2003 SUMMARY REPORT
of
ROUND LAKE

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Round Lake encompasses approximately 228.6 acres and has a shoreline length of 4.4 miles and is part of the Squaw Creek (Long Lake) drainage of the Fox River watershed. Round Lake's water quality is better than many of the other lakes in Lake County.

Water clarity, as measured by Secchi disk transparency readings, averaged 6.25 feet for the 2003 season, which was 39% lower than the 1999 average of 10.32 feet, and 16% lower than the 1995 average of 7.44 feet, but still above the county median of 3.41 feet. The historical Secchi disk transparency average in Round Lake is 7.27 feet.

Total phosphorus (TP) concentrations in Round Lake were below the county medians. The 2003 average TP concentration was 0.025 mg/L in the epilimnion and 0.115 mg/L in the hypolimnion, compared to the county medians of 0.059 mg/L and 0.186 mg/L in the epilimnion and hypolimnion, respectively. The 2003 epilimnion average is 32% higher than the 1999 average of 0.019 mg/L. However, the TP average concentrations in the epilimnion in 1991 (0.031 mg/L) and 1995 (0.024 mg/L) were similar to the 2003 average.

Round Lake had above average concentrations of total dissolved solids (TDS) and conductivity readings. Both parameters increased from 1995 and 1999 concentrations. The most likely cause for these increases in TDS concentrations and conductivity readings is input from dissolved solids (particularly road salt) washed into the lake from storm events.

Eighteen aquatic plant species and several emergent shoreline plants were found. Eurasian water milfoil (EWM), an exotic, was the dominant plant in Round Lake in 2003 being found in 65% of all samples. Coontail and sago pondweed were the next most common, being found in 33% and 29% of all samples, respectively. Based on light level penetration, aquatic plants could grow in the majority of the lake. Even in September when light penetration was the shallowest, over 75% of the lake area was receiving adequate light for plant growth.

Approximately 92% of the shoreline of Round Lake was classified as developed. Seawall and lawn were the two most common shoreline types comprising 28% and 22% of the shoreline, respectively. The shoreline was assessed for the degree of shoreline erosion and approximately 30% or 7,088 feet of the shoreline was classified as slightly eroding, 4% or 1,062 feet was moderately eroding, and only 1% or 287 feet was severely eroding.

One bird listed as a threatened species in Illinois, the red-shouldered hawk, was found along the southern shoreline of the lake. Its presence is note-worthy since two juvenile birds were seen with two adults, suggesting a nest nearby.

LAKE IDENTIFICATION AND LOCATION

Round Lake (T45N, R10E, Sections 20 and 21) is located east of Cedar Lake Road and north of Washington Road within the Villages of Round Lake, Round Lake Beach, and Round Lake Park (Avon Township). It is part of the Squaw Creek (Long Lake) drainage of the Fox River watershed. Round Lake's immediate watershed is approximately 2,510 acres, with a watershed to lake ratio of 11:1. (Figure 1). It receives water from Highland Lake from a small creek that enters Round Lake from the northeast. Water leaves the lake via the Round Lake Drain along the northwestern shoreline and flows into Long Lake. Water from Round Lake eventually drains into the Fox River.

Round Lake encompasses approximately 228.6 acres and has a shoreline length of 4.4 miles. A 1989 bathymetric (depth contour) map of the lake indicates a maximum depth of 32 feet with an average depth of 8.4 feet and a lake volume of 1,842 acre-feet (Figure 2, below and Table 1, Appendix A). Lake elevation is approximately 763 feet above mean sea level.

Round Lake is listed as an ADID (advanced identification) wetland by the U.S. Environmental Protection Agency (USEPA). This indicates that the lake and surrounding natural environments have potential to have high quality aquatic resources.

BRIEF HISTORY OF ROUND LAKE

Round Lake is a natural glacial lake resulting from the last glaciation several thousand years ago. As the glacier receded from the county it left numerous lakes and wetlands.

The lake has been an important part of the lives of local people for many years. In C.F. Johnson's 1896 book <u>Angling in the Lakes of Northern Illinois: How and Where To Fish Them</u> (The American Field Publishing Company, Chicago, IL), Round Lake is described as "a splendid piece of fishing water", with extensive aquatic plant beds. The map from his book (Figure 3) shows large populations of emergent vegetation along the lake's shoreline.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Round Lake has been an important part of the social and economic climate of the area for a long time. Fish and wildlife were reported to be plentiful in and around the lake during European settlement of the area. It was likely important to native Indian cultures as well. Much of the documented uses of the lake begin in the late 1800's. Recreational activities such as fishing and boating have always been part of the lake usage. Round Lake was also used extensively for ice harvesting in the early 1900's.

Figure 1. Watershed.

Figure 2. 1989 bathymetric map of Round Lake.

