately 11.3 acres with a shoreline length of 1.13 miles. It is part of the Flint Creek drainage of the Fox River watershed.

Flint Lake's water quality is one of the poorest of any lake in Lake County. All of the water quality parameters measured were above the averages of other lakes that we have monitored. Flint Lake had an average Secchi disk transparency reading of 0.83 feet, which is well below the county median of 3.41 feet. The lake had high concentrations of total phosphorus (TP), soluble reactive phosphorus (SRP), nitrate nitrogen (NO_3-N), ammonia nitrogen (NH_3-N), and total suspended solids (TSS). The lake also had high concentrations of total dissolved solids (TDS) and high conductivity readings as a result of input from solids washed into the lake from storm events throughout the watershed. All parameters, except TSS, were similar at both the inlet and outlet sample locations, suggesting upstream sources. Low water levels coupled with an abundant carp population in the lake exacerbated the water quality problems in the lake.

Aquatic plants were scarce in Flint Lake, due mostly to the poor water clarity caused by the large carp population in the lake. In addition, the water level in the lake dropped after May, exposing much of the lake bottom. Sago pondweed was the dominant plant in Flint Lake in 2003 comprising 42% of all samples.

Approximately 94% of the shoreline of Flint Lake was classified as developed, with the only undeveloped area being a parcel on the west shoreline. The most common shoreline type was buffer (which is a strip of unmowed vegetation preferably consisting of native plants located at the water's edge), which comprised 58% of the shoreline. Lawn habitat was the next most common at 31%.

Approximately 60% or 2,435 feet or the shoreline of Flint Lake was classified as slightly eroding. Moderate erosion was found along 1,128 feet or 28% of the shoreline. No severe erosion was found around Flint Lake.

Several exotics were found growing along the shoreline, including buckthorn, honeysuckle, purple loosestrife, and reed canary grass. Similar to aquatic exotics, these terrestrial exotics are detrimental to the native plant ecosystems. Removal or control of exotic species is recommended.

An osprey, an endangered species in Illinois, and a sandhill crane, a threatened species in Illinois, were observed around Flint Lake. However, it is unknown if these birds were nesting in the area or if they were using the area seasonally.

LAKE IDENTIFICATION AND LOCATION

Flint Lake (T43N, R9E, Section 15) is a private lake located north of state highway 22 and east of Old Barrington Road in the Village of Lake Barrington (Cuba Township). It is part of the Flint Creek drainage of the Fox River watershed. Flint Lake's immediate watershed is large, consisting of approximately 36.8 square miles, with approximately 27.1 square miles of this in Lake County (Figure 1). The watershed to lake ratio is 2,084:1. There are two major inlets to the lake, the Grassy Lake Drain which enters at the southeastern end of the lake and Flint Creek which enters at the southern end of the lake. The lake also receives water via a small drainage ditch along the western shoreline from a 3.5 acre detention basin located approximately 350 feet to the west of the lake. The outlet is a spillway structure at the north end of the lake. Flint Creek then flows north, eventually flowing into the Fox River.

Flint Lake encompasses approximately 11.3 acres and has a shoreline length of 1.13 miles. The current maximum depth was determined to be 4.8 feet, as measured in May 2003 at the outlet. Since no bathymetric (depth contour) map of Flint Lake is known to exist, the volume of the lake was estimated based on data from lakes with known depths and volumes. Mean depth was obtained by multiplying the maximum depth by 0.5. Volume was obtained by multiplying the mean depth by the lake surface area. Based on these calculations, Flint Lake has an estimated mean depth of 2.4 feet and an estimated volume of 27.1 acre-feet. This is probably an overestimate of volume since the maximum depth was recorded near the spillway, while the majority of the lake is less than two feet deep. Lake elevation is approximately 750 feet above mean sea level.

BRIEF HISTORY OF FLINT LAKE

Flint Lake is a widening of Flint Creek. In was created in 1967 by the excavation of the existing creekbed and the installation of a spillway dam. Figure 2 shows the area in a 1939 aerial photograph. Home construction around the lake increased at the time of lake creation.

Four sewage treatment plants (STP), and one historical STP, are operating or have operated within Flint Lake's watershed. The largest one is the Barrington Wastewater Treatment Plant in Barrington, which discharges its effluent into Flint Creek. Its average flow rate is 3.68 MGD (design maximum flow of 12.0 MGD). TSS loads average 12 pounds per month with a maximum of 24 lbs/day. Ammonia nitrogen loads average 1.2 lbs/month with a maximum of 3 lbs/day, April through October. Small treatment plants in the watershed include the Barrington Hills Country Club STP, the Mount Saint Joseph STP, and the North Barrington Elementary School STP. The Barrington Hills Country Club plant discharges into Flint Creek and has an average flow rate of 0.025 MGD. The Mount Saint Joseph plant discharges into a small tributary that flows into Grassy Lake. This plant has an average flow rate of 0.013 MGD. The North Barrington Elementary School plant discharges into the Grassy Lake Drain and has a flow rate of 0.010 MGD.

