2003 SUMMARY REPORT
of
INTERNATIONAL MINING AND CHEMICAL COMPANY (IMC) LAKE

Lake County, Illinois

Prepared by the

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

International Mining and Chemical (IMC) Lake is part of the Bull Creek drainage of the Des Plaines River watershed. The lake receives water from the surrounding landscape, mainly stormwater runoff from roads and parking lots. IMC Lake encompasses approximately 6.7 acres and has a shoreline length of 0.4 miles. We determined the current maximum depth to be 10.2 feet, measured in July 2003.

Water clarity, as measured by Secchi disk transparency readings, averaged 4.96 feet for the season, which is slightly above the county median (where 50% of the lakes are above and below this value) of 3.41 feet. Secchi readings were lowest in May (2.33 feet) and highest in September (8.50 feet). Total phosphorus (TP) concentrations in IMC Lake were below the county average (0.059 mg/L). The 2003 average TP concentration was 0.039 mg/L in the epilimnion, which is good considering the amount of stormwater the lake receives. The low TP concentrations are due, in part, to the extensive aquatic plant populations in the lake that stabilize bottom sediments and utilize available nutrients.

Alkalinity concentrations in IMC Lake were well below county medians and were the lowest concentrations that we have recorded in Lake County. In the epilimnion, the average alkalinity concentration was 83 mg/L $CaCO_3$, compared to the county median of 161 mg/L $CaCO_3$. In the hypolimnion the average was 94 mg/L $CaCO_3$, compared to the county median of 193 mg/L $CaCO_3$.

IMC Lake had high conductivity readings and concentrations of total dissolved solids (TDS). The 2003 average conductivity reading in the epilimnion was 1.9960 milliSiemens/cm, which is almost three times higher than the county median of 0.7503 milliSiemens/cm. The 2003 epilimnetic average for TDS was 1072 mg/L, compared to the county median of 451 mg/L. The May samples for TDS (1340 mg/L) and conductivity (2.6120 milliSiemens/cm) were the highest lake values recorded in the county since we began measuring these parameters. An additional parameter, chlorides, was found in high concentrations in the lake. Average concentrations exceeded standards set by the Illinois Environmental Protection Agency, and thus are negatively impacting the aquatic life in the lake. Road salt used for winter road maintenance is the likely source of these high values.

Eight aquatic plant species and several emergent shoreline plants were found. Coontail was the dominant plant in the lake in 2003. It was found in 71% of all the samples during the season. Eurasian water milfoil, an exotic, was also present, comprising 48% of all samples. One species, brittle naiad, was found in IMC Lake which marks the first time we have found this species in Lake County.

The shoreline was assessed for the degrees and types of shoreline erosion. Along the shoreline of IMC Lake only a limited amount of erosion was noted. Approximately 800 feet along the northern shoreline was classified as slightly eroding. During the shoreline assessment several exotic terrestrial plant species were noted. The removal of these plants is recommended.

LAKE IDENTIFICATION AND LOCATION

International Mining and Chemical (IMC) Lake (T44N, R11E, Section 18) is located east of State Highway 45 and south of Winchester Road in the Village of Libertyville (Libertyville Township). It is part of the Bull Creek drainage of the Des Plaines River watershed. IMC Lake's watershed is approximately 84.3 acres, and has a watershed to lake ratio of 13:1 (Figure 1). The lake receives water from the surrounding landscape, mainly stormwater runoff from numerous parking lots. IMC Lake has six 12" diameter pipes draining into the lake at various locations and one 12" outlet pipe on the northeastern section of the lake shoreline.

IMC Lake encompasses approximately 6.7 acres and has a shoreline length of 0.4 miles. We determined the current maximum depth to be 10.2 feet, measured in July 2003. Since no bathymetric (depth contour) map of IMC 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, IMC Lake has an estimated mean depth of 5.1 feet and an estimated volume of 34.2 acre-feet. Lake elevation is approximately 745 feet above sea level.

BRIEF HISTORY OF IMC LAKE

Based on a 1939 aerial photograph, IMC Lake was historically a wetland area that was later dredged into a small lake. A 1993 aerial photograph shows the lake near its present shape. A 1997 photograph shows the lake shoreline in its present form, although with no development around the lake. Development began around the lake in approximately 1998, with office buildings and parking lots being constructed along the western and southern ends of the lake. A walking path was constructed around the lake for the aesthetic enjoyment of the employees of the businesses in the area.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

IMC Lake is a private lake used for water detention and aesthetic enjoyment. No swimming, fishing, or boating are allowed on the lake. The lake is informally managed by the Libertyville Business Park Association, although no activities have been conducted in recent years.

The composition of land uses within a lake's watershed often influences its water quality. The major land use in the IMC Lake watershed (based on 2000 land use maps) is industrial (39.9%), followed by office (24.8%), forest and grassland (17.8%; Figure 3). The remaining land use types were water (7.8%), transportation (6.2%), and public and private open space (3.5%).

Figure 1. Watershed.

Figure 2. 1939 photo.

Figure 3. Land use.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were collected monthly from May - September at the deep-hole location near the center of the lake (Figure 4). See Appendix B for water sampling methods.

IMC Lake's water quality is similar to many lakes in Lake County (Table 1 in Appendix A). Most of the water quality parameters measured were near the averages of other lakes that we have monitored. Several important findings were noted.

Water clarity, as measured by Secchi disk transparency readings, averaged 4.96 feet for the season, which is slightly above the county median (where 50% of the lakes are above and below this value) of 3.41 feet. Secchi readings were lowest in May (2.33 feet) and highest in September (8.50 feet). Negatively, correlated with the clarity readings were the concentrations of total suspended solids (TSS), which were also highest in May (8.1 mg/L) and lowest in September (1.8 mg/L; see Figure 5). Solids suspended in the water reduce the depth at which the Secchi disk can be seen. These suspended solids, such as sediment or other minerals, were actually a larger source of the poor water clarity since >88% of the seasonal epilimnetic average for TSS consisted of non-volatile suspended solids (NVSS). Increases in suspended sediment or minerals in the water are likely the result of stormwater runoff from the adjacent landscape. We also noted large amounts of debris that washed into the lake from the two inlet pipes on the northwest corner of the lake. A 1.36-inch rainfall event occurred 48 hours prior to the May sampling date, which may explain why the May Secchi reading was low and the TSS concentrations high. The abundant aquatic plant populations in the lake also help to maintain lower TSS concentrations by stabilizing the lake bottom sediment and by utilizing some of the available nutrients in the water. 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 from April to October. For more information see **Objective II: Illinois Volunteer Lake Monitoring Program.**

The lake was only weakly stratified during the sampling season. A thermocline was established in June at seven feet and also in July at approximately five feet, but had dissipated by the August sampling date. The lake probably exhibits polymictic tendencies, meaning stratification and turnover occur repeatedly over the year. This may be the result of climatic factors (i.e., wind and wave action, temperature) and the shallow nature of the lake. Lakes that do not stratify or stratify only weakly may have fewer problems with low dissolved oxygen (DO) problems or the build up and release of excessive nutrients.