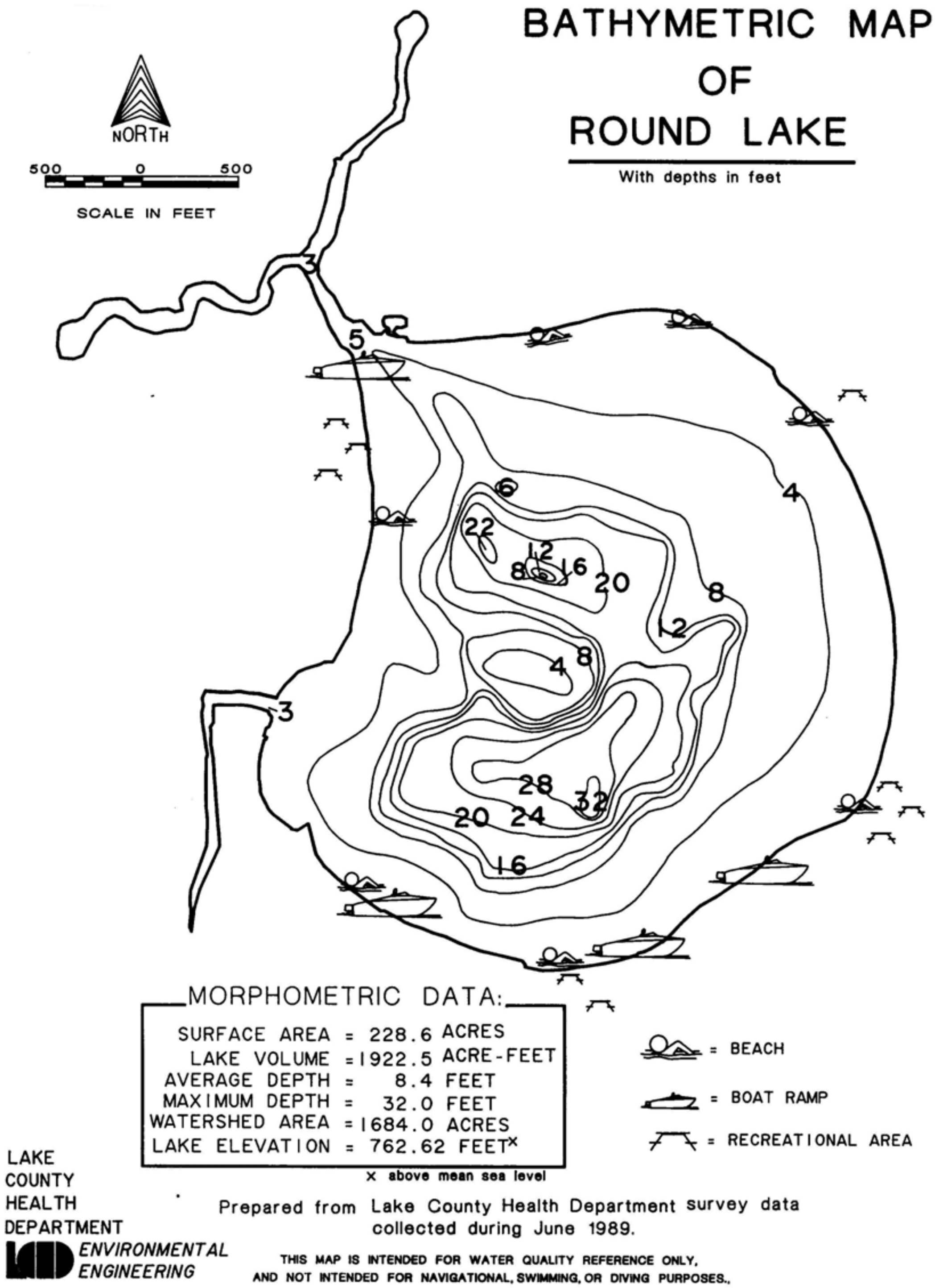
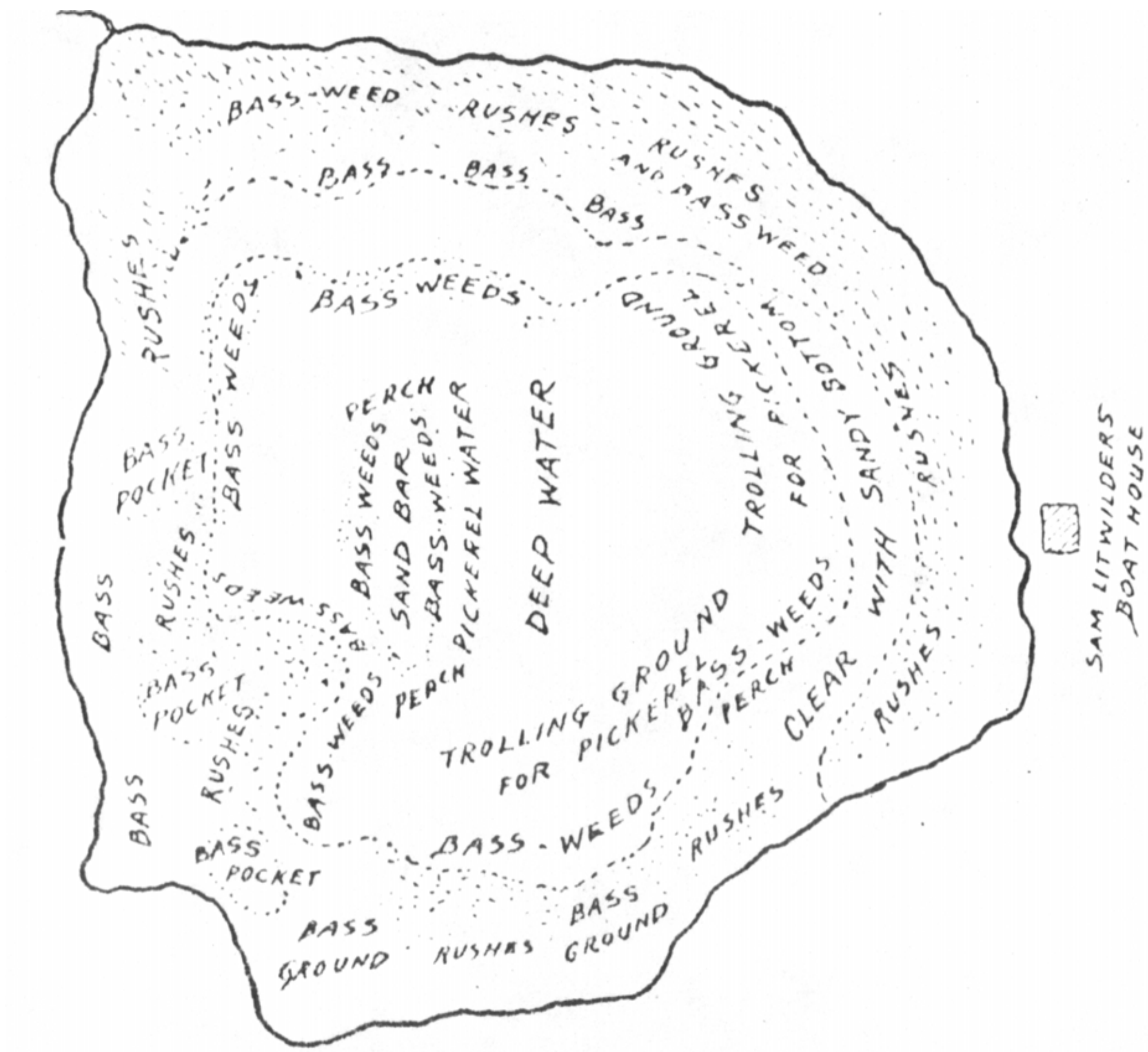


Figure 3. 1896 C.F. Johnson's map of Round Lake.



Summer cottages began appearing in the 1920's and '30s. A 1939 aerial photograph of Round Lake can be seen in Figure 5. The cottages were then converted and used as permanent summer homes shortly after World War II. Residential home building has continued to the point where the majority of the lake is surrounded by homes or parkland. A spillway structure was installed in the 1950s for water level control.

The major land use in the Round Lake watershed (based on 2000 land use maps) is single family homes (34.7%), followed by water (16.8%), transportation (15.9%), and public and private open space (14.5%; Figure 4, below and Table 2). All of the remaining types each consisted of less than 10% of the land uses in the watershed. The type and composition of the land uses in the watershed may have an impact of a number of issues related to the overall health of the lake.

There are numerous bottom owners of the lake, however, the majority of the lake bottom is owned by the Alpine Country Club. As mentioned previously, the lake is within the municipal boundaries of three communities (Round Lake, Round Lake Beach, and Round Lake Park). Officials and residents of these communities have for many years expressed concern for the safety of lake users. This concern stems from the multiple jurisdictions that exist on the lake and the difficultly in enforcing safety regulations. To address this issue, in 2003, the three municipalities entered into an intergovernmental agreement that will allow the enforcement of boating and other safety regulations on the lake (see **Objective I: User Conflicts** for more information). In addition a commission (the Round Lake Commission) was established that will advise the municipalities on lake issues. The commission meets several times a year and consists of a nine-member board.

There are two public beaches on Round Lake. Bengson Park, owned and managed by the Village of Round Lake Park, and Round Lake Beach Park, owned and managed by the Village of Round Lake Beach. We monitor these beaches bimonthly for *E. coli* bacteria from early May to Labor Day. Results of the 2003 beach sampling will be discussed in the body of this report. Two public boat ramps are also at these respective beaches. Other access point include: Shorewood Subdivision at Lane Court, Shorewood Subdivision at Oak Avenue, Edwards Subdivision Beach, and the Osela (Ukranian) Camp.

We have conducted water quality studies on Round Lake in 1989, 1991, 1995, and 1999 in addition to this year. We have also conducted water quality studies on Cranberry Lake (which flows into Highland Lake) in 2000, and Highland Lake (which flows into Round Lake) and Long Lake (downstream of Round Lake) in 2001. Details of all these studies will be discussed in the body of this report.

Figure 4. Land use.

Figure 5. Aerial photo 1939.

Figure 6. Sample site and access locations.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were collected monthly from May - September at the deep-hole location near the center of the lake (Figure 6). See Appendix B for water sampling methods.

Round Lake's water quality is better than many of the other lakes in Lake County (Table 3 in Appendix A). Most of the water quality parameters measured were below or 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 6.25 feet for the 2003 season, which is above the county median (where 50% of the lakes are above and below this value) of 3.41 feet. Secchi disk readings were deepest in June (8.69 feet) and shallowest in August (4.99 feet). The 2003 average was 39% lower than the 1999 average of 10.32 feet, and 16% lower than the 1995 average of 7.44 feet. The decrease in clarity from 1995 may be attributed to many factors including algae blooms, boating activities, and stormwater events. For comparison, Cranberry Lake had a Secchi reading average of 10.96 feet in 2000. In 2001, Highland Lake and Long Lake had Secchi reading averages of 6.58 feet and 4.11 feet, respectively (see Table 4 in Appendix A for a comparison of the Secchi readings and other parameters among these lakes). Thus, the clarity in Round Lake is more similar to the lakes upstream than downstream. The Volunteer Lake Monitor (VLM) has been recording Secchi disk transparencies in Round Lake continuously since 1991. The historical Secchi readings can be seen in Figure 7 below and in Table 5 in Appendix A. The historical Secchi disk transparency average is 7.33 feet. This program has been very successful and should continue in the future to monitor trends in Round Lake's water clarity. The differences between VLM data and our data as seen in Figure 7 and Table 5 can be attributed in part to variability among individuals observing the Secchi disk, the time of year, and number of the readings.

The lake was not stratified during the May sampling date, however a thermocline was established during the remainder of the sampling season. The thermocline was located at approximately 12 feet in June, 16 feet in July, 22 feet in August, and 28 feet in September. Dissolved oxygen (DO) concentrations in Round 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 30 feet in May, 20 feet in June, 22 feet in July, 18 feet in August, and 28 feet in September. Based on the 1989 bathymetric map of Round Lake, most of the volume of the lake was oxic. Even in August, when anoxic conditions existed below 18 feet, over 94% of the volume of the lake had DO concentrations above 1 mg/L. Similar results were found in 1995 and 1999.