Figure 1. Watershed.

Figure 2. 1939 photo.

The one historical plant, the Village of Lake Zurich NW STP, discharged its effluent into the Grassy Lake Drain and had a flow rate of 0.30 MGD and operated from 1954-1990.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Flint Lake is used primarily for the aesthetics of the homeowners around the lake. No motorboats are allowed on the lake, but fishing is allowed. There are currently 17 lake bottom owners. One of the parcels belongs to the Flint Lake Interested Property Owners Association, which manages a park on the west end of the lake. The park is private and for the use of Association members. The lake has no public access.

The composition of land uses within a lake's watershed often influences its water quality. According to the 1994 Flint Creek Watershed Management Plan (Lake County Stormwater Management Commission and the Northeastern Illinois Planning Commission) the major land uses in the Flint Lake watershed were agriculture (42.2%), residential (33.3%), water (5.5%), industrial (2.1%), commercial (2.0%), and "other" (14.9%).

We have conducted water quality studies on several lakes in the Flint Lake watershed, including Grassy Lake (2000), Honey Lake (1998, 2001), Echo Lake (1995, 2000), Lake Zurich (1989, 1991, 1998, 2002), Lake Louise (1988, 1998, 2003), and Columbus Park Lake (2000). Highlights of some of the most recent reports (2000-2003) will be included in the body of this report, with particular attention given to Grassy Lake and Lake Louise, which are immediately upstream of Flint Lake. Additional information on these recent reports can be found on our internet site (www.co.lake.il.us/health/ehs/lakes.htm).

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were collected monthly from May - September at the lake's inlet and outlet (Figure 3). The May inlet sample was taken at a different location than the June – September samples. The May location was chosen because it was centrally located between the two inlets. For the remainder of the season, the water levels in the lake did not permit us from obtaining samples at this location and subsequently the June – September samples were taken at the bridge on Woodland Drive. See Appendix B for water sampling methods.

Flint Lake's water quality is one of the poorest of any lake in Lake County (Table 1 in Appendix A). All of the water quality parameters measured were above the averages or medians (where 50% of the lakes are above and below this value) of other lakes that we have monitored. Several important findings were noted.

Water clarity, as measured by Secchi disk transparency readings, at the outlet sample site averaged 0.83 feet for the season, which is well below the county median of 3.41 feet. The readings were deepest in May and June (0.98 feet) and shallowest in August (0.56

Figure 3. Sample location.

feet). The poor readings were due to the shallow nature of the lake and from the abundant carp population present. The carp activity in the shallow water resuspends sediment from the lake bottom decreasing clarity and exasperating other water quality problems. To track future water quality trends, it is recommended that the lake become enrolled in the Volunteer Lake Monitoring Program (VMLP), which trains a volunteer to measure the Secchi disk readings bimonthly from April to October. For more information see **Objective II: Illinois Volunteer Lake Monitoring Program.**

Total phosphorus (TP) concentrations at both the inlet and outlet of Flint Lake were extremely high. The 2003 average TP concentrations were 0.564 mg/L at the inlet and 0.500 mg/L at the outlet, which is nearly 10 times the county median for oxic samples of 0.059 mg/L. Coupled with the high TP concentrations, Flint Lake had high concentrations of soluble reactive phosphorus (SRP). SRP is usually utilized by aquatic organisms at it becomes available. However, due to the extreme concentrations of phosphorus, aquatic organisms were not able to assimilate all available SRP. For comparison, average epilimnetic (near surface) TP concentrations in lakes upstream were much lower. Lake Zurich, which is near the top of the watershed had an average of 0.028 mg/L (2002) and Honey Lake had an average of 0.038 mg/L (2001). These two lakes are very different from Flint Lake since they are deep glacial lakes with large volumes, good aquatic plant populations, and do not receive STP effluent. Grassy Lake, which is immediately upstream from Flint Lake via the Grassy Lake Drain, had a epilimnetic TP concentration average of 0.195 mg/L (2000). Grassy Lake is more similar to Flint Lake (shallow, with large numbers of carp) and is the recipient of current and historical STP effluent. Lake Louise, which is upstream from Flint Lake via Flint Creek had a average epilimnetic TP concentration of 0.194 mg/L in 2003, which is very similar to concentrations found in Grassy Lake in 2000. Thus, the TP concentrations increase in each body of water downstream. This is not surprising since the downstream lakes receive higher water volumes coming from larger watershed areas. The nutrients in upstream lakes may be compounding in downstream lakes. Another threat to the lake is probably fertilizer (which is often high in phosphorus) applied to the lawns near the lake. It is recommended that homeowners use a no-phosphorus fertilizer on their lawns.

