2002 SUMMARY REPORT
of
FISH LAKE

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Fish Lake, historically known as Old Fish Lake or Lake Duncan, is a glacial lake that was dammed circa 1935. The lake encompasses approximately 95.6 acres and has a shoreline length of 2.5 miles.

Water clarity, as measured by Secchi disk transparency readings, averaged 4.02 feet for the season, which is slightly above the county median (where 50% of the lakes are above and below this value) of 3.81 feet. The 2002 average is a slight increase from the 1997 average of 3.53 feet, although the Secchi readings in 1997 were more consistent than the 2002 readings.

The seasonal average total suspended solid (TSS) concentration in 2002 (11.3 mg/L) is higher than the 1997 average (8.9 mg/L). Planktonic algae blooms during the summer probably contributed to the higher TSS readings and reduced water clarity. However, other solids, such as sediment suspended in the water are a larger source of the poor water clarity since most of the TSS consisted of non-volatile suspended solids in all months sampled.

Total phosphorus (TP) concentrations in Fish Lake are high. The 2002 average TP concentration is 0.102 mg/L in the epilimnion and 0.188 mg/L in the hypolimnion. Nitrate nitrogen (NO_3-N) was found in high concentrations in May (0.303 mg/L) and June (0.791 mg/L) in the epilimnion. This is probably the result of spring turnover or run-off. High nutrient concentrations resulted in algae blooms and decreased water clarity.

Dissolved oxygen (DO) concentrations in Fish Lake did not indicate any significant problems. In 2002, all DO concentrations at the surface were >5mg/L, although poor DO concentrations were noted in 1997.

Twelve aquatic plant species and several emergent shoreline plants were found in Fish Lake. Eurasian water milfoil, an exotic, is the dominant plant in the lake, being found at 53% of all plant sites sampled.

The dominant shoreline type on the lake was wetland, comprising 88% of the total shoreline perimeter. Beach was the next most common type at 10%, while the remaining types (buffer, shrub, seawall, and lawn) made up the remaining 2%.

The shoreline was assessed for the degrees and types of shoreline erosion. However, no apparent erosion was taking place on Fish Lake, due mostly to the type of shoreline present.

Three bird species listed as endangered by the state of Illinois are found on Fish Lake. Two of them, the common tern and northern harrier, were only seen once and are assumed to not be nesting in the area. However, the black tern was seen throughout the summer and two adults were observed feeding two newly fledged young in August, suggesting a nest nearby.

LAKE IDENTIFICATION AND LOCATION

Fish Lake (T45N, R9E, Sections 34 and 35) is located west of U.S. Highway 12 and north of State Highway 120 in unincorporated Volo (Grant Township). It is part of the Fish Lake drainage of the Fox River watershed. No major streams or lakes drain into Fish Lake since it is at the top of the drainage. Water leaves the lake at the north end, by way of the Fish Lake Drain, draining into Fischer Lake then Wooster Lake and Duck Lake and eventually into Fox Lake.

Fish Lake encompasses approximately 95.6 acres and has a shoreline length of 2.5 miles. Historically, the maximum depth was reported to be 16 feet. However, LCHD staff determined the current maximum depth to be 19 feet, measured in April 2002. Water levels were higher at this time of the year. The maximum depth during June-September was 16 feet. A 1971 bathymetric (depth contour) map states the average depth is 10 feet and the lake volume is 850 acre-feet (Figure 1). The current lake volume may be different due to the age of the most recent bathymetric map and the maximum depth found in 2002. Lake elevation is approximately 753 feet above sea level.

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

BRIEF HISTORY OF FISH LAKE

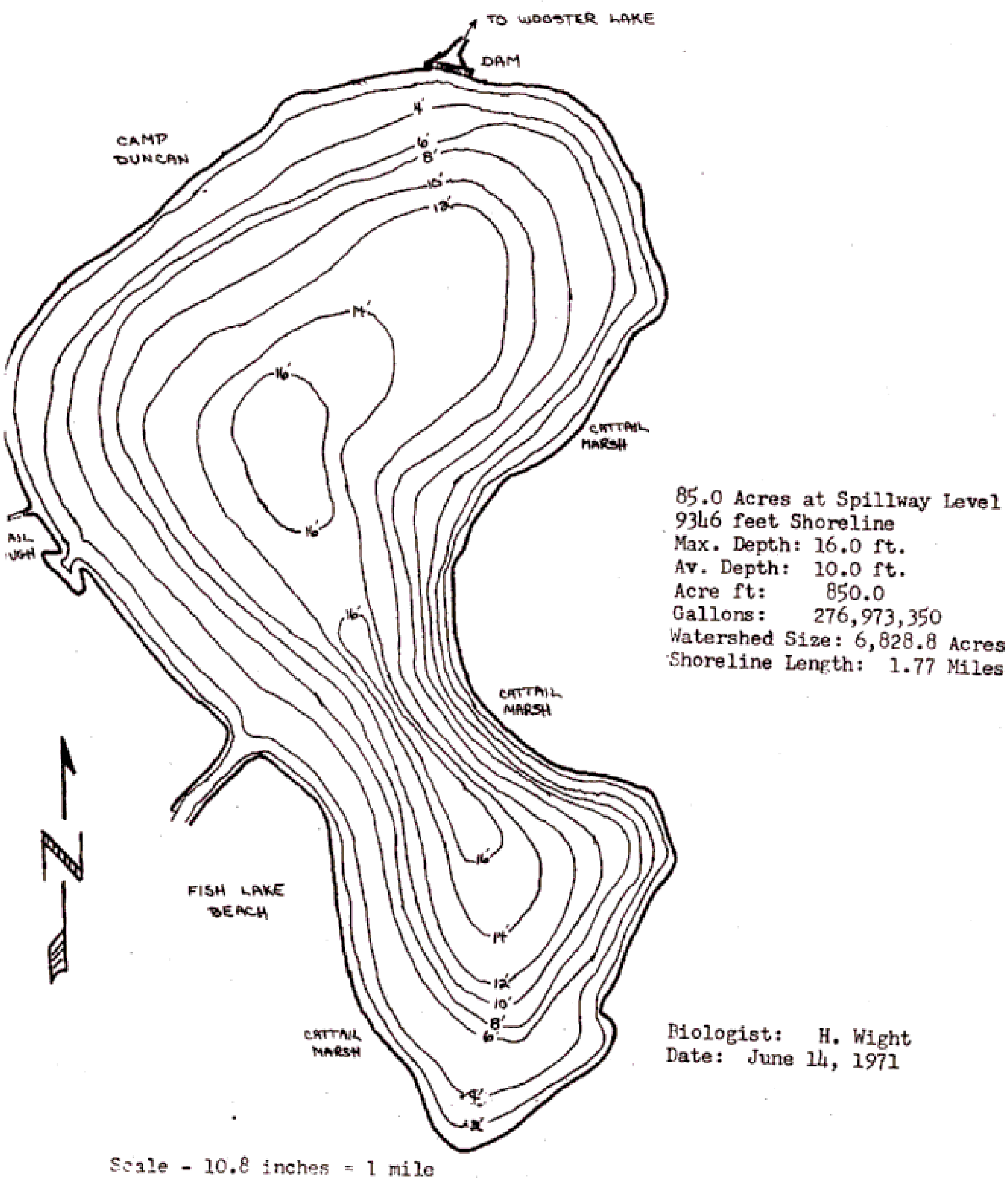
Fish Lake was historically known as Old Fish Lake and Lake Duncan. The lake was a glacial lake that was dammed circa 1935. The lake experienced a moderately severe fishkill in the winter of 1969-70 and another fishkill in 1976 that prompted the Fish Lake Beach campground owners to purchase and install an aeration system.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Fish Lake is used by the YMCA Camp Duncan in the summer and by residents and guests of the Fish Lake Beach campground. Fish Lake Beach is open from April 1 – October 15. Fishing, swimming, and non-motorized boating are the most common recreational activities on the lake. Fish Lake Beach stocks 2,000 pounds of channel catfish into the lake annually. The Lake County Forest Preserve District (LCFPD) purchased land on the east side of the lake in 2002. This includes approximately 3,000 feet of shoreline. Initial field surveys by LCFPD have indicated the presence of three plant species (*Carex cryptolepis, Juncus alpinus rariflorus,* and *Panicum flexile*) and five bird species (pied-billed grebe, black tern, black-crowned night heron, common moorhen, and yellow-headed blackbird) listed as threatened or endangered by the state of Illinois.