Total phosphorus (TP) concentrations in Round Lake were below the county medians. The 2003 average TP concentration was 0.025 mg/L in the epilimnion and 0.115 mg/L in the hypolimnion, compared to the county medians of 0.059 mg/L and 0.186 mg/L in the

Figure 7. Secchi data.

epilimnion and hypolimnion, respectively. The 2003 epilimnetic average is 32% higher than the 1999 average of 0.019 mg/L. However, the TP average concentrations in the epilimnion in 1991 (0.031 mg/L) and 1995 (0.024 mg/L) were similar. In addition to the data from our studies, the Illinois Environmental Protection Agency (IEPA) found the average TP concentrations in the epilimnion to be 0.017 mg/L and 0.020 mg/L in 1992 and 2002, respectively. Values above 0.03 mg/L in the epilimnion are considered sufficient to cause nuisance algae blooms. The 2003 hypolimnetic average is down from the 1999 average of 0.249 mg/L, however the 1999 average is higher due to the fact that the lake had not yet turned over before the September sample date, resulting in a large build up of nutrients below the thermocline where the sample was taken. In 2003, the lake had not completely turned over either, but the thermocline was below the water sample depth in September. The 1995 TP average in the hypolimnion was 0.097 mg/L. Only one sample from the hypolimnion was collected in 1991. The IEPA did not collect a hypolimnion sample in 1992. In assessing all this data, it appears that the TP concentrations in Round Lake are stable.

When looking upstream from Round Lake, in 2000, Cranberry Lake had an epilimnetic average TP of 0.024 mg/L, while Highland Lake, in 2001, the epilimnetic average TP was 0.030 mg/L. Downstream at Long Lake, in 2001, the epilimnetic average TP was significantly higher at 0.092 mg/L. Long Lake's water quality is poorer due to its larger watershed size, historical inputs from sewage treatment plants, and a poor aquatic plant community. Both Round Lake and Highland Lake have similar water quality due, in part to their deep depths (Round Lake = 32.0 feet, Highland Lake = 30.0 feet) and aquatic plant communities, which help stabilize bottom sediment and compete with algae for nutrients.

The threats to Round Lake's water quality include urban stormwater and overmanagement of the aquatic plant populations. Stormwater from urbanized areas, as well as development within the watershed can carry large amounts of sediment, nutrients, and pollutants into the lake. Lawn fertilizer (which is often high in phosphorus) applied to the lawns near the lake is one such nutrient. It is recommended that homeowners use a no-phosphorus fertilizer on their lawns. Overmanagement of the aquatic plants will allow nuisance algae to dominate causing a decrease in water clarity, which may result in a decline in the lake's fishery, impair recreational uses, and create an aesthetically displeasing situation.

As mentioned previously, the average concentrations for several parameters in Round Lake were below the county medians, however, above average concentrations of total dissolved solids (TDS) and conductivity readings were found. There is a strong correlation between these two parameters as the higher the concentration of TDS in the water, the higher the conductivity reading. The 2003 epilimnetic average for TDS was 597 mg/L, which is higher than the county median of 451 mg/L, and also higher than the 1999 Round Lake average of 479 mg/L. TDS concentrations were not recorded in any other sampling year. The 2003 average conductivity reading in the epilimnion was 1.0730 milliSiemens/cm, which is higher than the county median of 0.7503 milliSiemens/cm. The historical data also indicated a steady increase in conductivity readings. The epilimnetic averages from our studies in 1995 and 1999 were 0.6290 milliSiemens/cm and 0.8364 milliSiemens/cm, respectively. The average conductivity in the epilimnion in the 2002 IEPA study was 0.9180 milliSiemens/cm. For comparison, Cranberry Lake (which receives minimal runoff from roads) had an epilimnetic average for conductivity of 0.3809 milliSiemens/cm in 2000. Highland Lake had an average epilimnetic conductivity reading of 0.4080 milliSiemens/cm in 1996 and 0.5560 milliSiemens/cm in 2001. Long Lake's average epilimnetic conductivity readings increased from 0.5222 milliSiemens/cm in 1996 to 0.9403 milliSiemens/cm in 2001. The most likely cause for these increases in TDS concentrations and conductivity readings is input from dissolved solids washed into the lake from storm events. One of the most common dissolved solids is road salt used in winter road maintenance. Because of the high conductivity readings, one additional parameter, chlorides, was calculated based on a formula created with known chloride and TDS concentrations and conductivity readings. Chloride concentrations help determine if this was the case since most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. The seasonal average for calculated chlorides in Round Lake in 2003 was 214 mg/L in the epilimnion and 228 mg/L in the hypolimnion. The IEPA standard for chloride is 500 mg/L. Once values exceed this standard the water body is deemed to be impaired, thus impacting aquatic life. It appears that the road salt is compounding in Round Lake and other lakes in the county. 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.

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 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 Round Lake in 2003 was 41:1, indicating a phosphorus-limited system. The 1999 ratio was 51:1. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

Water levels on Round Lake have been measured daily by a dedicated citizen of Round Lake since 1994. The average annual water level change (the maximum minus the minimum levels for the year, based on data from January 1994 through October 2003) was 12.363 inches. The largest fluctuation was seen in 1994 (a 16.6 inch change), while the smallest fluctuation was seen in 1997 (6.9 inch change). In 2003, the water levels were highest in May and lowest in October (9.8 inch change). 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. It is recommended that the daily lake elevation readings continue. In addition, a staff gage could be installed to aid in monitoring water levels. It is also recommended that the VLMP volunteer record the lake level from the staff gage or obtain the daily lake level reading on the same day that the Secchi readings are taken.

Rain events probably contribute additional sediment or nutrients (like phosphorus) to a lake, which may have influenced the water sample results. Rain occurred within 48 hours prior to water sampling in July (0.57 inches) and September (0.47 inches) as recorded at the Lake County Stormwater Management Commission rain gage in Round Lake Park. However, an assessment of the impact of the July and September rains did not reveal any significant influences on the water quality results.

Based on data collected in 2003, standard classification indices compiled by the IEPA were used to determine the current condition of Round 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 and productive). This index can be calculated using total phosphorus values obtained at or near the surface. The TSIp for Round Lake in 2003 classified it as a eutrophic lake (TSIp = 50.8). This is an increase from the 1995 and 1999 TSIp of 49.9 and 43.4, respectively, when the lake was classified as mesotrophic. Eutrophic lakes are the most common types of lakes throughout the lower Midwest, and they are particularly common among manmade lakes. See Table 6 in Appendix A for a ranking of average TSIp values for Lake County lakes (Round Lake is currently #19 of 130, Cranberry Lake is #15, Highland Lake is #31, Long Lake is #84). 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 may not expect to achieve a high ranking even with intensive management.

In Round 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 full degree of support. However, due to the extensive aquatic plant populations in the lake, the recreation use index showed a partial impairment. The degree of overall use of the lake was classified as full support.

We have been testing the two public beaches (Bengson Park and Round Lake Beach Park) bimonthly for *E. coli* bacteria from early May to Labor Day annually since 1988. Prior to 2002, the beaches were tested for fecal coliform bacteria. Beginning in 2002, the testing protocol was changed to monitor *E. coli* bacteria, which is one species in the coliform group. In 2003, there were no closures at either beach due to high *E. coli* bacteria counts. In 2002, Bengson Park beach was closed for one day. Since 1988, Bengson Park has been closed seven times and Round Lake Beach Park beach closed four times. We have monitored other beaches on Round Lake (Shorewood Subdivision at Lane Court, Shorewood Subdivision at Oak Avenue, Edwards Subdivision Beach, and the Osela [Ukranian] Camp), but testing was discontinued after the 1993 season as the beaches are not properly licensed by the state.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Round Lake were assessed monthly from May through September 2003 (see Appendix B for methods). Eighteen aquatic plant species and several emergent shoreline plants were found (see Table 7, below). Terrestrial shoreline plants were also noted, but not quantified.

Eurasian water milfoil (EWM), an exotic, was the dominant plant in Round Lake in 2003 being found in 65% of all samples (Table 8 in Appendix A). Coontail and sago pondweed were the next most common, being found in 33% and 29% of all samples, respectively. Illinois pondweed was found in 14% of samples, C*hara*, a macro-algae, was found in 13% of samples, and slender naiad was found in 11% of all samples. All other species were found in less than 10% of all samples for the season. Both slender and southern naiad were found later in the sampling season (August and September), which is typical of the naiads. Northern water milfoil was also found in Round Lake in 2003. This milfoil looks similar to EWM, but is native to North America and is usually not invasive.