High concentrations of nitrate nitrogen (NO_3-N) and ammonia nitrogen (NH_3-N) were also found in Flint Lake. The average concentrations for NO_3-N were 2.850 mg/L at the inlet and 1.418 mg/L at the outlet. The median concentration for NO_3-N countywide is 0.106 mg/L. NH_3-N, similar to SRP, is usually quickly assimilated by aquatic organisms and in most lakes is found in concentrations below laboratory detection limits. Both Grassy Lake and Lake Louise had only small detectable amounts of both nitrogens in the years they were sampled. Again, the shallow nature of the lake coupled with a large carp population and a large watershed that includes several STP sources are the probable reasons for these high concentrations.

High nutrient concentrations are usually indicative of water quality problems. Algae need light and nutrients, most importantly carbon, nitrogen and phosphorus, to grow. Light and carbon are not normally in short supply (limiting). This means that nitrogen and phosphorus are usually the limiting factors in algal growth. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.) that are more difficult to control than sources of phosphorus. To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. The average ratio between total nitrogen and total phosphorus for Flint Lake in 2003 was 8:1, indicating a nitrogen-limited system. Most lakes in Lake County are phosphorus-limited. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

Flint Lake's average concentrations of total dissolved solids (TDS) and conductivity readings were higher than the county medians. These two parameters are correlated since the higher the concentrations of TDS in the water the higher the conductivity readings. The 2003 averages for TDS were 905 mg/L at the inlet and 861 mg/L at the outlet, which are over twice as high as the county median for oxic samples of 451 mg/L. Similarly, the 2003 average conductivity readings were 1.5818 milliSiemens/cm at the inlet and 1.5188 milliSiemens/cm at the outlet, which are twice as high as the county median for oxic samples of 0.7503 milliSiemens/cm. For comparison, Grassy Lake and Lake Louise had recent TDS concentrations of 588 mg/L and 528 mg/L, respectively, and conductivity readings of 0.9301 milliSiemens/cm and 0.9350 milliSiemens/cm, respectively. The possible cause for these high TDS concentrations and conductivity readings in Flint Lake is input from solids washed into the lake from storm events in the watershed. Streambank erosion from both the Grassy Lake Drain and Flint Creek may also be a source. One of the most common dissolved solids is road salt used in winter road maintenance. Because of the high conductivity readings, one additional parameter, chlorides, was calculated based on a formula created with known chloride and TDS concentrations and conductivity readings. Chloride concentrations help determine if this was the case since most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. The seasonal average for calculated chlorides in Flint Lake in 2003 was 392 mg/L at the inlet and 370 mg/L at the outlet. The 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. It appears that the road salt is compounding in many lakes in the county, including Flint Lake. Some lakes in the county have seen a doubling of conductivity readings in the past 5-10 years. In a study by Environment Canada (equivalent to our USEPA), it was estimated that 5% of aquatic species such as fish, zooplankton and benthic invertebrates would be affected at chloride concentrations of about 210 mg/l. Additionally, shifts in algae populations in lakes were associated with chloride concentrations as low as 12 mg/l.

Another parameter, total suspended solids (TSS) was found in extremely high concentrations in Flint Lake at both sample sites. The 2003 average TSS concentrations were 18.1 mg/L (with a maximum of 42.0 mg/L in May) at the inlet and 45.6 mg/L (with a maximum of 69.6 mg/L in August) at the outlet, which is almost two and a half times and over six times, respectively, the county median for oxic samples of 7.5 mg/L. The extremely high concentrations at the outlet can be attributed, in part, to the shallow nature of the lake and abundant carp population in the lake and their activity of resuspending sediment into the water column. Similarly, at the inlet, the May sample result of 42.0 mg/L, which was taken in the main body of the lake between the two inlets, may also have been the result of carp activity. The inlet samples from June – September were taken at the bridge on Woodland Avenue where carp were not active. However, even these samples had high TSS concentrations, suggesting upstream sources.