The aeration system in Fish Lake consists of three compressors each with a horsepower rating of 0.20 and an operating pressure of 10 psi. Each compressor runs a diffuser.

Figure 1. 1971 bathymetric map of Fish Lake.



However, in 2002 LCHD staff noted only one diffuser running efficiently enough to produce bubbles at the water's surface. The diffusers are set on the lake bottom at approximately 10 feet. Efficiency and implications of the aeration system will be discussed in the water quality section of the report.

In 2002, no herbicides or algaecides were applied in Fish Lake. However, the Fish Lake Beach campground has a weed cutter that it uses to control aquatic plant growth along its shoreline and along the shoreline of Camp Duncan.

LIMNOLOGICAL DATA – WATER QUALITY

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

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

Water clarity, as measured by Secchi disk transparency readings, averaged 4.02 feet for the season, which is slightly above the county median (where 50% of the lakes are above and below this value) of 3.81 feet. Secchi disk readings were similar in May (7.65 feet) and June (7.78 feet), then decreased considerably as the season progressed with a low of 1.15 feet in September. The 2002 average is a slight increase (14%) from the 1997 average of 3.53 feet, although the Secchi readings in 1997 were more consistent than the 2002 readings.

Correlated with the decrease in clarity was the increase in total suspended solids (TSS; Figure 3), since solids suspended in the water reduce the depth at which the Secchi disk can be seen. In May and June when the Secchi depths were the deepest, TSS concentrations were low (3.5 mg/L and 3.1 mg/L, respectively). However, in July, August, and September TSS concentrations were higher, corresponding to the lower Secchi disk readings. Planktonic algae blooms during the summer probably contributed to the higher TSS concentrations and reduced water clarity. However, other solids, such as sediment suspended in the water were a larger source of the poor water clarity since most of the TSS consisted of non-volatile suspended solids in all months sampled. Increases in suspended sediment in the water likely are the result of wind and wave action and carp activity. In addition, the limited aquatic vegetation present in the lake and the shallow littoral zone contribute to the increase in TSS readings. The 2002 seasonal average TSS concentration in the epilimnion (11.3 mg/L) was 27% higher than the 1997 average (8.9 mg/L). The concentrations in July and August 2002 were considerably higher than in the same months in 1997. Weather related events are one possible explanation. The summer of 2002 had air temperatures above normal and precipitation below normal, while the 1997 summer had air temperatures below normal and precipitation above normal.

Figure 2.

Figure 3.

The lake was not stratified during the May sampling date. A thermocline was established in June at 10 feet, and at 6 feet in July. By August the lake was stratified near the bottom (14 feet) and had completed turnover by the September sampling date.

Total phosphorus (TP) concentrations in Fish Lake were high. The 2002 average TP concentration was 0.102 mg/L in the epilimnion and 0.188 mg/L in the hypolimnion. The county median is 0.056 mg/L in the epilimnion and 0.170 mg/L in the hypolimnion. Values above 0.03 mg/L in the epilimnion are considered sufficient enough to cause nuisance algae blooms. TP concentrations in the hypolimnion increased steadily from May to July. Prior to the August sampling, the thermocline weakened, allowing TP from the hypolimnion to mix with the epilimnion, causing the TP concentrations to decrease in the hypolimnion and increase in the epilimnion in these months. The 2002 average TP concentrations in the epilimnion decreased by 24% from 1997 (0.134 mg/L), however the average concentrations from the hypolimnion decreased considerably (46%) from 1997 (0.348 mg/L) to 2002.