Another exotic, which is commonly found in lakes in Lake County, is curlyleaf pondweed. This plant was found in Round Lake in only one sample in June. Its presence should be monitored since it can also expand to nuisance levels.

During the last aquatic plant survey that we conducted on Round Lake in 1999, 11 submersed aquatic plant species and *Chara*, were found. See Table 9 in Appendix A for a comparison of the historical plant surveys on Round Lake. A 1989 survey found 15 species plus *Chara*, including grass-leaved pondweed (*Potamogeton gramineus*), an Illinois endangered species. However, since 1989 attempts to find grass-leaved pondweed have been unsuccessful.

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. We did find the weevil in Round Lake in 2003 as well as in Long Lake in 2001. The population size of the weevils is unknown, but they may help control, to some degree, the EWM in the lake.

Readings at the water quality sampling point indicated that enough light, sufficient for aquatic plants to photosynthesize (known as the 1% light level or the photic zone), was found to approximately 14 feet in May, 19 feet in June, 15 feet in July, 13 feet in August, and 12 feet in September. Based on these depths and calculations from the 1989 bathymetric map, aquatic plants could grow in the majority of the lake. Even in

September when light penetration was the shallowest, over 75% of the lake area was receiving adequate light penetration for plant growth. Since certain areas in the littoral zone did not support aquatic plants for a variety of reasons (i.e., probable herbicide treatments, poor substrate), it was calculated that the maximum aquatic plant coverage was 65% (note: this is plant coverage on the lake bottom and not an estimate of plants at the water's surface). While a majority of the lake bottom was, or could have been, covered with aquatic plants, it was estimated that less than 5% of the lake's surface was covered with plants.

Although aquatic plants were not perceived as a problem, the dominance of EWM in the lake is a concern. EWM can outcompete many of the native aquatic plants and frequently grows to the surface interfering with recreational activities. Any aquatic plant management plan should include targeting EWM. At the present time, it is recommended that if herbicide treatments do occur, that areas of EWM be spot-treated (a whole-lake treatment is not recommended at this time). As mentioned previously, care should be exercised with regard to aquatic plant management in Round Lake, since the plants are one of the reasons the lake has such good water quality. Overmanagement of these plant communities would have negative impacts to the water quality and overall health of Round Lake. More information on aquatic plant management can be found in **Objective II: Aquatic Plant Management Options**.

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, Round Lake had a FQI of 23.5. The median FQI of lakes that we have studied from 2000-2003 is 14.0. For comparison, Cranberry Lake, in 2000, had an FQI of 37.2. In 2001, Highland Lake and Long Lake had FQIs of 14.5 and 13.6, respectively.

Table 7. Aquatic and shoreline plants on Round Lake, May - September 2003.

Aquatic Plants	
Coontail	*Ceratophyllum demersum*
Chara	*Chara* sp.
American Elodea	*Elodea canadensis*
Water Stargrass	*Heteranthera dubia*
Northern Water Milfoil	*Myriophyllum sibiricum*
Eurasian Water Milfoil#	*Myriophyllum spicatum*
Slender Naiad	*Najas flexilis*
Southern Naiad	*Najas guadalupensis*
Spiny Naiad	*Najas marina*
White Water Lily	*Nymphaea tuberosa*
Curlyleaf Pondweed#	*Potamogeton crispus*
Illinois Pondweed	*Potamogeton illinoensis*
American Pondweed	*Potamogeton nodosus*
Small Pondweed	*Potamogeton pusillus*
Flatstem Pondweed	*Potamogeton zosterifomis*
Wigeon Grass	*Ruppia maritima*
Sago Pondweed	*Stuckenia pectinatus*
Vallisneria (eel grass)	*Vallisneria americana*
Shoreline Plants	
Box Elder	*Acer negundo*
Norway Maple	*Acer platanoides*
Silver maple	*Acer saccharinum*
Tree-of-Heaven#	*Ailanthus altissima*
Burdock#	*Arctium minus*
Swamp Milkweed	*Asclepias incarnata*
Common Milkweed	*Asclepias syriaca*
Beggar Ticks	*Bidens* sp.
Sedges	*Carex* sp.
Buttonbush	*Cephalanthus occidentalis*
Chicory#	*Cichorium intybus*
Dogwood	*Cornus* sp.
Hawthorn	*Crataegus* sp.
Queen Anne's Lace#	*Daucus carota*
Spikerush	*Eleocharis* sp.
Ash	*Fraxinus* sp.
Ground Ivy#	*Glechoma hederacea*
Black Walnut	*Juglans nigra*
Red Cedar	*Juniperus virginiana*
Jewelweed	*Impatiens pallida*
Ivyleaf Morningglory#	*Ipomoea hederacea*
Blue Flag Iris	*Iris* sp.

Table 7. Aquatic and shoreline plants on Round Lake, May - September 2003 (cont'd).

Honeysuckle#	*Lonicera* sp.
Bugleweed	*Lycopus* sp.
Purple Loosestrife#	*Lythrum salicaria*
White Sweet Clover#	*Melilotus alba*
Red Mulberry	*Morus rubra*
Virginia Creeper	*Parthenocissus quinquefolia*
Reed Canary Grass#	*Phalaris arundinacea*
Blue Spruce	*Picea pungens*
Smartweed	*Polygonum* sp.
Cottonwood	*Populus deltoides*
Black Cherry	*Prunus serotina*
White Oak	*Quercus alba*
Pin Oak	*Quercus palustris*
Red Oak	*Quercus rubra*
Gray-headed Coneflower	*Ratibida pinnata*
Buckthorn#	*Rhamnus cathartica*
Staghorn Sumac	*Rhus typhina*
Multiflora Rose#	*Rosa multiflora*
Blackberry	*Rubus* sp.
Black-eyed Susan	*Rudbeckia serotina*
Curled Dock#	*Rumex crispus*
Elderberry	*Sambucus* sp.
Common Arrowhead	*Sagittaria latifolia*
Willow	*Salix* sp.
Foxtail	*Setaria* sp.
Canada Goldenrod	*Solidago candensis*
Bittersweet Nightshade#	*Solanum dulcamara*
Sow Thistle#	*Sonchus* sp.
River Bulrush	*Scirpus fluviatilis*
Softstem Bulrush	*Scirpus validus*
Common Bur-Reed	*Spaganium eurycarpum*
Red Clover#	*Trifolium pratense*
Cattail	*Typha* sp.
Elm	*Ulmus* sp.
Chinese Elm#	*Ulmus parvifolia*
Blue Vervain	*Verbena hastata*
Violet	*Viola* sp.
Wild Grape	*Vitis* sp.

 # Exotic species

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted in July 2003 to determine the condition of the lake shoreline (see Appendix B for methods). Of particular interest was the condition of the shoreline at the water/land interface.

Approximately 92% of the shoreline of Round Lake was classified as developed. Seawall and lawn were the two most common shoreline types comprising 28% and 22% of the shoreline, respectively (Figure 8). Buffer (a strip of unmowed vegetation, preferably consisting of native plants), riprap, and shrub types consisted of 16%, 14%, and 11% of the shoreline, respectively. The remaining 9% of the shoreline was classified as beach, prairie, wetland, and woodland. Due to the poor root structure of turfgrass (lawn), it is recommended that these shoreline types be converted to buffer. Native plants, with deeper root structures, will stabilize the soil better and provide a filter mechanism for nutrients and pollutants that run off the surrounding landscape after rain events.

While many of the seawalls on Round Lake were in good condition, several were beginning to fail or were severely failing. Likewise, riprap areas were effectively protecting the shoreline, except in several places where old concrete chunks were used in place of proper riprap. These broken concrete chunks are ineffective at absorbing wave energy, due in part to the flat surfaces of the concrete that actually deflect wave energy into the spaces between the slabs, eventually eroding the bank behind the concrete. Similarly, numerous homeowners used an array of materials along the shoreline to serve as erosion control structures (although ineffective) including metal and plastic poles, bricks, and cut firewood. Large amounts of debris were also seen along the shoreline, particularly in the channels.

The shoreline was assessed for the degrees and types of shoreline erosion (Figure 9). Approximately 30% or 7,088 feet of the shoreline was classified as slightly eroding, 4% or 1,062 feet was moderately eroding, and only 1% or 287 feet was severely eroding. The moderately eroded areas were concentrated mainly in the northern channels, however, a few small sections were found along the shoreline in the main body of the lake. Three severely eroded sections were found (one 161-foot section in the northwestern channel and 77-foot and 50-foot sections in the southwestern channel). It is strongly recommended that the moderately and severely eroded section be address immediately to prevent further degradation of the shoreline and the increase of sediment into Round Lake. For options on repairing eroded shorelines, see **Objective III: Shoreline Erosion Control**.