Dissolved oxygen (DO) concentrations in IMC Lake did not indicate any significant problems. Generally concern arises when DO concentrations fall below 5 mg/L in the epilimnion. In 2003, all DO concentrations near the surface were above 5 mg/L. Anoxic conditions (where DO concentrations drop below 1 mg/L) did exist below eight feet in July, August, and September. Since no bathymetric map of IMC Lake exists, an accurate

Figure 4. Sample location.

Figure 5. TSS and Secchi

assessment of the DO conditions cannot be made. However, due to the abundant aquatic plant populations in the lake (see **Aquatic Plant Assessment** section) and the potential for large amounts of stormwater containing nutrients and pollutants, which may increase the oxygen demand in the lake, fluctuations in the DO concentrations may be occurring.

The 2003 average total phosphorus (TP) concentration in IMC Lake was 0.039 mg/L in the epilimnion, which is below the county median for oxic samples (0.059 mg/L). Algae, both filamentous and planktonic, were seen during the sampling season. TP concentrations in the epilimnion fluctuated during the season (range: 0.032 – 0.051 mg/L), but were the highest in May, most likely due to the rainfall event prior to sampling. Despite the highly urbanized watershed, IMC Lake had relatively low TP concentrations when compared to other lakes in similar watersheds. These low concentrations are likely due to the large aquatic plant populations in the lake, which utilize much of the available phosphorus. This available phosphorus, known as soluble reactive phosphorus (SRP), was found in low concentrations in the lake and frequently in concentrations below laboratory detection limits.

Alkalinity concentrations in IMC Lake were well below county medians and were the lowest concentrations that we have recorded in Lake County since we have been recording this parameter. In the epilimnion, the average alkalinity concentration was 83 mg/L $CaCO_3$, compared to the county median of 161 mg/L $CaCO_3$. In the hypolimnion the average was 94 mg/L $CaCO_3$, compared to the county median of 193 mg/L $CaCO_3$. Most lakes in northern Illinois are classified as having "hard" water (121 - 180 mg/L $CaCO_3$), however IMC Lake is classified as having only "moderately hard" water (61 – 120 mg/L $CaCO_3$). This "softer" water has minimal impacts on aquatic life although may influence plant diversity and distribution. The reason for the low alkalinities may be the large amount of sodium (from road salt) entering the lake which causes ion exchange and thus reduces the $CaCO_3$ concentrations in the lake.

IMC Lake had high conductivity readings and concentrations of total dissolved solids (TDS). Conductivity readings and TDS are correlated since the higher the concentrations of TDS in the water the higher the conductivity readings. The 2003 average conductivity reading in the epilimnion was 1.9960 milliSiemens/cm, which is significantly higher than the county median of 0.7503 milliSiemens/cm. The 2003 epilimnetic average for TDS was 1072 mg/L, which is also significantly higher than the county median of 451 mg/L. The May samples for TDS (1340 mg/L) and conductivity (2.6120 milliSiemens/cm) were the highest lake values recorded in the county since we began measuring these parameters. Because of the high conductivity readings, one additional parameter, chloride, was measured since the suspected source of the high readings was road salt. 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 chlorides was 545 mg/L in the epilimnion and 572 mg/L in the hypolimnion. The Illinois Environmental Protection Agency (IEPA) standard for chloride is 500 mg/L. Once values exceed this standard the water body is deemed to be impaired, thus impacting aquatic life. 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. Thus, the high chloride concentrations in IMC Lake are negatively impacting the aquatic life in the lake. These concentrations are not entirely surprising considering that over 70% of the IMC Lake watershed consists of impervious surfaces (i.e., roads, parking lots, buildings). Also, large piles of road salt were seen in April 2003 in the corners of the parking lots south of the lake. Thus, any stormwater runoff from these parking lots immediately enters the lake. The use of road salt should be curtailed, or alternatives assessed, to minimize the impacts to the lake. However, despite the chloride impairment in the lake we noticed several species of fish and wildlife, including birds, fish, reptiles, and amphibians (see **Wildlife Assessment** section) using the lake. We do not, however, know what the impacts of the chloride concentrations are to these species or to the zooplankton and benthic invertebrates in the lake.

High nutrient concentrations are usually indicative of water quality problems. Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that two nutrients (N&P) 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 IMC Lake in 2003 was 19:1, indicating a phosphorus-limited system. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

Water levels on IMC Lake fluctuated throughout the season. The maximum change in water level occurred from July to August (8.50 inch decrease), with a maximum seasonal change of 11.63 inches during the study. 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. Water levels on IMC Lake may be more susceptible to large fluctuations due to the large amount of stormwater it receives.

Rain runoff 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 (1.36 inches), June (0.07 inches), July (0.54 inches), and August (0.26 inches) as recorded at the Lake County Stormwater Management Commission rain gage in Diamond Lake. The May rainfall may have the greatest influence on the water quality results, since this is when the poorest Secchi reading and highest seasonal concentrations of nitrate nitrogen, TP, TDS, TSS, total solids, total volatile solids, chlorides, as well as conductivity readings were recorded. The large amounts of stormwater prior to the May 6th sampling date likely contained water rich in nutrients, salts, pollutants, and solids that washed in after snowmelt and spring rains from the surrounding landscape, which is mostly roads, commercial buildings, and parking lots.

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 IMC 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 total phosphorus values obtained at or near the surface. The TSIp for IMC Lake in 2003 classified it as a eutrophic lake (TSIp = 56.9). 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 (IMC Lake is currently #43 of 130). This ranking is only a relative assessment of the lakes in the county. The current rank of a lake is dependent upon many factors including lake origin, water source, nutrient loads, and morphometric features (volume, depth, substrate, etc.). Thus, a small shallow manmade lake with high nutrient loads could not expect to achieve a high ranking even with intensive management.