Fish Lake also had high concentrations of soluble reactive phosphorus (SRP) in the hypolimnion, particularly in June (0.155 mg/L) and July (0.253 mg/L). SRP was trapped under the thermocline at this time and was unavailable for most aquatic life. By the August sampling date, the thermocline was beginning to weaken allowing some nutrients to mix with the epilimnion. Once in these upper waters, the SRP was utilized by aquatic life, such as algae. A similar pattern was seen in 1997 with the SRP in the hypolimnion.

Nitrate nitrogen (NO_3-N) was found in high concentrations in May (0.303 mg/L) and June (0.791 mg/L) in the epilimnion. This is probably the result of spring turnover or run-off. Later in the season, algae and other organisms were able to utilize the nitrogen to the point where it was below detection limits in July, August, and September. Both ammonia nitrogen (NH_3-N) and total Kjeldahl nitrogen (TKN) concentrations in the hypolimnion showed a pattern similar to SRP, increasing through the months of May, June, and July, then decreasing in August and September.

The high nutrient concentrations in the lake may be coming from internal (sediment, algae decay, etc.) or external sources (run-off). Since Fish Lake is near the top of its watershed, it does not receive large amounts of water from other sources. However, extensive agricultural fields are located to the south of the lake and drain into the lake. Over time nutrients may have accumulated in the lake from run-off and have been recycled by way of internal processes. Also, in the past the Koenemann Sausage Company allegedly discharged effluent that may have added nutrients, like phosphorus, into the lake in violation of IEPA regulations. Fish Lake will likely have high nutrient concentrations for some time.

The average ratio between total nitrogen and total phosphorus for Fish Lake in 2002 was 23:1, indicating a phosphorus-limited system. This is up slightly from the 1997 ratio of 16:1. 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. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

Dissolved oxygen (DO) concentrations in Fish Lake did not indicate any significant problems. Generally concern arises when DO concentrations fall below 5 mg/L in the epilimnion. In 2002, all DO concentrations at the surface were >5mg/L. In May and September, when the lake was not stratified, the entire water column (surface to bottom) was fully oxic (>1 mg/L). Anoxic conditions (where DO concentrations drop below 1 mg/L) did exist below 13 feet in June, 7 feet in July, and 13 feet in August. The DO concentrations in 2002 were an improvement from conditions observed in 1997 when surface concentrations dropped to 1.7 mg/L in August. Conditions in the lake (i.e., shallow morphology, temperature, algae dominance) may cause DO concentrations to fluctuate widely, which may result in low DO concentrations at various times. In order to determine if these DO conditions are a problem, the volume at specific depths (preferably in one foot increments) is needed. Since only an old bathymetric map of Fish Lake exists, an accurate assessment of the DO conditions cannot be made.

The aeration system in Fish Lake is undersized. Based on a 96 acre lake, an aeration system designed to destratify the lake would need to have a 6.7 to 9.7 horsepower compressor with a 86 to 124 cubic feet per minute (CFM) capacity. Currently the system has three compressors at 0.2 hp (0.6 hp total). The aeration system in Fish Lake was not likely installed to destratify the entire lake, but to provide a refugia for fish during low DO conditions since the lake has experienced fishkills and low DO concentrations in the past. During 2002, LCHD staff observed only one diffuser working, thus, two diffusers were either not operating or operating improperly. If this system's use is continued, it is recommended that it be maintained to allow proper operation of all three diffusers. The effectiveness of the aeration system to serve as a refugia for fish is difficult to assess. In 2002 the lake did not experience any obvious DO problems, however, as mentioned previously LCHD staff did record low DO concentrations in August 1997. Owners of the system may look at having the aerators on only during the times of the year (mid-summer and winter) when fishkills are more likely to happen. The aerators should be turned off in the late-fall/early winter to allow the lake to completely freeze over. This will force resident Canada Geese to leave the area. Approximately one month after ice-over the aerators can be turned on again until ice-off.

Water levels on Fish Lake fluctuated throughout the season. The maximum change in water level occurred from May to July (19 inch decrease), however the overall seasonal change (May to September) was 7.63 inches during the study. Fluctuations in water levels may be the result of natural rain events or lack thereof. Since Fish Lake is near the top of its watershed, it relies heavily on rain events to replenish water lost through evaporation or outflow and the summer of 2002 had above normal air temperatures and below average precipitation. 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.

Rain events probably contribute additional sediment or nutrients (like phosphorus) to a lake, which may have influenced the water sample results. However, rain occurred within 48 hours prior to water sampling only in May (1.78 inches) as recorded at the Lake County Stormwater Management Commission rain gage in Wauconda.

Based on data collected in 2002, standard classification indices compiled by the Illinois Environmental Protection Agency (IEPA) were used to determine the current condition of Fish Lake. A general overall index that is commonly used is called a trophic state index or TSI. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich productive). This index can be calculated using total phosphorus values obtained at or near the surface. The TSIp for Fish Lake in 2002 classified it as a hypereutrophic lake (TSIp = 70.9). This is a slight improvement from the 1997 TSIp of 74.8. Eutrophic lakes are the most common types of lakes throughout the lower Midwest, and they are particularly common among manmade lakes. See Table 2 in Appendix A for a ranking of average TSIp values for Lake County lakes (Fish Lake is currently #77 of 103). This ranking is only a relative assessment of the lakes in the county. The current rank of a lake is dependent upon many factors including lake origin, water source, nutrient loads, and morphometric features (volume, depth, substrate, etc.). Thus, a small shallow manmade lake with high nutrient loads could not expect to achieve a high ranking even with intensive management.

In Fish Lake, the IEPA aquatic life impairment index was low, indicating a full degree of support for all aquatic organisms in the lake. However, due to the poor water clarity the swimming index indicated only a partial degree of support. Similarly due to high trophic status of the lake, the recreation use index showed a partial impairment.