Emergent aquatic vegetation was not very common around Round Lake, primarily due to large amount of shoreline that is either armored (seawall or riprap) or beach. However, where possible, emergent vegetation should be planted or encouraged to grow. These plants (arrowhead, bulrushes, spikerushes, etc.) help stabilize the shoreline by buffering wind and wave action. It may be difficult for emergent plants to become established on Round Lake due to the relatively hard substrates, high recreational boat traffic, and wind and wave action, but certain protected areas around the lake may have more success.

Figure 8. Shoreline types

Figure 9. Erosion.

Along the shoreline, buffer strips should be installed between the water and manicured lawns to reduce nutrient-rich runoff into the lake. Buffer strips can even be installed in front of or behind seawalls and riprap. Both emergent vegetation and buffer strips also provide habitat for fish and wildlife that use the lake.

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

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Good numbers of wildlife, particularly birds, were noted on and around Round Lake. See Appendix B for methods. Several of the species listed in Table 10 (below) were seen during spring or fall migration and were assumed not to be nesting around the lake.

Habitat around Round Lake was fair, primarily due to its urban surroundings. However, mature hardwood trees were found around many sections of the shoreline. These trees provided good habitat for many species of wildlife, mainly birds. However, the large areas of beach and manicured lawn also provide ample habitat for Canada geese. Nuisance geese have become increasingly common in the Midwest, especially in urban areas. For more information on goose management see **Objective V: Canada Geese**.

One bird listed as a threatened species in Illinois, the red-shouldered hawk, was found along the southwestern shoreline of the lake. Its presence is note-worthy since two juvenile birds were seen with two adults, suggesting a nest nearby. Efforts should be made to help preserve this habitat.

We did not conduct any fish surveys in 2003. However, the Illinois Department of Natural Resources (IDNR) conducted a fish assessment in 1998. At that time the IDNR recommended a 15-inch minimum length limit and three per day catch on largemouth bass, a 24-inch minimum length limit and one per day catch on northern pike, and an aquatic plant management strategy. A 1988 IDNR study found the Iowa darter (*Etheostoma exile*)in Round Lake, which is listed as endangered in Illinois.

Table 10. Wildlife species observed on Round Lake, April – September 2003.

<u>Birds</u>	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
Ring-billed Gull	*Larus delawarensis*
Great Blue Heron	*Ardea herodias*
Spotted Sandpiper	*Actitis macularia*
Red-shouldered Hawk+	*Buteo lineatus*
Mourning Dove	*Zenaida macroura*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Common Flicker	*Colaptes auratus*
Downy Woodpecker	*Picoides pubescens*
Great Crested Flycatcher	*Myiarchus crinitus*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
Chimney Swift	*Chaetura pelagica*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Black-throated Green Warbler	*Dendroica virens*
Yellow-rumped Warbler	*Dendroica coronata*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*
Indigo Bunting	*Passerina cyanea*
<u>Mammals</u>	
Gray Squirrel	*Sciurus carolinensis*
<u>Amphibians</u>	
None noted.	
<u>Reptiles</u>	
Painted Turtle	*Chrysemys picta*

Table 10. Wildlife species observed on Round Lake, April – September 2003 (cont'd).

Mussels	
Giant Floater	*Pyganodon grandis*
Insects	
Cicadas	Cicadidae
Dragonfly	Anisoptera
Painted Lady Butterfly	*Vanessa cardui*
Monarch Butterfly	*Danaus plexippus*

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

EXISTING LAKE QUALITY PROBLEMS

- *User Conflicts*

  Because Round Lake is in a residential area with two public boat launches, user conflicts are common. There is particular concern for user safety on the lake. In addition, the lake falls under the jurisdiction of three municipalities. In 2003, the municipalities entered into an intergovernmental agreement that will allow the enforcement of boating and other safety regulations on the lake. In addition a commission (the Round Lake Commission) was established that will advise the municipalities on lake issues.

- *High Total Dissolved Solids Concentrations and Conductivity Readings*

  Water quality samples showed high total dissolved solids concentrations and high conductivity readings, increasing 25% and 28%, respectively, since 1999. These readings are likely the result of stormwater runoff from residential roads, particularly from winter road salt. Conductivity readings have steadily increased from 1995 to present in Round Lake (a 71% increase) as well as in Highland Lake and Long Lake. These parameters should be monitored. In addition, the use of road salt by the villages and township should be assessed, reduced and alternatives researched.

- *Aquatic Vegetation*

  While 18 species of aquatic plants were found in Round Lake, the exotic Eurasian water milfoil (EWM) was dominant. Due to the multiple uses of Round Lake, an aquatic plant management plan should be developed. Beneficial native plants (both submersed and emergent) are present in the lake and should be encouraged to expand to enhance habitats for fish and other wildlife and well as improve water quality. While most of the lake bottom was covered or potentially covered with aquatic plants, less than 5% of the lake surface area actually had plants that may have impeded boating activities. Some control of EWM is recommended, however, overmanagement of the plant populations may have negative impacts on the water quality in the lake.

- *Shoreline Erosion*

  Approximately 30% or 7,088 feet of the shoreline was classified as slightly eroding, 4% or 1,062 feet was moderately eroding, and only 1% or 287 feet was severely eroding. The moderately eroded areas were concentrated mainly in the northern channels, however, a few small sections were found along the shoreline in the main body of the lake. Three severely eroded sections were found (one 161-foot section in the northwestern channel and 77-foot and 50-foot sections in the southwestern channel). It is strongly recommended that the moderately and severely eroded sections are addressed immediately to prevent further degradation of the shoreline and the increase of sediment into Round Lake.

- *Invasive Shoreline Plant Species*

  Numerous exotic plant species (i.e., buckthorn, honeysuckle, multiflora rose, purple loosestrife, and reed canary grass) were found on the shores of Round Lake. These species are particularly problematic as they outcompete native plants and offer little value in terms of shoreline stabilization or wildlife habitat. Plants should be removed and replaced with native shoreline plants.

POTENTIAL OBJECTIVES FOR THE ROUND LAKE MANAGEMENT PLAN

I. User Conflict Options
II. Aquatic Plant Management Options
III. Shoreline Erosion Control
IV. Eliminate or Control Exotic Plant Species
V. Canada Goose Management
VI. Enhance Wildlife Habitat Conditions

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: User Conflicts

One of the most challenging management issues on residential lakes involves their use by a variety of different interest groups (i.e., user conflicts). Problems occur when the lake is used at the same time for recreational activities that inherently conflict. Numerous potential conflicts can be cited. For example, fishermen may feel the quality of their fishing experience is greatly diminished when powerboats are using the lake. Often, the overriding priority when dealing with user conflicts is safety. Unfortunately, these conflicts are not limited to human-to-human conflicts. Fish and wildlife may also be adversely affected by human activities. For example, studies have found that certain species of water birds (i.e., loons, gulls, terns, and some waterfowl) that nest near the water's edge had reduced nesting success in areas were heavy boat traffic was occurring. Similarly, other studies have found poor fish spawning success in shallow areas exposed to heavy boat traffic, since spawning fish may either not be able to spawn or may not be able to defend their eggs from predation because they leave the area to hide from the disturbance. Additionally, sediment that is suspended from wave action may cover and suffocate the fish eggs. The disturbance becomes of particular concern when threatened or endangered species are affected.

User conflicts can also have significant effects on how a lake is managed. For example, water skiers may feel that the aquatic plant populations (i.e., weeds) are impeding with their ability to safely use certain portions of the lake and want the weeds removed or dramatically reduced. At the same time, the fishermen and wildlife enthusiasts want no plant reductions because they believe the plants are enhancing the habitat in the lake. Add to this the human psychological sentiment of wanting any alternative except the one that benefits the person(s) with whom you have conflict, and the result is a complex, multifaceted problem.

Solutions to these problems are generally not easy and frequently require a level of compromise by most of the interested parties. One of the first steps to achieving a solution is to determine who the users are and how they use the lake. A survey is suggested as a way to help answer these questions. A good example is from Lake Ripley, Wisconsin, where a comprehensive questionnaire was mailed to all area residents. The results helped Lake Ripley's management entity clarify the uses on the lake and assist in the development of a management plan. We have a copy of this questionnaire for review.