In IMC Lake, the IEPA aquatic life impairment index was low, indicating a full degree of support for all aquatic organisms in the lake. Similarly, the swimming index indicated a degree of full support. However, due to high trophic status of the lake, the recreation use index showed a partial impairment. The degree of overall use of the lake was classified as full support.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in IMC Lake were assessed monthly from May through September 2003 (see Appendix B for methods). Eight aquatic plant species and several emergent shoreline plants were found (see Table 3, below). Terrestrial shoreline plants were also noted, but not quantified.

Coontail was the dominant plant in the lake in 2003. It was found in 71% of all the samples during the season. Eurasian water milfoil (EWM), an exotic, was also present comprising 48% of all samples. Sago pondweed and Chara, a macro-algae, were the next most common species, being found in 38% and 31% of all samples, respectively. Another exotic, curlyleaf pondweed, was also found in IMC Lake in 29% of the plant samples.

One species, brittle naiad, was found in IMC Lake which marks the first time we have found this species in Lake County. It is a species that grows in “softer” water conditions, such as those found in southern Illinois. As mentioned in the **Water Quality** section, the alkalinity concentrations in IMC Lake were very low which classified its water as “moderate hard”, which may have been “soft” enough to allow this species to grow.

During the plant sampling, we searched for the milfoil weevil (*Euhrychiopsis lecontei*) on EWM plants. This weevil attacks the tip and stem of the plant and is currently being used as a biological control for EWM in many lakes in the Midwest. The weevils are found naturally in many lakes. Unfortunately, no weevils were found in IMC Lake in 2003.

The 1% light levels (the point where plant photosynthesis ceases) reached the lake bottom in May, June, and September. In July and August, the water clarity was poor and the 1% light levels only reached to six feet. This had minimal impact to aquatic plant populations since most of the lake is less than six feet deep. The potential aquatic plant coverage along the lake bottom is 100%, however, most of the plants did not reach the surface of the lake.

Based on the 2003 data, there is probably no need to implement any aquatic plant management activities at this time. However, due to the nature and purpose of the lake (water detention and aesthetics) there may be a need to develop an aquatic plant management plan. If excessive plant growth at the surface increases, one of the options found in **Objective III: Aquatic Plant Management** may be assessed. Aquatic plants are beneficial since they stabilize lake bottom sediments and utilize nutrients that may otherwise be used by algae. A balanced aquatic plant management plan would address the desires of the management entity of the lake, while managing for the lake's overall ecological health.

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, IMC Lake had a FQI of 9.4. The median FQI of lakes that we have studied from 2000-2003 is 14.0.

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

Aquatic Plants	
Chara	*Chara* sp.
Coontail	*Ceratophyllum demersum*
Eurasian Water Milfoil#	*Myriophyllum spicatum*
Slender Naiad	*Najas flexilis*
Brittle Naiad	*Najas minor*
Curlyleaf Pondweed#	*Potamogeton crispus*
Small Pondweed	*Potamogeton pusillus*
Sago Pondweed	*Stuckenia pectinatus*
Shoreline Plants	
Alder	*Alder* sp.
Aster	*Aster* spp.
Canada Thistle#	*Cirsium arvense*
Queen Anne's Lace#	*Daucus carota*
Purple Coneflower	*Echinacea purpurea*
Slender Spikerush	*Eleocharis acicularis*
Honeysuckle#	*Lonicera* sp.
Birdsfoot Trefoil#	*Lotus corniculatus*
Cottonwood	*Populus deltoides*
Curled Dock#	*Rumex crispus*
Willow	*Salix* sp.
Hardstem Bulrush	*Scirpus acutus*
Softstem Bulrush	*Scirpus validus*
Compass Plant	*Silphium laciniatum*
Cherry	*Prunus* sp.
Goldenrod	*Solidago* sp.
Cattail	*Typha* 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.

The entire shoreline of IMC Lake was classified as developed. Parking lots or walking paths surround the lake. The entire shoreline has a 5-15 foot buffer strip between the lake and the parking lots or walking paths (Figure 6). The buffer consists of shrub and herbaceous species, many of them native plants. Continued maintenance and expansion

Figure 6. Shoreline types.

Figure 7. Erosion.

of this buffer strip is strongly recommended, as it helps stabilize the shoreline soils and provides habitat for many wildlife species. This buffer strip likely helps filter many of the pollutants and nutrients that may accumulate on the parking lots and surrounding land. However, this filtering may be limited since most of the rainwater from the parking lots drains into one of the stormwater pipes and subsequently drains directly into the lake.

The shoreline was assessed for the degree and type of shoreline erosion. Along the shoreline of IMC Lake only a limited about of erosion was noted (Figure 7). Approximately 800 feet along the northern shoreline was classified as slightly eroding. This erosion may be the result of wave and ice damage or rising and falling water levels common in a lake of this nature. The eroded areas are not in need of immediate attention, but should be monitored for future and more severe damage.

Some exotic plant species were found growing along the shoreline, including honeysuckle, birdsfoot trefoil, curled dock, and Queen Anne's Lace. None were found in large numbers, but could become problems if not contained, particularly honeysuckle. 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 IV: Eliminate or Control Exotic Species**.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

A number of wildlife species, particularly birds, were noted on and around IMC 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 IMC Lake was only fair, due mostly to its urban setting. The buffer strip around the lake provides some habitat, as does the wooded area along the eastern shoreline between the lake and the golf course. Additional habitat may be created around the lake, such as erecting birdhouses or allowing brush and trees that have fallen into the water remain. More information can be found in **Objective V: Enhance Wildlife Habitat Conditions**.

We did not conduct any fish surveys in 2003. However, numerous bluegills were seen during the field season. Due to the high conductivity readings and high concentrations of chloride in the lake, diversity of fish and other aquatic organisms may be limited to those that are tolerant of these conditions.

A pied-billed grebe, which is listed as a threatened species in Illinois, was seen on the lake in April. While this species likely did not nest in the area, the lake did provide important migration habitat. Good water quality and habitat are important for migrating birds as they rest and replenish energy reserves lost during migration.

One wildlife problem that was identified was the large numbers of resident Canada geese that were seen throughout the season. Resident geese contribute large amounts of feces to the surrounding landscape that eventually washes into the lake, which can exacerbate the nutrient problems in the lake, leading to excessive algae blooms. Controlling resident geese can be difficult and in some cases permits are required by the Illinois Department of Natural Resources. Maintaining the buffer strips around the lake and replacing some of the turfgrass in the watershed will help discourage geese from using these areas. In addition, allowing the lake to completely freeze in the winter will encourage geese to move away from the lake. More information can be found in **Objective VI: Canada Geese Management.**

One of the concerns of the lake's management entity is the presence and damage done by muskrats. These rodents may cause problems with shoreline stabilization by digging holes in the shoreline bank and potentially clogging drain pipes with debris generated while foraging and building homes. Management of muskrats requires an ongoing monitoring plan that includes removal of the animals and repairing the damaged shoreline bank. More information on management options for controlling these problems can be found in **Objective VII: Muskrat Management**.