LCHD has been testing the beaches at Camp Duncan and Fish Lake Beach bimonthly for bacteria from early-May to Labor Day in each of the years 1988-1993 and 2000-2002. Prior to 2002, the beach was tested for levels of fecal coliform bacteria. Beginning in 2002, the testing protocol was changed to monitor *E. coli* bacteria. In 2002 Camp Duncan was closed on two consecutive days (August 6-7) for high levels of *E. coli* bacteria (seasonal range of 0>2,419 colonies [cfu]/100 ml). Fish Lake Beach was closed one day (August 20; seasonal range of 1-1,203 cfu/100 ml). Illinois Department of Public Health standards for *E. coli* bacteria are currently set at 235 cfu/100 ml. The sources of *E. coli* bacteria can be numerous but at both beaches the suspected sources are waterfowl, particularly geese and swans, both of which are summer residents around the lake and were frequently seen on the beaches. More information can be found in **Objective VI: Canada Geese**.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Fish Lake were assessed monthly from May through September 2002 (see Appendix B for methods). Twelve aquatic plant species and several emergent shoreline plants were found (see Table 3, below).

Eurasian water milfoil (EWM), an exotic, was the dominant plant in Fish Lake in 2002 (see Table 4 in Appendix A). It was found in 53% of all plant samples, being most dominant later in the season (July-September). Curlyleaf pondweed, also an exotic, and sago pondweed were both found in 29% of samples, with curlyleaf pondweed being found more abundant in May and June while sago pondweed was more common in July and August. White water lily and coontail were also found in similar abundances (26% and 28% of all samples, respectively).

During the plant sampling, LCHD staff searched for the milfoil weevil (*Euhrychiopsis lecontei*) on EWM plants. This weevil attacks the tip and stem of the plant and is currently being used as a biological control for EWM in many lakes in the Midwest. The weevils are found naturally in many lakes. Unfortunately, no weevils were found in Fish Lake in 2002.

The 1% light levels (the point where plant photosynthesis ceases) decreased throughout the summer with the deepest light penetration occurring in May (10.5 feet) and the shallowest occurring in August (1.5 feet). This correlates with the maximum depth at which plants were found. For example, in June plants were found to a depth of 8.6 feet, however, later in the season (August and September) the maximum plant depth was only 6.5 feet. Due to these factors it was estimated that only 20% of the lake was covered with aquatic plants (note: this is plant coverage on the lake bottom and not an estimate of plants at the water's surface). These values also correspond to the poor water quality aspects that were described in the **Water Quality Assessment** section.

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 2002, Fish Lake had a FQI of 18.1. The average FQI of lakes studied by LCHD from 2000-2002 is 14.2.

Table 3. Aquatic and shoreline plants on Fish Lake, May - September 2002.

<u>*Aquatic Plants*</u>	
Coontail	*Ceratophyllum demersum*
American Elodea	*Elodea canadensis*
Small Duckweed	*Lemna minor*
Eurasian Water Milfoil	*Myriophyllum spicatum*
White Water Lily	*Nymphaea tuberosa*
Spatterdock	*Nuphar variegata*
Water Stargrass	*Heteranthera dubia*
Curlyleaf Pondweed	*Potamogeton crispus*
Flatstem Pondweed	*Potamogeton zosterifomis*
Wigeon Grass	*Ruppia maritima*
Sago Pondweed	*Stuckenia pectinatus*
Vallisneria (eel grass)	*Vallisneria americana*
<u>*Shoreline Plants*</u>	
Purple Loosestrife	*Lythrum salicaria*
Reed Canary Grass	*Phalaris arundinacea*
Buckthorn	*Rhamnus cathartica*
Willow	*Salix* sp.
Chairmaker's Rush	*Scirpus pungens*
Cattail	*Typha* sp.
Elm	*Ulmus* sp.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted in July 2002 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 63% of the shoreline of Fish Lake was classified as undeveloped. The only developments on the lake are the YMCA Camp Duncan and the Fish Lake Beach campground. The dominant shoreline type on the lake was wetland, comprising 88% of the total shoreline (Figure 4). Beach was the next most common type at 10%, while the remaining types (buffer, shrub, seawall, and lawn) made up the remaining 2%.

The shoreline was assessed for the degrees and types of shoreline erosion. However, no apparent erosion was taking place on Fish Lake (Figure 5). This is likely due to the types of shoreline found on the lake. Wetland and beach made up 98% of the shoreline and erosion is difficult to ascertain on these types of shoreline. So, while some erosion may be taking place it was not measurable with the methods used by LCHD.

Figure 4.

Figure 5.

Several exotics were found growing along the shoreline, including reed canary grass, purple loosestrife, and buckthorn. The purple loosestrife was found in scattered numbers with the highest concentrations along the northwestern shoreline. Buckthorn and reed canary grass were also not found in large numbers, but could become problems if not contained. 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.

In 2002, the LCFPD found three plant species (*Carex cryptolepis*, *Juncus alpinus rariflorus,* and *Panicum flexile*) in the wetland area on the east side of the lake that are listed as threatened or endangered species by the state of Illinois.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

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

Habitat around Fish Lake was fair to good. The dominance of cattails provides habitat for some wildlife species, but precludes a more diverse abundance of species due to its lack of plant diversity. The scattered trees around the lake provide good habitat for many insectivorous birds.

Three bird species listed as endangered by the state of Illinois were found on Fish Lake. Two of them, the common tern and the northern harrier, were only seen once and were assumed to be not nesting in the area. However, the black tern was seen throughout the summer and two adults were observed feeding two newly fledged young in August, suggesting a nest nearby. Fish Lake provides ample habitat for nesting black terns as well as other species. In 2002, LCFPD found five state threatened or endangered bird species (pied-billed grebe, black tern, black-crowned night heron, common moorhen, and yellow-headed blackbird) in the wetland area on the east side of the lake.

Both Camp Duncan and Fish Lake Beach Campground have expressed concerns over beaver activity on the lake, particularly at the outlet. Beavers can have a significant impact on natural ecosystems through their various activities including cutting and girdling of trees and construction of dams. In Fish Lake, the damming of the outlet may cause water level problems in the lake. More information of beavers can be found in **Objective VII: Beaver Management**.

No fish surveys were conducted by LCHD in 2002. However, carp were seen in the shallow areas and in the flooded cattails. Their presence reduces habitat for fish and wildlife as well has reduces water quality in the lake. As mentioned previously the lake is stocked each year with channel catfish.