Alkalinity concentrations in Flint Lake were also extremely high, with the seasonal averages of the inlet (282 mg/L $CaCO_3$) and outlet (274 mg/L $CaCO_3$) well above the county median for oxic samples (161 mg/L $CaCO_3$). The September concentrations at both sample locations were identical (330 mg/L $CaCO_3$) and mark the highest alkalinity concentrations recorded in a county lake since we have been measuring this parameter. For comparison, Grassy Lake and Lake Louise had recent average epilimnetic concentrations of 205 mg/L $CaCO_3$ and 181 mg/L $CaCO_3$, respectively. The source of the high concentrations in Flint Lake may be coming from sources in Flint Creek such as the Barrington STP, or possibly from groundwater sources.

While the averages of all the parameters measured were above the county medians, there were few differences between the parameters at the inlet and outlet, suggesting that the sources of these nutrients and solids are likely coming from upstream and not solely from internal processes. The exception would be the TSS concentrations, which can be explained by the carp activity in the lake at the two sample locations. Both the May inlet and outlet sample results were different than the June – September samples. The May samples were similar to the epilimnetic averages of Grassy Lake and Lake Louise, as described earlier.

The differences seen between May samples and the June – September samples may be attributed to the drop in water levels, which occurred between May and June. Lower water levels may have concentrated nutrients and solids, causing the increases observed in the data. The maximum one-month change occurred between May and June when the lake level dropped by 7.87 inches. The maximum change over the season (May to August) was a 8.26-inch decrease. Significant changes in water levels may have a negative impact on water quality. In addition, lakes with fluctuating water levels potentially have more shoreline erosion problems.

Due to the shallow nature of the lake, a thermocline was never established. Dissolved oxygen (DO) concentrations in Flint Lake did fluctuate during the season. Generally concern arises when DO concentrations fall below 5 mg/L in the epilimnion. In 2003, the DO concentrations near the surface were below 5 mg/L in June and August at the outlet. All of the DO concentrations at the inlet were above 5 mg/L. The lake never experienced anoxic conditions (where DO concentrations drop below 1 mg/L) during our study. The low DO readings in June and August at the outlet may be the result of shallow nature of the lake and the presence of large amounts of duckweed found near the outlet, which may have caused a high degree of oxygen demand in the evening hours.

Rain events probably contribute additional sediment or nutrients (like phosphorus) to a lake, which may have influenced the water sample results. Rain occurred within 48 hours prior to water sampling in May (0.63 inches) and September (0.42 inches) as recorded at the Lake County Stormwater Management Commission rain gage in Wauconda. Not surprisingly, May and September were the months when the water level was the highest and were the only months during the sampling season when the entire lake was navigatable with a canoe.

Based on data collected in 2003, standard classification indices compiled by the Illinois Environmental Protection Agency (IEPA) were used to determine the current condition of Flint 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 can be calculated using TP values obtained at or near the surface. The TSIp for Flint Lake in 2003, based on the average TP at the outlet, classified it as a hypereutrophic lake (TSIp = 93.8). Eutrophic lakes are the most common types of lakes throughout the lower Midwest, and they are particularly common among manmade lakes. See Table 2 in Appendix A for a ranking of average TSIp values for Lake County lakes (Flint Lake is currently #128 of 130; Grassy Lake is #119, Lake Louise is #118). 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, it would be difficult for a small shallow manmade lake with high nutrient loads to achieve a high ranking even with intensive management.

Due to the extremely poor water quality in Flint Lake, all of the IEPA indices (the aquatic life impairment index, the swimming index, the recreation use index, and thus the overall use index) indicated a level of nonsupport. Flint Lake in one of the few lakes in the county in which all indices were at the level of nonsupport.

The options available for improving the water quality of Flint Lake are minimal. Removal of carp and deepening the lake by dredging would be the two most effective means to improve the water quality. However, removal of carp would require using a fish poison to kill all the fish in the lake and it is likely that carp would quickly recolonize the lake due to their presence upstream (i.e., Flint Creek, Grassy Lake). Dredging is generally cost prohibitive due to the expense of removing the sediment and identifying a disposal site. Costs can be as high as $15/yd^3$. Deepening Flint Lake by one foot would require the removal of almost 44,000 yd^3, at a cost of $660,000. In addition, the dredging may be short-lived due to the sediment inputs coming into the lake from the Grassy Lake Drain and Flint Creek. Another option would be to remove the spillway and allow Flint Lake to revert back to being part of Flint Creek. This would likely cause much of the current lake bottom to become recolonize by terrestrial or semi-aquatic emergent plants.