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

Birds	
Pied-billed Grebe+	*Podilymbus podiceps*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Greater Scaup	*Aythya marila*
Ring-billed Gull	*Larus delawarensis*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Killdeer	*Charadrius vociferus*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
American Robin	*Turdus migratorius*
Rock Dove	*Columba livia*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*
Swamp Sparrow	*Melospiza georgiana*
Song Sparrow	*Melospiza melodia*

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

Mammals	
Muskrat	*Ondatra zibethicu*s
Amphibians	
American Toad	*Bufo americanus*
Green Frog	*Rana clamitans melanota*
Reptiles	
Painted Turtle	*Chrysemys picta*
Snapping Turtle	*Chelydra serpentina*
Fish	
Bluegill	*Lepomis macrochirus*
Koi	*Cyprinus* sp.

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

EXISTING LAKE QUALITY PROBLEMS

- *Lack of a Quality Bathymetric Map*

  A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Currently, no bathymetric map of IMC Lake exists.

- *High Total Dissolved Solids Concentrations and Conductivity Readings*

  Water quality samples showed high total dissolved solid (TDS) concentrations and high conductivity readings. These readings are likely the result of stormwater runoff from residential roads, laden with winter road salt. Average TDS concentrations and conductivity readings were the highest recorded in a county lake since the parameters have been measured. In addition, chloride concentrations were higher than IEPA standards, indicating that the lake is being impacted by road salt.

- *Aquatic Vegetation*

  While eight species of aquatic plants were found in IMC Lake, coontail was dominant and the exotics Eurasian water milfoil and curlyleaf pondweed were also present. Due to the shallow nature of the lake, aquatic plants could cover the entire lake, producing an aesthetically unpleasing situation. However, the aquatic plant populations in the lake help maintain good water clarity by stabilizing bottom sediment and utilizing available nutrients in the sediment and water. An aquatic plant management plan may be needed in the future if the abundant plant populations inhibit proper water detention or aesthetics.

- *Invasive Shoreline Plant Species*

  Numerous exotic plant species (i.e., honeysuckle, birdsfoot trefoil, curled dock, and Queen Anne's Lace) were found on the shores of IMC Lake. None were found in large numbers, but could become problems if not contained, particularly honeysuckle, which can outcompete native plants and offers little value in terms of shoreline stabilization or wildlife habitat. These plants should be removed and replaced with native shoreline plants.

- *Problem Wildlife*

  Two species of wildlife (Canada Goose and muskrat) were perceived as potential problems around IMC Lake. Geese feces is high in nutrients, which can create water quality problems in the lake as well as aesthetically displeasing areas around the lake. Muskrats can destabilize shoreline banks, causing erosion or clog pipes through their foraging and home building activities. Managing both species requires a variety of techniques and in some cases may require permits or licenses from the Illinois Department of Natural Resources.

POTENTIAL OBJECTIVES FOR THE IMC LAKE MANAGEMENT PLAN

I. Create a Bathymetric Map Including a Morphometric Table
II. Illinois Volunteer Lake Monitoring Program
III. Aquatic Plant Management Options
IV. Control Exotic Plant Species
V. Enhance Wildlife Habitat Conditions
VI. Canada Geese Management
VII. Muskrat Management

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. Currently, no bathymetric map of IMC Lake exists.

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.

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Objective III: Aquatic Plant Management Options

All aquatic plant management techniques have both positive and negative characteristics. If used properly, they can all be beneficial to a lake's well being. If misused or abused, they all share similar outcomes - negative impacts to the lake. Putting together a good aquatic plant management plan should not be rushed. Plans should consist of a realistic set of goals well thought out before implementation. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. For an aquatic plant management plan to achieve long term success, follow up is critical. A good aquatic plant management plan considers both the short and long-term needs of the lake. The management of the lake's vegetation does not end once the nuisance vegetation has been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and remove as necessary. An association or property owner should not always expect immediate results. A quick fix of the vegetation problems may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly solve the problem. The management options covered below are commonly used techniques that are coming into wider acceptance and have been used in Lake County. There are other plant management options that are not covered below as they are not very effective, unreliable, or are too experimental to be widely used.

Option 1: No Action

If the lake is dominated by *native*, *non-invasive* species, the no action option could be ideal. Under these circumstances native plant populations could flourish and keep nuisance plants from becoming problematic. However, if a no action aquatic plant management plan in a lake with non-native, invasive species, nothing would be done to control the aquatic plant population of the lake regardless of the type and extent of the vegetation. Nuisance vegetation could continue to grow until epidemic proportions are reached. Growth limitations of the plant and the characteristics of the lake itself (light penetration, lake morphology, substrate type, etc.) will dictate the extent of infestation. Rooted plants, such as curly leaf pondweed (*Potamogeton crispus*) and elodea (*Elodea canadensis*), will be bound by physical factors such as substrate type and light availability. Plants such as Eurasian water milfoil and coontail, which can grow unrooted at the surface regardless of water depth, could grow to cover 100% of the water's surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

Pros

There are positive aspects associated with the no action option for plant management. The first, and most obvious, is that there is no cost. However, if an active management plan for vegetation control were eventually needed, the cost would be substantially higher than if the no action plan had not been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, no chemicals, mechanical alteration, or introduction of any organisms would take place. This is important since studies have shown that nuisance plants are more likely to invade disrupted areas. If the lake contains native, non-invasive plant species, expansion of the native plant population would increase the overall biodiversity and health of the lake. Habitat, breeding areas, and food source availability would greatly improve. Use of the lake would continue as normal and in some cases might improve (fishing) if native plants keep "weedy" plants under control.

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

Cons

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

Water quality could also be negatively impacted with the implementation of the no action option. Deposition of large amounts of organic matter and release of nutrients upon the death of the massive stands of vegetation is a probable outcome of the no action option. These dead plants will contribute to the sediment load of the lake and could accelerate its filling in. The large nutrient release when the plants die back in the fall could lead to lake-wide algae blooms and an overall increase of the internal nutrient load. In addition, the decomposition of the massive amounts of vegetation will lead to a depletion of the lakes dissolved oxygen. This can cause fish stress, and eventually, if the stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake's ecosystem.