Table 5. Wildlife species observed on Fish Lake, April – September 2002.

<u>Birds</u>	
Common Loon	*Gavia immer*
Double-crested Cormorant	*Phalacrocorax auritus*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
Lesser Scaup	*Aythya affinis*
Bufflehead	*Bucephala albeola*
Common Merganser	*Mergus merganser*
American Coot	*Fulica americana*
Ring-billed Gull	*Larus delawarensis*
Common Tern*	*Sterna hirundo*
Black Tern*	*Chlidonias niger*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularia*
Solitary Sandpiper	*Tringa solitaria*
Red-tailed Hawk	*Buteo jamaicensis*
Northern Harrier*	*Circus cyaneus*
Turkey Vulture	*Cathartes aura*
Mourning Dove	*Zenaida macroura*
Belted Kingfisher	*Megaceryle alcyon*
Common Flicker	*Colaptes auratus*
Downy Woodpecker	*Picoides pubescens*
Eastern Kingbird	*Tyrannus tyrannus*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Phoebe	*Sayornis phoebe*
Willow Flycatcher	*Empidonax traillii*
Purple Martin	*Progne subis*
Cliff Swallow	*Petrochelidon pyrrhonota*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
Rough-wing Swallow	*Stelgidopteryx ruficollis*
Bank Swallow	*Riparia riparia*
Chimney Swift	*Chaetura pelagica*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
Marsh Wren	*Cistothorus palustris*

Table 5. Wildlife species observed on Fish Lake, April – September 2002 (cont'd).

Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Rock Dove	*Columba livia*
Cedar Waxwing	*Bombycilla cedrorum*
Warbling Vireo	*Vireo gilvus*
Northern Parula Warbler	*Parula americana*
Yellow-rumped Warbler	*Dendroica coronata*
American Redstart	*Setophaga ruticilla*
Palm Warbler	*Dendroica palmarum*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Prothonotary Warbler	*Protonotaria citrea*
Northern Waterthrush	*Seiurus noveboracensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*
Swamp Sparrow	*Melospiza georgiana*
Song Sparrow	*Melospiza melodia*
Mammals	
Gray Squirrel	*Sciurus carolinensis*
Muskrat	*Ondatra zibethicus*
Amphibians	
American Toad	*Bufo americanus*
Bull Frog	*Rana catesbeiana*
Green Frog	*Rana clamitans melanota*
Western Chorus Frog	*Pseudacris triseriata triseriata*
Reptiles	
Painted Turtle	*Chrysemys picta*

Table 5. Wildlife species observed on Fish Lake, April – September 2002 (cont'd).

Insects	
Cicadas	Cicadidae
Dragonfly	Anisoptera
Damselfly	Zygoperta
Sulphur Butterfly	Pieridae
Monarch Butterfly	*Danaus plexippus*

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

EXISTING LAKE QUALITY PROBLEMS

- *Lack of a Quality Bathymetric Map*

  A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Currently, only an old 1971 map exists for Fish Lake.

- *Poor Water Clarity*

  Fish Lake had a Secchi disk transparency reading of 4.02 feet, which is an improvement from 1997, and slightly above the county average. Poor clarity, particularly in July, August, and September was partially the result of increased algae blooms. In addition, sediment resuspended from wind and wave action and carp activity also contribute to the poor clarity.

- *High Nutrient Concentrations*

  The lake had high concentrations of total phosphorus (TP), soluble reactive phosphorus (SRP) as well as nitrate nitrogen (NO_3-N) and total Kjeldahl nitrogen (TKN). Data on all parameters from 1997 and 2002 were similar. High nutrients, particularly TP and SRP, contribute to the algae blooms and poor water clarity.

- *Limited Aquatic Vegetation*

  While 12 species of aquatic plants were found in Fish Lake, the exotic Eurasian water milfoil was dominant. The second most common plant, curlyleaf pondweed is also an exotic. 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.

- *Invasive Shoreline Plant Species*

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

POTENTIAL OBJECTIVES FOR THE FISH LAKE MANAGEMENT PLAN

I. Bathymetric Map
II. Illinois Volunteer Lake Monitoring Program
III. Nuisance Algae Management Options
IV. Aquatic Plant Management Options
V. Control Exotic Plant Species
VI. Canada Geese
VII. Beaver Management
VIII. Enhance Wildlife Habitat Conditions

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Bathymetric Map

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Currently only an old 1971 bathymetric map of Fish Lake exists.

Maps can be created by agencies like the Lake County Health Department - Lakes Management Unit or other companies. Costs vary, but can range from $3,000-10,000 depending on lake size.

Objective II: Participate in the Volunteer Lake Monitoring Program

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection agency (Illinois EPA) to gather fundamental information on Illinois inland lakes, and to provide an educational program for citizens. Annually, 150-200 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 250 citizen volunteers. The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake.

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

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

For more information about the VLMP contact the VLMP Regional Coordinator:

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

Objective III. Aquatic Plant Management Options

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

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

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 Fish Lake, if aquatic herbicides are used, the selection of the type of chemical used is important. Since the substrate of the lake consists of highly organic soft sediment, any chemicals in pellet form may lose their effectiveness due to absorption from the substrate. In addition, since the lake is not completely covered in aquatic plants, spot treatments with a liquid systemic herbicide, like 2,4-D would be the preferred option. 2,4-D will affect the dicots (i.e., Eurasian water milfoil, coontail) but will not affect monocots like *Vallisneria* or water stargrass. However, if curlyleaf pondweed (which is a monocot) becomes problematic, spot treatments with a contact herbicide like Reward® may be necessary.

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 biodiveristy. 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. Granular 2,4-D is generally applied at $350-425/SA. Reward® is generally applied at 1-2 gallons per surface acre at a cost of about $425 per surface acre.

Option 3: Hand Removal

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

Pros

Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. Hand removal is an activity in which all lake residents could participate. The work involved in removing plants can provide a rewarding sense of accomplishment. By removing excess vegetation, use of beaches and piers would be improved. Many of the improved water quality benefits of a well-executed herbicide program or harvesting program are also shared by hand removal. Wildlife habitat, such as fish spawning beds, could be greatly improved. This in turn would benefit other portions of the lake's ecosystem.