In addition to the in-lake issues that would need to be addressed, the source of the high nutrient concentrations coming from upstream sources could render any in-lake management futile. Based on the water quality data from Grassy Lake in 2000 and Lake Louise in 2003, the upstream sources of nutrients appears to be coming from the area of

Flint Creek between Lake Louise and Flint Lake. This area is highly developed and includes many land uses. As mentioned previously, streambank erosion may be a source of these solids and nutrients. The area also includes the Barrington STP, which as mentioned earlier discharges its effluent into Flint Creek and has an average flow rate is 3.68 MGD (design maximum flow of 12.0 MGD).

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Flint Lake were assessed monthly from May through September 2003 (see Appendix B for methods). Due to the low water levels in the lake, no plant sampling was conducted in August, and sampling was restricted to the northern portion of the lake in June and July. Eight aquatic plant species and several emergent shoreline plants were found (see Table 3, below). Terrestrial shoreline plants were also noted, but not quantified.

Aquatic plants were scarce in Flint Lake, due mostly to the poor water clarity caused by the large carp population in the lake. In addition, the water level in the lake dropped after May, exposing of much of the lake bottom. Sago pondweed was the dominant plant in Flint Lake in 2003 comprising 42% of all samples. Duckweed (a free floating plant) was the next most common, being found in 19% of all samples. Coontail and yellow pond lily were both found in 12% of the samples. The presence of yellow pond lily is noteworthy since this lily is uncommon in Lake County.

Three exotic aquatic plant species were found in Flint Lake. Curlyleaf pondweed was found in one sample in both June and September. This plant can be problematic in some lakes in the county, but at the present time is not a concern in Flint Lake. The two other exotics, wild lettuce and water hyacinth, were found in September. Someone most likely released these plants into the lake in August or early September since they were not seen prior to this time. Both of these plants are not commonly found in this area, but are common plants in the aquatic garden trade. People sometimes release the plants into natural areas after they outgrow their aquatic garden containers, not knowing the damage they can cause. These plants can cause major problems in natural areas in southern states like Florida. However, since both plants have southern origins, they are not expected to survive the winter here. The release of any exotic plant is strongly discouraged.

The 1% light levels (the point where plant photosynthesis ceases) were found to the bottom of the lake in June, July, and September. In May, the 1% light level penetrated down to 2.5 feet and in August was found at 1.5 feet. In most lakes this parameter is an important factor in aquatic plant growth and distribution, however, in Flint Lake the shallow nature of the lake makes this parameter insignificant.

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). This is done for every floating and submersed plant species 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 2003, Flint Lake had a FQI of 11.8. The median FQI of lakes that we have studied from 2000-2003 is 14.0. For comparison, Grassy Lake and Lake Louise had FQIs of 5.8 and 7.5, respectively, in the years they were studied.

Table 3. Aquatic and shoreline plants on Flint Lake, May - September 2003.

Aquatic Plants	
Coontail	*Ceratophyllum demersum*
Water Hyacinth[#]	*Eichhornia crassipes*
Small Duckweed	*Lemna minor*
Yellow Pond Lily	*Nuphar advena*
Wild Lettuce[#]	*Pistia stratiotes*
Curlyleaf Pondweed[#]	*Potamogeton crispus*
American Pondweed	*Potamogeton nodosus*
Sago Pondweed	*Stuckenia pectinatus*
Shoreline Plants	
Box Elder	*Acer negundo*
Silver maple	*Acer saccharinum*
Giant Ragweed	*Ambrosia trifida*
Swamp Milkweed	*Asclepias incarnata*
Common Milkweed	*Asclepias syriaca*
Aster	*Aster* sp.
New England Aster	*Aster novae-angliae*
Beggar Ticks	*Bidens* sp.
Canada Thistle[#]	*Cirsium arvense*
Dogwood	*Cornus* sp.
Queen Anne's Lace[#]	*Daucus carota*
Spikerush	*Eleocharis* sp.
Blue Flag Iris	*Iris hexagona*
Black Walnut	*Juglans nigra*
Honeysuckle[#]	*Lonicera* sp.
Purple Loosestrife[#]	*Lythrum salicaria*
Reed Canary Grass[#]	*Phalaris arundinacea*
Smartweed	*Polygonum* sp.
Pin Oak	*Quercus palustris*
Buckthorn[#]	*Rhamnus cathartica*
Curled Dock[#]	*Rumex crispus*
Common Arrowhead	*Sagittaria latifolia*

Table 3. Aquatic and shoreline plants on Flint Lake, May - September 2003 (cont'd).

Willow	*Salix* sp.
Weeping Willow	*Salix alba tristis*
Bittersweet Nightshade#	*Solanum dulcamara*
Goldenrod	*Solidago* sp.
Cattail	*Typha* sp.
Stinging Nettle#	*Urtica dioica*
Blue Vervain	*Verbena hastata*
Wild Grape	*Vitis* sp.