In addition to the ecological impacts, many physical uses of the lake will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick stands of plants. Swimming could also become increasingly difficult due to thick vegetation that would develop at beaches. Fishing could become more and more exasperating due in part to the thick vegetation and also because of the stunted fish population. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by tangled mats of vegetation and the odors that will develop when they decay. The combination of the above events could cause property values on the lake to suffer. Property values on lakes with weedy plant/algae problems have been shown to decrease by as much as 15-20%.

Costs
No cost will be incurred by implementing the no action management option. However, if in the future a management plan was initiated, costs might be significantly higher since a no action plan was originally followed.

Option 2: Aquatic Herbicides
Aquatic herbicides are the most common method to control nuisance vegetation/algae. When used properly, they can provide selective and reliable control. Products can not be licensed for use in aquatic situations unless there is less than a 1 in 1,000,000 chance of any negative effects on human health, wildlife, and the environment. Aquatic herbicides are not allowed to be environmentally persistent, bioaccumulate, or have any bioavailability. Prior to herbicide application, licensed applicators should evaluate the lake's vegetation and, along with the lake's management plan, choose the appropriate herbicide and treatment areas, and apply the herbicides during appropriate conditions (i.e., low wind speed, D.O. concentration, temperature).

There are two groups of herbicides: contact and systemic. Contact herbicides, like their name indicates, kill on contact. These herbicides affect only the above ground portion of the plant that they come into contact with and therefore do not kill the root system. An example of a contact herbicide is diquat. Systemic herbicides are taken up by the plant and disrupt cellular processes, which in turn cause plant death. These herbicides kill both the above ground portions of the plant as well as the root system. An example of a systemic herbicide is fluridone. Both types of herbicides are available in liquid or granular forms. Liquid forms are concentrated and need to be mixed into water to obtain the desired concentration. The solution is then sprayed on the water's surface or injected into the water in the treatment areas. Granular herbicides are broadcast in a known rate over the treatment area where they sink to the bottom. Some granular products slowly release the herbicide, which is then taken up by the plant. These are referred to as SRP formulations (Slow Release Pellet). Other granular herbicides come in crystal form and dissolve as they come in contact with water. This is typical of herbicides such as copper sulfate. Many herbicides come in both liquid and granular forms to fit the management needs of the lake. Herbicide applications can either be done as whole lake treatments or as more selective spot treatments. Multiple herbicides are often mixed and applied together. This is called a tank mix. This is done to save time, energy, and cost.

Aquatic herbicides are best used on actively growing plants to ensure optimal herbicide uptake. For this reason, herbicides are normally applied mid to late spring when water temperatures are above 60^0F. This is the time of year when the plants are most actively growing and before seed/vegetative propagule formation. Follow up applications should be done as needed. When choosing an aquatic herbicide it is important to know what plants are present, which ones are problematic, which plants are beneficial, and how a particular herbicide will act upon these plants. The herbicide label is very important and should always be read before use. There may be more than one herbicide for a given plant. As with other management options, proper usage is the key to their effectiveness, benefits, and disadvantages.

Currently, there is no active management of the aquatic plants in IMC Lake. Aquatic plants could be found on 100% of the lake bottom in 2003, however since the recreational uses of the lake are minimal, the need to chemically treat the lake may also be minimal. However, if the management entity chooses to treat the lake with herbicides, care should be exercised as to the type of chemicals used. If herbicides are used, it is recommended that spot treatments be done on target plants that are becoming invasive (i.e., coontail, EWM, and curlyleaf pondweed), while allowing beneficial native plants (i.e., slender and brittle naiad and sago pondweed), to grow in certain areas of the lake. The plant populations will provide habitat for fish and wildlife as well as compete with algae for nutrients and help stabilize lake bottom sediment. Water clarity should improve with the increase in plants and decrease in algae.

In areas where EWM and coontail are mixed with beneficial native plants like brittle naiad or sago pondweed, then an herbicide application of 2,4-D would be recommended since this product kills dicots (broadleaf plants like EWM and coontail) and not monocots (grass-like plants like the pondweeds). However, 2,4-D products will not work on curlyleaf pondweed. To control curlyleaf pondweed a contact herbicide like diquat is recommended. Any treatments should occur early (May) as to prevent the curlyleaf from forming its seeds (called turions), which may help reduce the following years plant density. An earlier treatment will also prevent the EWM from spreading and outcompeting the native plants, since EWM begins growing earlier in spring than many of the native plants. However, an additional spot treatment may be needed later in the year to control coontail since this plant emerges later in the spring than EWM or curlyleaf pondweed.

Pros

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

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

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

Cons

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

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

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

Over-removal, and possible regrowth of nuisance vegetation that may follow will drastically impair recreational use of the lake. Swimming could be adversely affected due to the likelihood of increased algal blooms. Swimmers may become entangled in large mats of filamentous algae. Blooms of planktonic species, such as blue-green algae, can produce harmful toxins as well produce noxious odors. If regrowth of nuisance vegetation were to occur, motors could become entangled making boating difficult. Fishing would also be negatively impacted due to the decreased health of the lake's fishery. The overall appearance of the lake would also suffer due to an increase in unsightly algal blooms and massive stands of vegetation. This in turn could have an unwanted effect on property values. Studies have shown that problematic algal blooms can decrease property values by 15-20%.

Costs
To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's aquatic plant management plan. Diquat (Reward®) costs approximately $425/SA and endothall (Aquathol K®) costs approximately $150-175/SA. The 2,4-D products (Aquacide®, Aqua-Kleen®, Navigate®, Weedar 64®) cost approximately $350-425/SA.

Option 3: Hand Removal

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

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

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

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

Costs
Plant removal rakes can range in price from $50-150 and cutting tools commonly range in price from $50-200. Both are available from numerous catalogs and from the Internet. A homemade rake (heavy duty garden rake, rope, and weight) would cost about $20-40.