When addressing user conflicts, it is important to point out the rights of lake bottom owners and surface water usage in Illinois. As a lake bottom owner, a person may conduct various management activities (i.e., pier installation, aquatic plant herbicide treatments) that impact only the bottom they own, but they do not have the right to impede the reasonable use (i.e., boating, fishing, skiing) by others in the water above the bottom they own.

Another important component to consider is the enforcement of any use conflict resolutions. As with any rule or regulation, it is only as good as the ability to enforce it. A significant factor is determining who has jurisdiction to enforce any regulations. Any law enforcement officer can enforce boating regulations or ordinances enacted by the State of Illinois or local government entities. Verbal or "gentlemen's" agreements that go beyond (i.e., are more stringent) state laws are not legally binding. Similarly, a law enforcement officer may not enforce regulations adopted by a lake management association.

The following are several options that may help reduce some of the user conflicts that may be occurring on your lake.

Option 1: No Action

Under this option, no additional actions would be taken. The usage of the lake will continue in its present state. Problems that may be occurring between users will continue and tensions may increase. In addition, new problems may emerge if this option is chosen. For example, residents along a small underdeveloped lake that only use non-motorized boats may find that new residents that build homes around the lake assume they can use high horsepower boats.

Pros

There are no beneficial effects of taking no action when user conflicts are present.

Cons

Taking no action when user conflicts are present will result in the possible escalation of the conflicts both on and off the water. In addition, depending on the type of user conflict that is occurring, degradation of the water quality or overall lake health may occur.

Costs

Under this option there are no costs.

Option 2: Time Spacing

As the name implies, time spacing requires that certain times of the day are allocated for various activities, while other activities are restricted or not permitted. For example, water skiing or jet skiing may only be permitted between certain periods of the day (i.e., 9AM to 6PM). This option may be combined with other options such as zone spacing or speed/power limits. Certain areas of the lake may be restricted only during parts of the day (i.e., early morning or evening) or users may be required to use "no-wake" speeds during these times.

Pros

The benefits of time spacing include allowing various activities on the lake that may otherwise conflict. For example, not allowing powerboating in the early morning and evening hours will benefit other users (i.e., fishermen, wildlife viewers). Time spacing will also help people recognize that the lake is for everyone's enjoyment and that some compromise is necessary.

Cons

Depending on how the time spacing is arranged, certain interest groups may feel their needs are not being met. There may not be enough time allocated for their particular activity. These feelings may be exacerbated if fees have been required as part of the activities (i.e., boating stickers, launch fees).

Costs

The costs of this option include the purchase and placement of signs and public educational materials as well as enforcement. Buoys can cost between $50-150. Signs may cost $15-30 each. Off-duty law enforcement officers usually charge $30/hour to enforce boating laws or local ordinances.

Option 3: Zone Spacing

Designating areas of the lake where uses are restricted or even disallowed is known as zone spacing. A "no-wake" zone is an example of using zone spacing to achieve a management goal. Zone spacing is generally used to isolate or consolidate certain lake activities for various reasons. Frequently, user safety is a priority and thus activities such as water skiing or jet skiing are limited to the deeper areas of the lake where they will not conflict with other lake users, such as swimmers.

Another reason zone spacing is implemented is for the prevention of shoreline erosion. Wave action generated by boat traffic can cause erosion, which can be detrimental to property values and fish and wildlife habitat. In addition, the water quality of the lake may be degraded when wave activity suspends lake bottom nutrients and sediment. Shoreline erosion also adds nutrients and sediment to the lake, causing a decrease in water quality, which impacts all users of the lake.

Zone spacing can be applied to all types of watercraft. However, in recent years particular attention has been given to restricting the use of jetskies in certain areas of the lake. Jetskies can be particularly harmful to the shallow areas of the lake. Because of their shallow displacement in the water and their maneuverability, jetskies can access areas of the lake that many motorboats cannot and at higher speeds than nonmotorized boats such as canoes. Damage to aquatic life and water quality is more severe in these shallow areas.

In some cases, certain areas of lakes may be zoned "no entry" or "restricted use only". This designation is usually to protect sensitive fish and wildlife habitat that is inhabited by threatened or endangered species. These areas may have this restriction only during times of the year that are the most critical for a particular species (i.e., nesting or spawning season), or the restrictions may be year-round. Many fish and wildlife species have suffered population declines due to loss of habitat and poor breeding success. This is due in part to their sensitivity to disturbance.

A “no wake” zone is generally established in a defined area from the shoreline out to a certain point in a lake and is usually marked by buoys. This area should be sufficiently wide enough to allow wave action from boats to attenuate before reaching the shoreline. The size of the zone will depend on many factors including size and depth of the lake, the amount of shallow (<10 feet deep) areas, and the type of motors and boats used on the lake. Buoys should be placed beyond the area identified for protection, since studies have found that boaters occasionally drive on the outside, instead of the inside, of the buoy markers.

Pros
Zone spacing can be advantageous for many reasons. Restricting certain use groups to designated areas of the lake may alleviate human safety concerns on the lake (i.e., swimmers will not be endangered by water skiers). Also, sensitive areas of the lake will be protected from shoreline erosion or habitat degradation. Protecting shoreline around a lake is beneficial to lake users as it helps protect property values, water quality, and fish and wildlife habitat.

Cons
Similar to time spacing, certain interest groups may feel that their use of the lake is being unfairly restricted.

Costs
The costs of this option include the purchase and placement of signs and public educational materials as well as enforcement. Buoys can cost between $50-150. Signs may cost $15-30 each. Off-duty law enforcement officers usually charge $30/hour to enforce boating laws or local ordinances.

Option 4: Speed/Power Limits

Powerboat motor limits or no motor areas may be warranted on small shallow lakes or in areas of a lake that are particularly susceptible to erosion or otherwise need protection. As mentioned previously, boat traffic may produce wave action that may cause shoreline erosion or degrade fish and wildlife habitat. Disturbed sediment contributes to poor water clarity, which can negatively affect sight feeding fish and wildlife, and limit the available light needed for plant growth. Nuisance algae also benefit from disturbed sediment since this action makes nutrients available from the sediment that otherwise would stay settled on the bottom. Motor limits can reduce boat speeds however, the type of boat may be more important that the motor size or speed limit. A slender “cigar” style powerboat with a large motor size (i.e., 100 horsepower) may not produce as large a wake as a wide pontoon boat with a smaller motor (i.e., 10 horsepower). Recent studies have shown that a boat traveling at “near plane” speed actually displaces more water and potentially resuspends lake bottom sediment at a great volume than boats traveling at either idle speeds or speeds high enough to allow the boat to plane on the water’s surface. Some lakes have speed limits on the lake. These limits may be restricted to certain hours (for example, the Fox Chain ‘O Lakes has a nighttime speed limit of 25 miles per hour) or may be in force during the daylight hours. Enforcement is the most difficult aspect to this option.

Another option is to limit the number of boats that use a lake at one time. This is generally most effective on private lakes where the number of boats can be more easily controlled. Large lakes with public access would have a difficult time enforcing regulations of this nature. To achieve this option, a lake management entity could limit the issue of permits or stickers required for any boat using the lake. The number of permits will depend on the size of the lake and the type of boats being used. A management entity may allow unlimited nonmotorized boats (i.e., canoes, kayaks) but restrict the number of motorized boats. Management of boat traffic can be more specialized by limiting the number of motorized boats within or above a certain size class (based on boat length or motor size). These classes could also be charged different user fees (higher fees for larger motors). The fees could then be used to pay for the enforcement of these regulations.

Pros

This option also can benefit the lake in many ways. Lake user safety would likely be enhanced due to slower moving boat traffic. Limited boat traffic may lead to less wave action to batter shorelines and cause erosion, reducing the suspension of nutrients and sediment in the water column. Less nutrients and sediment in the water column may improve water quality by increasing water clarity and limiting nutrient availability for excessive plant or algae growth.

Less wave activity would mean recreation activities such as canoeing, paddleboating, and wildlife viewing may be enhanced. Lakes with “no motors” or “electric motors only” regulations may also benefit by the lack of noise pollution as well as the direct pollution from gas motors (particularly liquid gas and oil).

Cons

Enforcement and public education are the primary obstacles with these techniques. Public resistance to any regulation change may be strong, particularly if the lake is open to the public and has had no similar regulations in the past. Depending on the regulations implemented, there may be some loss of recreational use for some users. The strongest oppositions to this option would probably come from the powerboat users and water skiers. However, this problem may be solved if this option is combined with a time or space zoning option, where these activities may take place with minimal disturbance to other activities.