Cons

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

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

<u>Option 4: Water Milfoil Weevil</u>

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 LCHD-Lakes Management Unit has documented weevils (*E. lecontei* and/or *P. leucogaster*) in 24 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.

During the plant sampling LCHD staff searched for the milfoil weevil (*Euhrychiopsis lecontei*) on EWM plants in Fish Lake. This weevil attacks the tip and stem of the plant and is currently being used as a biological control for EWM in many lakes in the Midwest. The weevils are found naturally in many lakes. Unfortunately, no weevils were found in Fish Lake in 2002. However, given that EWM is the dominant aquatic plant and the natural shoreline of Fish Lake, natural or introduced populations of milfoil weevils to control EWM may be a feasible management option.

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 5: Reestablishing Native Aquatic Vegetation

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

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

This is the preferred option to help improve the water quality and habitat in Fish Lake.

Pros

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

Cons

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

Costs

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

Objective IV. Nuisance Algae Management Options

The growth of nuisance or excessive algae can cause a number of problems. Excessive algal growth can cause decreases in water clarity and light penetration. This can lead to several major problems such as loss of aquatic plants, decline in fishery health, and interference with recreational activities. Health hazards, such as swimmer's itch and other skin irritations have been linked to nuisance algae growth. Normally, excessive/nuisance algae growth is a sign of larger problems such excessive nutrients and/or lack of aquatic plants. Some treatment methods, such as copper sulfate, are only quick remedies to the problem. Solving the problem of nuisance algal growth involves treating the factors that cause the growth not the algae itself. Long-term solutions typically include an integrated approach such as alum treatments, revegetation with aquatic plants, and limiting external sources of nutrients. Interestingly enough, these long-term management strategies are seldom used, typically because of their high initial costs. Instead, the cheap, quick fix of using copper sulfate, though temporary, is much more widely used. However, the costs of continually applying copper sulfate over years, even decades, can eventually far exceed the costs of a slower acting, eventually more effective, integrated approach.

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

Option 1: No Action

With a no action management plan nothing would be done to control the nuisance algae regardless of type and extent. Nuisance algae, planktonic and/or filamentous, could continue to grow until epidemic proportions are reached. Growth limitations of the algae and the characteristics of the lake itself (light penetration, nutrient levels.) will dictate the extent of growth. Unlike aquatic plants, algae are not normally bound by physical factors such as substrate type. The areas in which filamentous and thick surface planktonic blooms (scum) occur can be affected by wind and wave action if strong enough. However, under normal conditions, with no action, both filamentous and planktonic algal blooms can spread to cover 100% of the surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

Pros

There are positive aspects associated with the no action option for nuisance algae management. The first, and most obvious, is that there is no cost. However, if an active management plan for algae control were eventually needed, the cost would be substantially higher than if the no action plan had been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, chemicals or introduction of any organisms would not take place. Use of the lake would continue as normal unless blooms worsened. In this case, activities such as swimming might have to be suspended due to an increase in health risks. Other problems such as strong odors (blue-green algae) might also increase in frequency.

Cons

Under the no action option, if nuisance algae becomes wide spread and able to reach epidemic proportions, there will be many negative impacts on the lake. The fishery of the lake may become stunted due the to lack of quality forage fish habitat and reduced predation. This will cause an explosion in the small fish population and with food resources not increasing, growth of fish will be reduced. Fish kills can result from toxins released by some species such as some blue-green algae. Blue-green algae can also produced toxins that are harmful to other algae. This allows blue-green algae to quickly dominate a body of water. Decreased dissolved oxygen levels, due to high biological oxygen demand from the excessive algae growth, will also have negative impacts on the aquatic life. Wildlife populations will also be negatively impacted by dense growths of algae. Birds and waterfowl will have difficulty finding quality plants for food or in locating prey within the turbid green waters. Additionally, some species, such as blue-green algae, are poor sources of food for zooplankton and fish.

Water quality could also be negatively impacted with the implementation of a no action option. Decomposition of organic matter and release of nutrients upon algal death is a probable outcome. Large nutrient release with algae die back could lead to lake-wide increases of internal nutrient load. This could in turn, could increase the frequency or severity of other blooms. In addition, decomposition of massive amounts of algae, filamentous and planktonic, will lead to a depletion of dissolved oxygen in the lake. This can cause fish stress, and eventually, if stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake's ecosystem.

In addition to ecological impacts, many physical lake uses will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick mats of filamentous algae. Swimming could also become increasingly difficult and unsafe due to thick mats and reduction in visibility by planktonic blooms. Fishing could become more and more exasperating due in part to the thick mats and stunted fish populations. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by large green mats and/or blooms of algae and the odors that may develop, such as with large blue-green blooms. The combination of above events could cause property values on the lake to suffer. Property values on lakes with algae problems have been shown to decrease by as much as 15-20%.

Costs
No cost will be incurred by implementing the no action management option.

Option 2: Algicides
Algicides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate ($CuSO_4$) and chelated copper products are the two main algicides in use. These two compounds are sold by a variety of brand names by a number of different companies. They all work the same and act as contact killers. This means that the product has to come into contact with the algae to be affective. Algicides come in two forms, granular and liquid. Granular herbicides are spread by hand or machine over an effected area. They can also be placed in a porous bag (such as a burlap sack) and dragged though the water in order to dissolve and disperse the product. Granular algicides are mainly used on filamentous algae where they are spread over the mats. As the granules dissolve, they kill the algae. Liquid algicides, which are much more widely used, are mixed with a known amount of water to achieve a known concentration. The mixture is then sprayed onto/into the water. Liquid algicides are used on both filamentous and planktonic algae. Liquid algaecides are often mixed with herbicides and applied together to save on time and money. The effectiveness of some herbicides is enhanced when mixed with an algicide. When applying an algicide it is imperative that the label is completely read and followed. If too much of the lake is treated at any one time an oxygen crash may occur. This may cause fish kills due to decomposition of treated algae. Additionally, treatments should never be made when blooms/mats are at their fullest extent. It is best to divide the lake into at least two sections depending on the size of the lake. Larger lakes will need to be divided into more sections. Then treat the lake one section at a time allowing at least two weeks between treatments. Furthermore, application of algicides should never be done in extremely hot weather (>90^{o}F) or when D.O. concentrations are low. This will help lessen the likelihood of an oxygen crash and resulting fish kills. When possible, treatments should be made as early in the season as possible when temperature and D.O. concentrations are adequate. It is best to treat in spring or when the blooms/mats starts to appear there by killing the algae before they become a problem.