Option 4: Reestablishing Native Aquatic Vegetation
Revegetation should only be done when existing nuisance vegetation, such as Eurasian water milfoil, are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. Without adequate light penetration, revegetation will not work. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake are allowed to naturally expand into adjacent areas thereby filling the niche left by the nuisance plants. Another technique utilizing existing plants is to transplant vegetation from one area to another. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 6 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

Pros

By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. Once established, expanded native plant populations will help to control growth of nuisance vegetation. This provides a more natural approach as compared to other management options. In addition, using established native plants to control excessive invasive plant growth can be less expensive in the long run than other options. Expanded native plant populations will also help with sediment stabilization. This in turn will have a positive effect on water clarity by reducing suspended solids and nutrients that decrease clarity and cause excessive algal growth. Properly revegetating shallow water areas with plants such as cattails, bulrushes, and water lilies can help reduce wave action that can lead to shoreline erosion. Increases in desirable vegetation will increase the plant biodiversity and also provide better quality habitat and food sources for fish and other wildlife. Recreational uses of the lake such as fishing and boating will also increase due to the improvement in water quality and the suppression of weedy species.

Cons

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

Costs

Costs will be higher if a consultant/nursery is contracted for design and labor. Additional costs will include herbivory protection materials such as metal posts and protective wire mesh (chicken wire).

Objective IV: Eliminate or Control Exotic Species

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. Plants such as purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus cathartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. The outcome is a loss of plant and animal diversity. This section will address terrestrial shoreline exotic species.

Purple loosestrife is responsible for the "sea of purple" seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. Due in part to an extensive root system, large seed production (estimates range from 100,000 to 2.7 million seeds per plant), and high seed germination rate, purple loosestrife spreads quickly. Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants, 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.

Option 1: No Action

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

Pros

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

<u>Option 2: Control by Hand</u>

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 3: Herbicide Treatment

Chemical treatments can be effective at controlling exotic plant species. However, chemical treatment works best on individual plants or small areas already infested with the plant. In some areas where individual spot treatments are prohibitive or 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 V: Enhance Wildlife Habitat Conditions

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

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

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

Option 1: No Action

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

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

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

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

Costs

The financial cost of this option may be zero. However, due to continual loss of habitats many wildlife species have suffered drastic declines in recent years. The loss of habitat 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.

Objective VI: Canada Geese Management

Canada geese (*Branta canadensis*) are migratory waterfowl common throughout North America. Geese in urban areas can be undesirable primarily due to the large amount of feces they leave behind. Recreational activities on lawns and parks are impeded due to goose feces. Large amounts of feces may end up in the water, either directly from geese on the water or rainwater runoff from lawns where feces have accumulated. Goose feces are high in organic phosphorus. High nutrient levels, particularly phosphorus, can contribute to excessive algae growth in lakes. This may inhibit other recreational activities such as boating or swimming, as well as create poor habitat for fish and wildlife, and possibly bad odors when the algae decays.

Geese become problematic for many reasons. They seek locations that have open water, adequate food supplies, and safety from predators. If these factors are present, geese may not migrate. Since geese exhibit a high level of site fidelity, they return to (or stay at) the same area each year. Thus, adults will likely come back to the same area year after year to nest. If conditions remain optimal, one pair of geese can quickly multiply causing additional problems. Increased development in Lake County has inadvertently created ideal habitat for goose populations. Manicured lawns mowed to the edge of lakes and detention ponds provide geese with open areas with ample food and security. Other conditions that encourage goose residency include open water during winter (primarily the result of aerators in lakes and ponds), mild winters, and people feeding birds with bread or similar human food.

Large populations of geese pose a potential disease threat both to resident and wild populations of waterfowl. This problem may be more serious in residential populations since these birds stay in one area for long periods of time are more likely to transmit any disease to neighboring groups of geese. There is no threat of disease transmission to humans or domestic dogs and cats since most of the diseases are specific to birds.

Option 1: No Action

Pros

This option has no costs, however, increasing numbers of geese will most likely exacerbate existing problems and probably create new ones, which in the future may cost more than if the problems are addressed immediately.

Cons

If current conditions continue and no action is taken, numbers of Canada Geese and problems associated with them will likely increase. An increase of goose feces washed into a lake will increase the lake's nutrient load and eventually may have a detrimental impact on water quality through excessive algae growth. One study (Manny et al. 1975) documented that each goose excretes 0.072 lbs of feces per day. This may not seem like a significant amount, but if 100 geese are present (many lakes in the county can experience 1,000 or more at a time) that equates to over 7 lbs of feces per day! Algae blooms may negatively impact recreational uses such as swimming, boating, and fishing. In addition, when algae dies, odor problems and depleted oxygen levels in the water occur. Increased numbers of geese may also result in overgrazed areas of grass.

Costs

There are a few short-term financial costs with this option. Costs of cleaning feces off lawns or piers are probably more psychological or physical than financial. Long-term costs may be more indirect, including increased nutrient deposition into lakes which may promote excessive algae and plants. Costs incurred may include money needed to control algae with algaecides.

Option 2: Removal

Since Canada Geese are considered migratory waterfowl, both state and federal laws restrict taking or harassing geese. Under the federal Migratory Bird Treaty Act, it is illegal to kill or capture geese outside a legal hunting season or to harass their nests without a permit. If removal of problematic geese is warranted or if nest and egg destruction is an option, permits need to be obtained from the Illinois Department of Natural Resources (217- 782-6384) and the U.S. Fish and Wildlife Service (217-241-6700).

Hunting is one of the most effective techniques used in goose management. However, since many municipalities have ordinances prohibiting the discharge of firearms, reduction of goose numbers by hunting in urban areas (i.e., lakes, ponds, and parks) may not be an option. Hunting does occur on many lakes in the county, but certain regulations apply (e.g., 100 yard minimum distance from any residential property). Contact the Illinois Department of Natural Resources for dates and regulations regarding the waterfowl hunting seasons. Also, contact local and county law enforcement agencies regarding any ordinances concerning hunting within municipal boundaries.

Egg addling, or destroying the egg by shaking, piercing, or freezing, can be used to reduce or eliminate a successful clutch. Eggs should be returned to the nest so the hen goose does not re-lay another clutch. However, if no eggs hatch, she may still lay another clutch. Leaving one or two eggs unaltered and allowing them to hatch may prevent another clutch from being laid and reduces the total year's reproduction. Egg addling requires a state and federal permit.

The capture and relocation of geese is no longer a desirable option. First, relocated geese may return to the same location where they were captured. Second, there is a concern over potential disease transmission from relocated geese to other goose populations. Finally, since goose numbers in Illinois are already high there is no need to supplement other populations in the area.

Pros

Removing a significant portion of a problem goose population can have a positive effect on the overall health of a lake. Reduction of feces on lawns and parks is beneficial to recreation users of all types. Less feces in the water means less phosphorus available for nuisance plant and algae growth. Thus, the overall water quality of the lake may be improved by this reduction in phosphorus.