 # Exotic species

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted in July 2003 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.

Approximately 94% of the shoreline of Flint Lake was classified as developed, with the only undeveloped area being a parcel on the west shoreline. The most common shoreline type was buffer (which is a strip of unmowed vegetation preferably consisting of native plants located at the water's edge), which comprised 58% of the shoreline (Figure 4). Lawn habitat was the next most common at 31%. Riprap and shrub habitat made up the remaining shoreline. While the buffer strips were the dominant shoreline type, the quality of the buffers were poor since most of them were narrow in width and consisted most of exotic species, particularly reed canary grass. The buffers should be expanded and exotic species removed and replaced with native plants, since the buffers are beneficial for the water quality of the lake by filtering nutrients and pollutants before they enter the lake and by creating habitat for fish and wildlife.

The shoreline was also assessed for the degrees and types of shoreline erosion. Approximately 60% or 2,435 feet of the shoreline of Flint Lake was classified as slightly eroding (Figure 5). Moderate erosion was found along 1,128 feet or 28% of the shoreline. No severe erosion was found around Flint Lake. The moderately eroded areas should be remediated immediately to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. More information can be found in **Objective IV: Shoreline Erosion Control**. When possible, the shorelines should be repair by using native plantings. Riprap and seawalls are considered less preferable.

Figure 4. Shoreline types.

Figure 5. Erosion.

Several exotics were found growing along the shoreline, including buckthorn, honeysuckle, purple loosestrife, and reed canary grass. Similar to aquatic exotics, these terrestrial exotics are detrimental to the native plant ecosystems around the lake. Removal or control of exotic species is recommended. More information can be found in **Objective V: Eliminate or Control Exotic Species**.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Good numbers of wildlife, particularly birds, were noted on and around Flint 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. Habitat around Flint Lake was only fair due to the residential areas around the lake. Additional habitat may be created around the lake, such as erecting birdhouses. More information can be found in **Objective VI: Enhance Wildlife Habitat Conditions**.

We did not conduct any fish surveys of Flint Lake in 2003. However, numerous carp were seen throughout the season. As mentioned previously, the carp reduce the water quality of the lake significantly by stirring up the lake bottom sediment. This is also detrimental to fish and wildlife habitat in the lake. Elimination of carp from Flint Lake would be difficult since they inhabit areas throughout Flint Creek and the Grassy Lake Drain.

In May, an osprey was seen flying over Flint Creek. Its presence is noteworthy since this bird is listed as an endangered species in Illinois. Since it was only seen once, it was assumed not to be nesting in the area. However, its presence on Flint Lake likely is the result of the lake's proximity to the Fox River, which is approximately 1.2 miles away. During the season we also observed a sandhill crane using the area. This crane is listed as a threatened species in Illinois. It is unknown if this bird was nesting in the area or if it was using the area seasonally.

Table 5. Wildlife species observed on Flint Lake, April – September 2003.

<u>*Birds*</u>	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Sandhill Crane+	*Grus canadensis*
Killdeer	*Charadrius vociferus*
Unknown Sandpiper	*Calidris* sp.
Osprey*	*Pandion haliaetus*
Turkey Vulture	*Cathartes aura*
Mourning Dove	*Zenaida macroura*
Common Flicker	*Colaptes auratus*
Downy Woodpecker	*Picoides pubescens*
Eastern Kingbird	*Tyrannus tyrannus*
Purple Martin	*Progne subis*
Tree Swallow	*Iridoprocne bicolor*
Rough-wing Swallow	*Stelgidopteryx ruficollis*
Chimney Swift	*Chaetura pelagica*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Red-winged Blackbird	*Agelaius phoeniceus*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Indigo Bunting	*Passerina cyanea*
White-throated Sparrow	*Zonotrichia albicollis*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*

Table 5. Wildlife species observed on Flint Lake, April – September 2003 (cont'd).

Mammals	
None noted.	
Amphibians	
Leopard Frog	*Rana pipiens*
Reptiles	
None noted.	
Fish	
Common Carp	*Cyprinus carpio*
Mussels	
Giant Floater	*Pyganodon grandis*

*** Endangered in Illinois**
+Threatened in Illinois

EXISTING LAKE QUALITY PROBLEMS

- *Poor Water Clarity*

  Flint Lake had an average Secchi disk transparency reading of 0.83 feet, which is well below the county median of 3.41 feet, and the poorest reading of any lake in the watershed. Poor clarity was attributed to the low water levels seen throughout the season, the extensive carp activity, and the nutrient and sediment inputs from the Grassy Lake Drain and Flint Creek. Flint Lake has a very large watershed (36.8 square miles) with four active STPs, which contribute to the lake's problems.