Costs

The costs of this option include the purchase and placement of signs and public educational materials as well as enforcement. Signs may cost $15-30 each. Off-duty law enforcement officers usually charge $30/hour to enforce boating laws or local ordinances.

Objective II. Aquatic Plant Management Options

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

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.

In Round Lake the maximum aquatic plant coverage was calculated to be 65%, based on the available light conditions in the lake. While this is over the 25-40% coverage recommended by the Illinois Department of Natural Resources, surface coverage on Round Lake was minimal (less than 5%). Most of the plants, even near the shoreline, remained under the surface of the water. Recreational activities such as boating, may have been adversely affected by the aquatic plants that grew near the surface. Thus, some control of the plant may be necessary. If aquatic herbicides are used, care should be taken regarding the type of herbicides used. Because the target species, EWM and coontail, are dicots and many of the native plants in the lake are monocots (including all of the pondweed species) the use of a dicot specific herbicide such as 2,4-D, would be preferred, since this product kills dicots and not monocots. This would control the nuisance plants, yet maintain the good plant diversity in the lake. Enhancing native plant populations will help control EWM through competition of available light. One option to treating large sections of the lake would be to treat boating lanes from the shoreline out to the deeper water where plants are not growing. This would minimize the herbicide expenses, yet providing increased recreational activities for lake users.

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. The 2,4-D products (Aquacide®, Aqua-Kleen®, Navigate®, Weedar 64®) cost approximately $350-425 per surface acre.

Option 3: Mechanical Harvesting

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

In Round Lake, mechanical harvesting could be used to cut boating lanes from the shoreline out to deeper water and around shoreline area used for swimming.

Pros

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

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

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

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

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

Other organisms, such as waterfowl, which commonly forage on native aquatic plants, would also be negatively impacted by the removal of these plants.

Another problem with mechanical harvesting, even if properly done, is that it can be a nonselective process. In the areas where harvesting is being conducted, one plant can not be removed and another left. All the plants are removed from that area. After the initial removal, regrowth of desirable plants does not typically occur in these harvested areas. Due to their weedy nature, plants such as Eurasian water milfoil, are able to grow more quickly than native plants and become more established in harvested areas. This will create a monoculture of nuisance vegetation. This causes an overall decrease in plant biodiversity, which can have detrimental effects to the entire ecosystem. Depending on the plant species, frequent harvesting might be required (typically 2-4 times per season). Along with this increased harvesting frequency come increased operational costs (labor, gas, maintenance, etc.). Nuisance plants such as coontail and Eurasian water milfoil can spread by vegetative fragments that may escape collection during the harvesting process and spread to uninfested parts of the lake. In addition to the release of plant fragments, as the plants are cut, there is a possibility of plant associated nutrients being released into the lake. This could cause an increase is algal blooms whenever harvesting in conducted. Short-term turbidity may also be created by the harvester paddle wheels stirring up sediment in harvested area.

Cost
Depending on the type of the harvester (cutting width, payload capacity, hull material, HP of the motor, trailer options, etc) prices range from $50,000 to $150,000. Operational and maintenance cost typically range from $161.00-$445.00/acre. Some companies, such as Aquarius Systems, sell used equipment at reduced prices.

<u>Option 4: Hand Removal</u>
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.

This is a preferred option for removing nuisance aquatic plants and algae from small areas around Round Lake.

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 5: Water Milfoil Weevil

Euhrychiopsis lecontei (*E. lecontei*) is a biological control organism used to control Eurasian water milfoil (EWM). *E. lecontei* is a native weevil, which feeds exclusively on milfoil species. It was originally discovered while investigating declines of EWM in a Vermont lake in the early 1990s. It was discovered in northeastern Illinois lakes by 1995. Another weevil, *Phytobius leucogaster*, also feeds on EWM but does not cause as much damage as *E. lecontei*. Therefore, *E. lecontei* is stocked as a biocontrol and is commonly referred to as the Eurasian water milfoil weevil. Currently, the we have documented weevils (*E. lecontei* and/or *P. leucogaster*) in 32 Lake County lakes. Many of these lakes have seen declines in EWM densities in recent years. It is highly likely that *E. lecontei* and/or *P. leucogaster* occurs in all lakes in Lake County that have excessive EWM growth.

Weevils are stocked in known quantities to achieve a density of 1-4 weevils per stem. As weevil populations expand, EWM populations may decline. After EWM declines, weevil populations decline and do not feed on any other aquatic plants. When EWM starts to grow again in the spring, the weevil populations respond by keeping the increasing milfoil under control before it becomes a problem. Once the weevil is established, EWM should no longer reach nuisance proportions and begins to become more sparse. Best results are achieved in lakes that have shallow EWM infestations in areas where it is undisturbed by recreational and management actives. Weevils need proper overwintering habitat such as leaf litter and mud, which are typically found on naturalized shorelines or shores with good buffer strips. Additionally, water temperatures need to be 68-70°F for maximum weevil activity. For this reason, weevils are typically stocked in late spring/early summer. Currently only one company, EnviroScience Inc., has a stocking program (called the MiddFoil® process). The program includes evaluation of EWM densities, of current weevil populations (if any), stocking, monitoring, and restocking as needed.

We did find *E. lecontei* in Round Lake in 2003. We also found *E. lecontei* downstream in Long Lake in 2001. It is unknown what the population size is in Round Lake. Additional research would need to be conducted if this option was pursued. Natural populations may become dense enough to help control the EWM in the lake as least to some degree in certain years. Additional stocking may not be necessary in Round Lake.

Pros

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

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

Cons

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

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

One of the most prohibitive aspects to weevil use is price. Typically weevils are stocked to achieve a density of 1-4 weevils per stem. This translates to 500-3000 weevils per acre. At a cost of $1 per weevil plus labor, a EWM management program using weevils can be expensive. Additionally, there is no guarantee that weevils will provide long term control or even produce any results at all.

Costs
EnviroScience, Inc.
3781 Darrow Road
Stow, Ohio 44224
1(800) 940-4025

Weevils are sold in units of 1000 bugs/unit and stocking rates must be at least 1 unit/stocked area. Normally there is a minimum purchase of 5-10 units. The cost of the weevils does not include the labor involved in initial surveys, stocking, and monitoring, which typically run an additionally $3,500-$4,500.

Option 6: Reestablishing Native Aquatic Vegetation

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

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake are allowed to naturally expand into adjacent areas thereby filling the niche left by the nuisance plants. Another technique utilizing existing plants is to transplant vegetation from one area to another. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 11 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

Pros

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

Cons

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

Costs

See Table 11 for plant pricing. 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 III. Shoreline Erosion Control

Erosion is a potentially serious problem to lake shorelines and occurs as a result of wind, wave, or ice action or from overland rainwater runoff. While some erosion to shorelines is natural, human alteration of the environment can accelerate and exacerbate the problem. Erosion not only results in loss of shoreline, but negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. This effect is felt throughout the food chain since poor water quality negatively affects everything from microbial life to sight feeding fish and birds to people who want to use the lake for recreational purposes. The resulting increased amount of sediment will over time begin to fill in the lake, decreasing overall lake depth and volume and potentially impairing various recreational uses.

Option 1: No Action

Pros

There are no short-term costs to this option. However, extended periods of erosion may result in substantially higher costs to repair the shoreline in the future.

Eroding banks on steep slopes can provide habitat for wildlife, particularly bird species (e.g., kingfishers and bank swallows) that need to burrow into exposed banks to nest. In addition, certain minerals and salts in the soils are exposed during the erosion process, which are utilized by various wildlife species.

Cons

Taking no action will most likely cause erosion to continue and subsequently may cause poor water quality due to high levels of sediment or nutrients entering a lake. This in turn may retard plant growth and provide additional nutrients for algal growth. A continual loss of shoreline is both aesthetically unpleasing and may potentially reduce property values. Since a shoreline is easier to protect than it is to rehabilitate, it is in the interest of the property owner to address the erosion issue immediately.

Costs

In the short-term, cost of this option is zero. However, long-term implications can be severe since prolonged erosion problems may be more costly to repair than if the problems were addressed earlier. As mentioned previously, long-term erosion may cause serious damage to shoreline property and in some cases lower property values.