Cons
If the habitat conditions still exist, more geese will likely replace any that were removed. Thus, money and time used removing geese may not be well spent unless there is a change in habitat conditions.

Costs
A Illinois residential waterfowl hunting license (including state and federal waterfowl stamps) is $39.00 for the 2002-2003 hunting season. For depredation permits, there is a $25 fee for the federal permit. Once the federal permit is issued the state permit can be obtained at no charge.

Option 3: Dispersal/Repellent Techniques
Several techniques and products are on the market that claim to disperse or deter geese from using an area. These techniques can be divided into two categories: harassment and chemical. With both types of techniques it is important to implement any action early in the season, before geese establish territories and begin nesting. Once established, the dispersal/repellant techniques may be less effective and geese more difficult to coerce into leaving.

The goal with harassment techniques is to frighten geese from an area using sounds or objects. Various products are available that simulate natural predators (i.e., plastic hawks and owls) or otherwise make geese nervous (i.e., balloons, shiny tape, and flags). Other products emit noises, such as propane cannons, which can be set on a timer to go off at programmed intervals (e.g., every 20-30 seconds), or recorded goose distress calls which can be played back over a loudspeaker or tape player. Over time these techniques may be ineffective, since geese become acclimated to these devices. Most of these products are more effective when used in combination with other techniques.

Another technique that has become popular is using dogs or swans to harass geese. Dogs can be used primarily in the spring and fall to keep birds from using an area by herding or chasing geese away from a particular area. Any dogs used for this purpose should be well trained and under the owners control at all times. Professional trainers can be contracted to use their dogs for this purpose. Dogs should not be used during the summer when geese are unable to fly due to molting. Swans are used because they are naturally aggressive in defending their territory, including chasing other waterfowl away from their nesting area. Since wild swans cannot be used for this technique, non-native mute swans are used. However, mute swans are not as aggressive and in some case are permissive of geese. Again, using a combination of techniques would be most effective.

Chemical repellents can be used with some effectiveness. New products are continually coming out that claim to rid an area of nuisance geese. Several products (ReJeX-iT® and GooseChase™) are made from methyl-anthranilate, a natural occurring compound, and can be sprayed on areas where geese are feeding. The spray makes the grass distasteful and forces geese to move elsewhere to feed. Another product, Flight Control™, works similarly, but has the additional benefit of absorbing ultra violet light making the grass appear as if it was not a food source. The sprays need to be reapplied every 14-30 days, depending upon weather conditions and mowing frequency.

Pros

With persistence, harassment and/or use of repellants can result in reduced or minimal usage of an area by geese. Fewer geese may mean less feces and cleaner yards and parks, which may increase recreational uses along shorelines. If large numbers of geese were once present, the reduction of fecal deposits into the lake may help minimize the amount of phosphorus entering the water. Less phosphorus in the water means less "food" available for plant and algae growth, which may have a positive effect of water quality. Finally, any areas overgrazed by geese may have a chance to recover.

Cons

The effectiveness of harassment techniques is reduced over time since geese will adapt to the devices. However, their effectiveness can be extended if the devices are moved to different locations periodically, or used in conjunction with other techniques.

Use of dogs can be time consuming, since the dog must be trained and taken care of. Dogs must also be used frequently in the beginning of the season to be effective at deterring geese. This requires time of the dog owner as well. Dogs (frequently herding dogs, like border collies) that are effective at harassing or herding geese are typically may not be the best pets for the average homeowner. They are bred as working dogs and consequently have high levels of energy that requires the owner's attention.

Repelling or chasing away geese from an area only solves the goose problem for that area and most likely moves the geese (and the problem) to another area. As long as there is suitable habitat nearby, the geese will not wander very far.

Costs

Costs for the propane cannons are approximately $660 ($360 for the cannon, $300 for a timer), not including the propane tank. The cost of ReJeX-iT® is $80/gallon, GooseChase™ is $95/gallon, and Flight Control™ costs $200/gallon. One gallon covers one acre of turf using ReJeX-iT® and, GooseChase™, and two acres using Flight Control™.

Option 4: Exclusion

Erecting a barrier to exclude geese is another option. In addition to a traditional wood or wire fence, an effective exclusion control is to suspend netting over the area where geese are unwanted. Geese are reluctant to fly or walk into the area. A similar deterrent that is often used is a single string or wire suspended a foot or so above the ground along the length of the shoreline.

Pros
Depending on the type of barrier used, areas of exclusion will have less fecal mess and may have higher recreational uses. Vegetation that was overgrazed by geese may also be able to recover.

Cons
This technique will not be effective if the geese are using a large area. Also, use of the area by people is severely limited if netting is installed. Fences can also limit recreational uses. The single string or wire method may be effective at first, but geese often learn to go around, over, or under the string after a short period of time. Finally, excluding geese from one area will force them to another area on a different part of the same lake or another nearby lake. While this solves one property owners problem, it creates one (or makes one worse) for another. Also, problems associated with excess feces entering the lake (i.e., increased phosphorus levels) will continue.

Costs
The costs of these techniques are minimal, unless a wood or wire fence is constructed. String, wire, or netting can be purchased or made from materials at local stores.

Option 5: Habitat Alteration
One of the best methods to deter geese from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for geese. Low vegetation near the water allows geese to feed and provides a wide view with which to see potential predators. In general, geese do not favor habitats with tall vegetation. To achieve this, create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn. Planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally can create buffer strips. A table in Appendix A has a list of native plants, seeding rates, and approximate costs that can be used when creating buffer strips.

Geese prefer ponds and lakes that have shorelines with gentle slopes to ones with steep slopes. While this alone will not prevent geese from using an area, steeper slopes used along with other techniques will be more effective. This option may not be practical for existing lake shorelines since any grading and/or filling would require permits and surveys, which would drive up the costs of redoing the shoreline considerably.

Aeration systems that run into the fall and winter prevent the lake from freezing, thus not forcing geese to migrate elsewhere. To alleviate this problem, turn aerators off during fall and early winter. Once the lake freezes over and the geese have left, wait a few weeks before turning the aerators on again if needed.

Pros
Altering the habitat in an area can not only make the habitat less desirable for geese, but may be more desirable for many other species of wildlife. A buffer strip has additional benefits by filtering run-off of nutrients, sediments, and pollutants and protecting the shoreline from erosion from wind, wave, or ice action. Finally, the more of the area that is in natural vegetation, the less turfgrass that needs to be constantly manicured and maintained.