- *High Nutrient Concentrations*

  The lake had high concentrations of total phosphorus (TP), soluble reactive phosphorus (SRP) as well as nitrate nitrogen (NO_3-N), and ammonia nitrogen (NH_3-N). High nutrients, particularly TP and SRP, contribute to the algae blooms and poor water clarity. The concentrations were similar at both sample locations suggesting upstream sources for the nutrients.

- *High Concentrations of Total Suspended Solids (TSS)*

  Flint Lake had high TSS concentrations at both the inlet and outlet. The concentrations at the inlet and outlet were almost two and one-half times and over six times higher than the county median, respectively. The high concentrations at the outlet were mostly due to the carp activity in the shallow water which resuspended sediment into the water column. Streambank erosion from both the Grassy Lake Drain and Flint Creek may also be a source.

- *High Conductivity Readings and Concentrations of Total Dissolved Solids (TDS)*

  The average concentrations of TDS and conductivity readings were higher than the county medians. The 2003 averages for TDS were 905 mg/L at the inlet and 861 mg/L at the outlet, which are over twice as high as the county median for oxic samples of 451 mg/L. Similarly, the 2003 average conductivity readings were 1.5818 milliSiemens/cm at the inlet and 1.5188 milliSiemens/cm at the outlet, which are twice as high as the county median for oxic samples of 0.7503 milliSiemens/cm. A possible cause for these high TDS concentrations and conductivity readings is input from solids washed into the lake from upstream sources. One of the most common dissolved solids is road salt used in winter road maintenance, however, this alone could not account for the high TDS concentrations and conductivity readings. Streambank erosion from both the Grassy Lake Drain and Flint Creek may also be a source.

- *Limited Aquatic Vegetation*

  Aquatic plants were scarce in Flint Lake, due mostly to the poor water clarity caused by the large carp population in the lake. In addition the water level in the lake dropped after May, exposing of much of the lake bottom. Sago pondweed was the dominant plant in Flint Lake in 2003 comprising 42% of all samples. Duckweed (a free floating plant) was the next most common, being found in 19% of all samples. Stabilization of water levels, reduction or elimination of carp, and reduction of nutrient and sediment inputs to the lake will help expand the plant populations.

- *Shoreline Erosion*

  Fluctuating water levels on Flint Lake has caused some shoreline erosion. Approximately 60% or 2,435 feet or the shoreline of Flint Lake was classified as slightly eroding. Moderate erosion was found along 1,128 feet or 28% of the shoreline. No severe erosion was found around Flint Lake, however, the moderately eroded areas should be remediated immediately to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs.

- *Invasive Shoreline Plant Species*

  Numerous exotic plant species (i.e., purple loosestrife, buckthorn, and reed canary grass) were found on the shores of Flint Lake. Reed canary grass is particularly problematic as it outcompetes native plants and offers little value in terms of shoreline stabilization or wildlife habitat. Plants should be removed and replaced with native shoreline plants.

POTENTIAL OBJECTIVES FOR THE FLINT LAKE MANAGEMENT PLAN

I. Create a Bathymetric Map Including a Morphometric Table
II. Illinois Volunteer Lake Monitoring Program
III. Controlling Excessive Number of Carp
IV. Shoreline Erosion Control
V. Eliminate or Control Exotic Plant Species
VI. Enhance Wildlife Habitat Conditions

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Create a Bathymetric Map Including a Morphometric Table

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

Objective II: Participate in the Volunteer Lake Monitoring Program

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

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

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

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

VLMP Regional Coordinator:
Holly Hudson
Northeast Illinois Planning Commission
222 S. Riverside Plaza, Suite 1800
Chicago, IL 60606
(312) 454-0400

Objective III: Controlling Excessive Number of Carp

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

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

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

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

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

Pros

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

Cons

There are many negative aspects to a no action management plan for carp management. The feeding habits of carp cause most of the associated problems.

As carp feed they root around in the lake sediment. This causes resuspension of sediment and nutrients. Increased nutrient levels can lead to increased algal blooms, which, combined with resuspended sediment, lead to increased turbidity (reduced clarity). As a result there is a decrease in light penetration, negatively impacting aquatic plants. Additionally, the rooting action of the carp causes the direct disruption of aquatic plants. Loss of aquatic plants can further aggravate sediment and nutrient loads in the water column due to loss of sediment stabilization provided by the plants. Additionally, the fishery of the lake may decline and/or become stunted due to predation issues related to decreased water clarity and loss of habitat. Other wildlife, such as waterfowl, which commonly forage on aquatic plants and fish, would also be negatively impacted by the decrease in vegetation.