Pros
When used properly, algicides can be a powerful tool in management of nuisance algae growth. A properly implemented plan can often provide season long control with minimal applications. Another benefit of using algicides is their low costs. The fisheries and waterfowl populations of the lake would greatly benefit due to a decrease in nuisance algal blooms. By reducing the algae, clarity would increase. This in turn would allow the native aquatic plants to return to the lake.

Newly established stands of plants would improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed (*Potamogeton amplifolius*) and sago pondweed (*Potamogeton pectinatus*). Additionally, copper products, at proper dosages, are selective in the sense that they do not affect aquatic vascular plants and wildlife.

By implementing a good management plan, usage opportunities for the lake would increase. Activities such as boating and swimming would improve due to the removal of thick blooms and/or mats of algae. Health risks associated with excessive algae growth (toxins, reduced visibility, etc.) The quality of fishing may recover due to improved habitat and feeding opportunities. In addition to increased usage opportunities, overall aesthetics of the lake would improve, potentially increasing property values.

Cons

The most obvious drawback of using algicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error and overuse can make them unsafe and bring about undesired outcomes. By continually killing particular algal species, lake managers may unknowingly be creating a larger problem. As the algae are continuously exposed to copper, some species are becoming more and more tolerant. This results in the use of higher concentrations in order to achieve adequate control, which can be unhealthy for the lake. In other instances, by eliminating one type of algae, lake managers are finding that other species that are even more problematic are filling the empty gap. These species that fill the gap can often be more difficult to control due to an inherent resistance to copper products. Additionally, excessive use of copper products can lead to a build up of copper in lake sediment. This can cause problems for activities such as dredging. Due to a large amount of copper in the sediment, special permits and disposal methods would have to be utilized.

Costs

To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's aquatic plant management plan. A chelated copper product such as Cutrine–Plus® is applied at 0.5 to1.5 gallons per acre-foot at a cost of $35 per gallon.

Option 3: Alum Treatment

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum does not directly kill algae as copper sulfate does. Instead, alum binds phosphorus making it unavailable, thus reducing algal growth. Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom. This floc layer can then prevent sediment bound phosphorus from entering the water column. Phosphorus inactivation using alum has been in use for 25 years. However, cost and sometimes unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds and small lakes, and its use in larger lakes is increasing. Alum treatment typically lasts 1 to 20 years depending on various parameters. Lakes with low mean depth to surface area ratio benefit more quickly from alum applications, while lakes with high mean depth to surface area ration (thermally stratified lakes) will see more longevity from an alum application due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited. Alum treatments must be carefully planned and carried out by an experienced professional. If not properly done, there may be many detrimental side effects.

Pros

Phosphorus inactivation is a possible long-term solution for controlling nuisance algae and increasing water clarity. Alum treatments can last as long as 20 years. This makes alum more cost effective in the long-term compared to continual treatment with algaecides. Studies have shown reductions in phosphorus concentrations by 66% in spring and 68% in summer. Chlorophyll *a*, a measure of algal biomass, was reduced by 61%. Reduction in algal biomass caused an increase in dissolved oxygen and a 79% increase in Secchi disk readings. Effects of alum treatments can be seen in as little as a few days. The increase in clarity can have many positive effects on the lake's ecosystem. With increased clarity, plant populations could expand or reestablish. This in turn would improve fish habitat and provide improved food/habitat sources for other organisms. Recreational activities such as swimming and fishing would be improved due to increased water clarity and healthy plant populations. Typically, there is a slight invertebrate decline immediately following treatment but populations recover fully by the following year.

Cons

There are several drawbacks to alum. External nutrient inputs must also be reduced or eliminated for alum to provide long-term effectiveness. With larger watersheds this could prove to be physically and financially impossible. Phosphorus inactivation may be shortened by excessive plant growth or motorboat traffic, which can disturb the flocculent layer and allow phosphorus to be released. Also, lakes that are shallow, non-stratified, and wind blown typically do not achieve long term control due to disruption of the flocculent layer. If alum is not properly applied toxicity problems may occur. Typically aluminum toxicity occurs if pH is below 6 or above 9. Most of Lake County's lakes are in this safe range. However, at these pHs, special precautions must be taken when applying alum. By adding the incorrect amounts of alum, pH of the lake could drastically change. Due to these dangers, it is highly recommended that a lake management professional plans and administers the alum treatment.

Costs

Current morphometic data is required to make proper calculations. However, based on 1971 volume of Fish Lake (850 acre-feet) an alum treatment would cost approximately $11,900 – 40,800.

Option 4: Revegetation With Native Aquatic Plants

This option is identical to Option 5 in **Objective III: Aquatic Plant Management** above.

Objective V: Eliminate or Control Exotic Species

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

Purple loosestrife is responsible for the "sea of purple" seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. Due in part to an extensive root system, large seed production (estimates range from 100,000 to 2.7 million seeds per plant), and high seed germination rate, purple loosestrife spreads quickly. Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants and is quick to become established on disturbed soils. Reed canary grass is an aggressive plant species that was introduced as a shoreline stabilizer. It is found on lakeshores, streambanks, marshes and exposed moist ground. Although it does serve to stabilize shorelines to some extent, it has low food value and does not provide winter habitat for wildlife. It is very successful in taking over disturbed areas and, if left unchecked, will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

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

Option 1: No Action

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

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

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

Recreational activities, especially wildlife viewing, may be hampered by such monocultures. Access to lake shorelines may be impaired due to dense stands of non-native plants. Other recreational activities, such as swimming and boating, may not be affected.