Option 2: Install a Seawall

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

Pros

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

Cons

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

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

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

Costs
Depending on factors such as slope and shoreline access, cost of seawall installation ranges from $85-100 per linear foot for steel and $95-110 per linear foot for vinyl. A licensed contractor installs both types of seawall. Additional costs may occur if the shoreline needs to be graded and backfilled, has a steep slope, or poor accessibility. Price does not include the necessary permits required. Additional costs will be incurred if compensatory storage is needed. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained. For seawalls, a site development permit and a building permit are needed. Costs for permits and surveys can be $1,500-2,000 for installation of a seawall. Contact the Army Corps of Engineers, local municipality, or the Lake County Planning and Development Department.

Around Round Lake, the costs to install a seawall along the moderately eroded shoreline (1,062 feet) would cost approximately $90,270 – 106,200 for steel and $100,890 – 116,820 for vinyl. The severely eroded section (287 feet) would cost approximately $24,395 – 28,700 for steel and $27,265 – 31,570 for vinyl.

Option 3: Install Rock Rip-Rap or Gabions

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

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

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

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

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

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

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

Costs
Cost and type of rip-rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $35-50 per linear foot. Costs for gabions are approximately $70-100 per linear foot when filled with rocks. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be $1,500-2,000 for installation of rip-rap or gabions, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

To repair the moderately eroding areas (1,062 feet) on Round Lake with rip-rap would cost approximately $37,170 – 53,100. The severely eroded areas (287 feet) would cost approximately $10,045 – 14,350 to repair.

Option 4: Create a Buffer Strip
Another effective method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat. Cost of creating a buffer strip is quite variable, depending on the current state of the vegetation and shoreline and whether vegetation is allowed to become

established naturally or if the area needs to be graded and replanted. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Non-native plants or noxious weedy species may be present and should be controlled or eliminated.

Stabilizing the shoreline with vegetation is most effective on slopes no less than 2:1 to 3:1, horizontal to vertical, or flatter. Usually a buffer strip of at least 25 feet is recommended, however, wider strips (50 or even 100 feet) are recommended on steeper slopes or areas with severe erosion problems. Areas where erosion is severe or where slopes are greater than 3:1, additional erosion control techniques may have to be incorporated such as biologs, A-Jacks®, or rip-rap.

Buffer strips can be constructed in a variety of ways with various plant species. Generally, buffer strip vegetation consists of native terrestrial (land) species and emergent (at the land and water interface) species. Terrestrial vegetation such as native grasses and wildflowers can be used to create a buffer strip along lake shorelines. A table in Appendix A gives some examples, seeding rates and costs of grasses and seed mixes that can be used to create buffer strips. Native plants and seeds can be purchased at regional nurseries or from catalogs. When purchasing seed mixes, care should be taken that native plant seeds are used. Some commercial seed mixes contain non-native or weedy species or may contain annual wildflowers that will have to be reseeded every year. If purchasing plants from a nursery or if a licensed contractor is installing plants, inquire about any guarantees they may have on plant survival. Finally, new plants should be protected from herbivory (e.g., geese and muskrats) by placing a wire cage over the plants for at least one year.

A technique that is sometimes implemented along shorelines is the use of willow posts, or live stakes, which are harvested cuttings from live willows (*Salix* spp.). They can be planted along the shoreline along with a cover crop or native seed mix. The willows will resprout and begin establishing a deep root structure that secures the soil. If the shoreline is highly erodible, willow posts may have to be used in conjunction with another erosion control technique such as biologs, A-Jacks ®, or rip-rap.

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or rip-rap. Native emergent vegetation can be either hand planted or allowed to become established on its own over time. Some plants, such as native cattails (*Typha* sp.), quickly spread and help stabilize shorelines, however they can be aggressive and may pose a problem later. Other species, such as those listed in a table in Appendix A should be considered for native plantings.

Pros

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

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

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

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

In addition to the benefits of increased fish and wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of various colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

Cons

There are few disadvantages to native shoreline vegetation. Certain species (i.e., cattails) can be aggressive and may need to be controlled occasionally. If stands of shoreline vegetation become dense enough, access and visibility to the lake may be compromised to some degree. However, small paths could be cleared to provide lake access or smaller plants could be planted in these areas.

Costs

If minimal amount of site preparation is needed, costs can be approximately $15 per linear foot, plus labor. Cost of installing willow posts is approximately $20-25 per linear foot. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as $1,500-2,000 depending on the types of permits needed.

Option 5: Install A-Jacks®

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

Pros

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

Cons

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

Costs

The cost of installation is approximately $50-75 per linear foot, but does not include permits and surveys, which can cost $1,500-2,000 and must be obtained prior to any work implementation. Additional costs will be incurred if compensatory storage is needed.

To repair the moderately eroding areas (1,062 feet) on Round Lake with A-Jacks® would cost approximately $53,100 – 79,650. The severely eroding areas (287 feet) would cost approximately $14,350 – 21,525 to repair.

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

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Once established, a buffer strip of native plants can be planted along side or on top of the roll (depending if rolls are made of synthetic or natural fibers). They are most effective in areas where plantings alone are not effective due to already severe erosion. In areas of severe erosion, other techniques may need to be employed or incorporated with these products.

Pros

Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from terrestrial sources. These factors help improve water quality in the lake by reducing the amount of nutrients available for algae growth and by reducing the sediment that flows into a lake.

Cons

These products may not be as effective on highly erodible shorelines or in areas with steep slopes, as wave action may be severe enough to displace or undercut these products. On steep shorelines grading may be necessary to obtain a 2:1 or 3:1 slope or additional erosion control products may be needed. If grading or filling is needed, the appropriate permits and surveys will have to be obtained.

Costs

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

To repair the moderately eroding areas (1,062 feet) on Round Lake with biologs, fiber rolls, or straw blankets would cost approximately $42,480 – 47,790. The severely eroding areas (287 feet) would cost approximately $11,480 – 12,915 to repair.

Option 7: Establish a "No Wake" Zone or No Motor Area

Establishing a "no wake" zone or no motor area will not solve erosion problems by itself. However, since shoreline erosion is generally not caused by one specific factor, these techniques can be effective if used in combination with one or more of the techniques described above.

A "no wake" zone is generally established in a defined area from the shoreline out to a certain point in a lake and is usually marked by buoys. This area should be sufficiently wide enough to allow wave action from boats to attenuate before reaching the shoreline. The size of the zone will depend on many factors including size and depth of the lake, the amount of shallow (<10 feet deep) areas, and the type of motors and boats used on the lake. No motor areas may be warranted on small shallow lakes or in areas of a lake that are particularly susceptible to erosion or otherwise need protection.

Pros

These techniques may reduce wave activity along shorelines susceptible to erosion. Limiting boat activity, particularly near shorelines or in shallow areas, may also have an additional benefit by improving water quality since less sediment may be disturbed and resuspended in the water column. Disturbed sediment contributes to poor water clarity, which can negatively effect sight feeding fish and wildlife and limit the available light needed for plant growth. Nuisance algae also benefit from disturbed sediment since this action makes available nutrients in the sediment that otherwise would stay settled on the bottom. This also may minimize plants being cut by boat props if the no wake buoys are outside plant beds.

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

Cons

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

Costs

Costs include the purchase and placement of signs, buoys, and enforcement, as well as maintenance of signs and buoys. No wake buoys cost approximately $35-150 each. Signs may cost $15-30 each.

Objective IV. Eliminate or Control Exotic Plant Species

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

Purple loosestrife is responsible for the "sea of purple" seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. Due in part to an extensive root system, large seed production (estimates range from 100,000 to 2.7 million seeds per plant), and high seed germination rate, purple loosestrife spreads quickly. Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants, 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: Biological Control</u>
Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase.

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

Small patches of purple loosestrife around Round Lake might benefit from releasing some of these beetles.

Pros

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

Cons

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

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

Costs

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

Option 3: Control by Hand

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

This is the preferred method of controlling the exotic species around Round Lake, since many of the area infested with these species are along individual homeowner's properties.

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

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

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

Option 4: Herbicide Treatment

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

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

Pros

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

Cons

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

Costs

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

Objective V: Canada Goose 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 is 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.

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

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.

<u>Option 6: Do Not Feed Waterfowl!</u>
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 VI: Enhance Wildlife Habitat Conditions

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

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

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

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.

Option 5: Limit Disturbance
Since most species of wildlife are susceptible to human disturbance, any action to curtail disturbances will be beneficial. Limiting disturbance can include posting signs in areas of the lake where wildlife may live (e.g., nesting waterfowl), establish a "no wake" area, boat horsepower or speed limits, or establish restricted boating hours. These are examples of time and space zoning for lake usage. Enforcement and public education are needed if this option is to be successful. In some areas, off-duty law enforcement officers can be hired to patrol the lake.

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

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

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

Cons

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

Costs

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