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

Costs

There is no cost associated with the no action option.

Option 2: Rotenone

Rotenone is a piscicide that is naturally derived from the stems and roots of several tropical plants. Rotenone is approved for use as a piscicide by the USEPA and has been used in the U.S. since the 1930's. It is biodegradable (breaks down into CO_2 and H_2O) and there is no bioaccumulation. Because rotenone kills fish by chemically inhibiting the use of oxygen in biochemical pathways, adult fish are much more susceptible than fish eggs (carp eggs are 50 times more resistant). Other aquatic organisms are less sensitive to rotenone. However, some organisms are effected enough to reduce populations for several months. In the aquatic environment, fish come into contact with the rotenone by a different method than other organisms. With fish, the rotenone comes into direct contact with the exposed respiratory surfaces (gills), which is the route of entry. In other organisms this type of contact is minimal. More sensitive nonfish species include frogs and mollusks but these organisms typically recover to pretreatment levels within a few months. Rotenone has low mammalian and avian toxicity. For example, if a human consumed fish treated with normal concentrations of rotenone, approximately 8,816 lbs. of fish would need to be eaten at one sitting in order to produce toxic effects. Furthermore, due to its unstable nature, it is unlikely that the rotenone would still be active at the time of consumption. Additionally, warm-blooded mammals have natural enzymes that would break down the toxin before it had any effects.

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

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

Pros

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

Cons

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

<u>Costs</u>

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

(Lake volume in Acre Feet)(2.022 gallons) = Gallons needed to treat lake

(Gallons needed)(Cost/gallon*) = Total cost

*Cost/gallon = $50-75 range

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

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.

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 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 $85-100 per linear foot for steel and $95-110 per linear foot 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 $1,500-2,000 for installation of a seawall. Contact the Army Corps of Engineers, local municipality, or the Lake County Planning and Development Department.

Around Flint Lake, the costs to install a seawall along the moderately eroded shoreline (1,128 feet) would cost approximately $95,880 – 112,800 for steel and $107,160 – 124,080 for vinyl, excluding permits.

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 $35-50 per linear foot. Costs for gabions are approximately $70-100 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 $1,500-2,000 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.

Around Flint Lake, the costs to install riprap along the moderately eroded shoreline (1,128 feet) would cost approximately $39,480 – 56,400, excluding permits.

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. 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 $15 per linear foot, plus labor. Cost of installing willow posts is approximately $20-25 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 $1,500-2,000 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 $50-75 per linear foot, but does not include permits and surveys, which can cost $1,500-2,000 and must be obtained prior to any work implementation. Additional costs will be incurred if compensatory storage is needed.

To repair the moderately eroding areas (1,128 feet) on Flint Lake with A-Jacks® would cost approximately $56,400 – 84,600.

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.

This is the preferred option to repair the eroded area around Flint Lake. Since the slope grade is relatively flat, this technique may be effective at controlling future erosion as well as providing needed habitat.

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 biodegradable 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 $40 to $45 per linear foot of shoreline, including plantings. This does not include the necessary permits and surveys, which may cost $1,500 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.

To repair the moderately eroding areas (1,128 feet) on Flint Lake with this option would cost approximately $45,120 – 50,760.

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, its roots exude a chemical that discourages other plant growth, and it is quick to become established on disturbed soils. Reed canary grass is an aggressive plant species that was introduced as a shoreline stabilizer. It is found on lakeshores, stream banks, marshes and exposed moist ground. Although it does serve to stabilize shorelines to some extent, it has low food value and does not provide winter habitat for wildlife. It is very successful in taking over disturbed areas and, if left unchecked, will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of 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*).

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

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

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

Pros

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

Costs

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

Option 2: Biological Control

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

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

Pros

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

Cons

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

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

Costs

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

Option 3: Control by Hand

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

Pros
Removal of exotics by hand eliminates the need for chemical treatments. Costs are low if stands of plants are not too large already. Once removed, control is simple with yearly maintenance. Control or elimination of exotics preserves the ecosystem's biodiversity. This will have positive impacts on plant and wildlife presence as well as some recreational activities.

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

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

Option 4: Herbicide Treatment

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

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

Proper use of these products is critical to their success. Always read and follow label directions.

Pros

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

Cons

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

Costs

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

Objective VI: 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 affects the overall health and biodiversity of the lake's ecosystems.

Option 2: Increase Habitat Cover
This option can be incorporated with Option 3 (see below). One of the best ways to increase habitat cover is to leave a minimum 25-foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see 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.

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 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.