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

Option 2: Biological Control
Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase.

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

Pros

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

Cons

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

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

Costs

The New York Department of Natural Resources at Cornell University (607-255-2821) sells overwintering adult beetles (which will lay eggs the year of release) for $2 per beetle and new generation beetles (which will lay eggs beginning the following year) at $0.25 per beetle. Some beetles may be available for free by contacting the Illinois Natural History Survey (217-333-6846).

Option 3: Control by Hand

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

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

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

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

Option 4: Herbicide Treatment

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

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

Pros
Herbicides provide a fast and effective way to control or eliminate nuisance vegetation. Unlike other control methods, herbicides kill the root of the plant,

which prevents regrowth. If applied properly, herbicides can be selective. This allows for removal of selected plants within a mix of desirable and undesirable plants.

Cons

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

Costs

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

Objective VI: Canada Geese (*Branta canadensis*)

Canada geese 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 2001-2002 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 $70/gallon, GooseChase™ is $92/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.

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

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

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

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

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

Costs
If minimal amount of site preparation is needed to create a buffer strip, costs can be approximately $10 per linear foot, plus labor. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

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

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

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

Reference:

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

Objective VII: Beaver Management

The beaver (*Castor canadensis)* is the largest rodent in North America. Adults typically weigh 40-50 pounds, but may weigh over 90 pounds. Beavers make their homes in lodges or dens along a lake or streambank. They can live in a small group of two or in larger colonies of five or more. Beavers generally confine their activities to an area within 1/2 mile of their lodge or den.

Beavers were common in Illinois prior to the 1900's. Extensive hunting and trapping in the late 1800's and early 1900's nearly extirpated the beaver from the state. However, conservation efforts, including hunting and trapping laws and reintroduction programs, in the middle 1900's successfully brought the populations back. Currently, beavers are found throughout Illinois.

Beavers are frequently blamed for destroying valuable shrubs and trees and flooding yards and farm fields. In a lake, beavers may dam a culvert or a stream causing lake water levels to rise or fall depending of the directional flow of the culvert or stream. On many lakes, beavers do not build dams since the water level is deep enough. In these cases they build lodges along the shoreline.

Beavers provide many benefits as well. Their engineering skills benefit natural environments by creating wetlands, pools, and other habitats favored by many other wildlife species including waterfowl, other mammals, amphibians, and fish. Several endangered species also benefit from habitats created by beaver.

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

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

Pros

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

Cons

Beaver populations may continue to increase, potentially causing more damage to valuable shrubs and trees. Significant alterations around the lake (reduction of plant life, particularly trees) may be viewed negatively by some lake residents. Also, higher water levels resulting from beaver dams may damage property or concern many landowners.

Costs

Costs for this option is primarily from beaver damage or destruction (i.e., cut trees, flood damage, etc.).

Option 2: Exclusion

One of the most successful options in beaver management is using exclusion techniques to prevent damage to valued resources, like shrubs and trees. Beavers have preferred foods (i.e., maple, aspen and willow trees) and will target these species before selecting other types of trees or shrubs.

Excluding the beavers from damaging these plants generally is accomplished by erecting a fence either around an area or individual plant that is to be protected. Any sturdy fencing material should work. In all cases, fences should be at least four feet in height, since beavers are not good climbers. The four foot height is necessary to prevent beaver from breaching the fence in winters with significant snow depths.

Individually, trees should be double wrapped with hardware cloth or welded wire. Wire should be to the base of the tree. Annual maintenance will be needed to prevent loose wire from slipping off the tree.

Pros

Excluding beaver from certain areas or individual plants will obviously prevent the damage or death of the plants selected for protection. Exclusion of beavers may also force them to move to another more suitable location since their main source of food and shelter has been made inaccessible.

Cons

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

Costs

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

Option 3: Removal

Removing beavers from an area is usually done by either live or kill trapping or shooting. Live traps may look like a box (Havahart traps) or an open clamshell (Hancock traps). These traps usually need to be set on dry land so the captured beaver does not drown. Kill traps (called conibear traps) are the most commonly used by trappers. These traps are usually set underwater, along a run, or at the surface of the water, generally near the lodge or den. Baits and scents are often used to lure beavers to traps. Seasonal trapping and hunting restrictions prohibit taking beaver when they are raising young. Licenses are required to trap or shoot beaver in Illinois. Many municipalities prohibit discharging a firearm within its boundaries.

Pros
Trapping beavers will remove the nuisance animals from the immediate area. If a commercial trapper is used, nothing else needs to be done by the landowner. Valuable shrubs and trees will be protected.

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

Costs
A trapping license in Illinois costs $10.50 in 2001, hunting license cost $7.50. A hunting license is not needed if only trapping is conducted. However, if either license is purchased a habitat stamp is also needed ($5.50). Live traps can range from $70 each (Havahart trap) to $350 each (Hancock trap) or more. Kill traps like a #330 conibear cost $18-20 each (cheaper if large numbers are purchased). A pair of setting tools needed to set conibear trap cost $10. Additional cost may include bait or scent.

Commercial trappers usually charge a set-up fee (approximately $200-250) and $100/beaver. Costs increase if beavers are live-trapped.

Option 4: Habitat Alteration

Altering the habitat around the dam or lodge can also avert beaver damage. Removing the preferred foods (i.e., maple, aspen, and willow) and replacing or replanting with less preferred foods (i.e., pine or spruce) may reduce the amount of damage.

Physically removing the dam or lodge may encourage the beaver to move elsewhere. However, permits from the Illinois Department of Natural Resources are needed for this.

Pros
Altering habitat or physical removal of a dam may encourage beaver to leave the area.

Cons
Beaver may still gnaw on non-preferred food items. Damaged or removed dams may be rebuilt. Significant time and effort would be needed to alter the habitats around a lake.

Costs
Costs will depend on the degree of habitat alteration that is done. Most of the costs will be in the form of personal time by landowners or other interested parties.

Objective VIII: 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 run-off 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.