Cons
Converting a portion or all of an area to tall grass or shrub habitat may reduce the lake access or visibility. However, if this occurs, a small path can be made to the lake or shorter plants may be used at the access location in the buffer strip.

Costs
If minimal amount of site preparation is needed to create a buffer strip, costs can be approximately $10 per linear foot, plus labor. 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. 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. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

Once established, a buffer strip of native plants needs little maintenance. If aerators are not run for several months, there will be a reduction in electrical costs.

Option 6: Do Not Feed Waterfowl!
There are few "good things", if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the "foods" (i.e., white bread) given to geese and other waterfowl are quite low. Since geese are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese that are accustom to hand feeding may become aggressive toward other geese or even the people feeding the geese.

Costs
There are no costs to this option, except the public education that is needed to encourage people not to feed waterfowl. In some cases, signs could be posted to discourage waterfowl feeding.

Reference:

Manny, B. A., R. G. Wetzel, and W. C. Johnson. 1975. Annual contribution of carbon, nitrogen, and phosphorus by migrant Canada geese to a hardwater lake. Verh. Internat. Verein. Limnol. 19:949-951.

Objective VII: Muskrat Management

The muskrat (*Ondatra zibethica)* is a common and widespread rodent of ponds, lakes, and streams in North America. Adults typically weigh 2-4 pounds. Muskrats generally confine their activities to an area within 300-400 feet of their den.

Muskrat populations are cyclical in nature and generally influenced by food availability. They eat a variety of food including cattails, rushes, and various aquatic plants. Occasionally they will eat other animals such as crayfish, mussels, or snails.

Due to their high reproductive potential, muskrats can quickly populate an area, and can have both positive and negative impacts. Their denning and foraging habits can create additional habitats for other wildlife species. Muskrats are also an important part of the fur trade in North America, being the most commonly trapped furbearer. However, muskrats can also be destructive since they feed on aquatic or emergent vegetation and build their dens by frequently burrowing into the bank of a pond, lake, or stream. Banks with muskrat burrows may be less stable and more prone to erosion. Below are some options to control damage by muskrats.

Option 1: No Action

With this option, no attempts are made to curtail muskrat activities. Muskrat populations may increase or decrease, depending on the circumstances in and around the lake. Damage to nearby plants or weakened shoreline banks may occur if the muskrat population continues to grow. If limited food sources are available, muskrats may leave the area in search for more suitable conditions elsewhere.

Pros

The quality habitats created by muskrats will continue to provide havens for fish and wildlife species. Wildlife watching will likely be improved.

Cons

Muskrat populations may continue to increase, potentially causing more damage to plants. Significant alterations around the lake (reduction of plant life) may be viewed negatively by some lake residents. Also, eroded shoreline banks, caused by muskrat burrows may damage property or concern many landowners.

Costs

Costs for this option is primarily from muskrat damage or destruction (i.e., cut vegetation, weakened or eroded banks, etc.).

Option 2: Exclusion

One option in muskrat management is using exclusion techniques to prevent damage to valued resources or to discourage muskrats from burrowing into banks.

Excluding the muskrats from areas generally is accomplished by erecting a fence either around areas or plants that are to be protected. Any sturdy fencing material should work.

In all cases, fences should be at least four feet in height and buried into the bank, since muskrats are not good climbers, but are obviously good diggers. The four foot height is necessary to prevent muskrat from breaching the fence in winters with significant snow depths.

Pros
Excluding muskrat from certain areas or plants will obviously prevent the damage or death of the plants and also protect the shoreline bank from erosion. Exclusion of muskrats may also force them to move to another more suitable location since their main source of food and shelter has been made inaccessible.

Cons
Preventing muskrat from damaging certain areas or plants may force them to select other areas or plants that are not protected. This may lead to having to exclude more areas or plants from damage than previously planned.

Costs
Hardware cloth or heavy duty welded wire are available for local hardware stores. Costs for fencing larger areas are dependent on fence type, height, and length.

Option 3: Removal
Removing muskrats from an area is usually done by kill trapping. Live traps (i.e., Havahart traps) are generally not used. Kill traps (called conibear traps) are the most commonly used by trappers. These traps are usually set underwater, along a run, or at the surface of the water, generally near the den. Baits and scents are sometimes used to lure muskrats to traps. Seasonal trapping and hunting restrictions prohibit taking muskrat when they are raising young. Licenses are required to trap muskrat in Illinois.

Pros
Trapping muskrats will remove the nuisance animals from the immediate area. If a commercial trapper is used, nothing else needs to be done by the landowner. Shoreline banks will be protected.

Cons
Physically removing muskrats is a time consuming and sometimes expensive technique that often is short-lived. Hiring someone to trap muskrat can be costly and seldom are all muskrats trapped out of an area. The few that remain will reproduce and the problem may continue. Even if all members of a population are trapped, it is likely that other muskrats will immigrate into the habitat vacated by the trapped individuals.

Costs
A 2003 trapping license in Illinois costs $10.50 and a hunting license costs $7.50. A hunting license is not needed if only trapping is conducted. However, if either license is purchased, a habitat stamp is also needed ($5.50). Live traps can range from $40 each (Havahart trap) or more. Kill traps like a #110 conibear cost

approximately $6 each (cheaper if large numbers are purchased). A pair of setting tools needed to set conibear trap costs $10. Additional cost may include bait or scent.

Commercial trappers usually charge a set-up fee (approximately $100-200) and $35-50/muskrat. Costs increase if muskrats are live-trapped.

Option 4: Habitat Alteration

Altering the habitat around the pond, lake, or stream can also avert muskrat damage. Shoreline banks that have been graded to a gentle slope (3:1 or less) will be less attractive to muskrats.

Banks should also be planted with native vegetation and not commercial turfgrass. Native plants have a deeper and more extensive root structure which will decrease any shoreline erosion should it occur due to the weakened bank stability resulting from muskrat burrows. Turfgrass has a shallow root structure and is a poor soil stabilizer.

If grading and planting the shoreline bank does not deter muskrats, then a layer of rock riprap with filter fabric underneath may work.

Pros

Altering habitat may encourage muskrat to leave the area, minimizing bank erosion or the elimination of plants.

Cons

Muskrat may still eat non-preferred food items. Damaged or removed dens may be rebuilt. Significant time and effort would be needed to alter the habitats around a lake.

Costs

Costs will depend on the degree of habitat alteration that is done. Most of the costs will be in the form of personal time by landowners or other interested parties. Cost and type of riprap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $30-45 per linear foot. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be $1,000-2,000 for installation of rip-rap or gabions, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department for permit information.