2002 SUMMARY REPORT
of
LAKE MINEAR

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

The filling of an abandoned gravel pit circa 1951 created Lake Minear. It is approximately 77.8 acres in size, has a shoreline length of 3.5 miles, and a maximum depth of 22 feet.

One of the most important findings in 2002 was the discovery by a lake resident of the presence of zebra mussels in Lake Minear. Zebra mussels may negatively impact the water quality of the lake in the future.

Lake Minear's water quality is better than most lakes in Lake County. All of the water quality parameters measured were below the averages or medians (where 50% of the lakes are above and below this value) of other lakes that the Lake County Health Department (LCHD) has monitored. All water quality parameters measured in 2002 were very similar to 1997, when LCHD last studied the lake.

Water clarity, as measured by Secchi disk transparency readings, averaged 10.06 feet for the season, which is well above the county median of 3.81 feet. Secchi disk readings were deepest in June (13.55 feet) and shallowest in May (7.97 feet). In 1997 the Secchi disk readings averaged 7.53 feet.

Total phosphorus (TP) concentrations in Lake Minear were very low. The 2002 average TP concentration was 0.017 mg/L in the epilimnion (based on only four samples, since July's sample had concentrations below the detection limit of 0.001 mg/L) and 0.026 mg/L in the hypolimnion.

Twelve aquatic plant species, one macro-algae, and several emergent shoreline plants were found. Throughout the sampling season, the exotic Eurasian water milfoil was the dominant plant comprising 76% of all samples. The next most common plants were slender naiad (18%) and watermeal (14%).

Approximately 42% of the shoreline of Lake Minear was classified as developed. Several different shoreline types were identified. The most common shoreline type was woodland (36%) followed by shrub (18%), beach (15%), riprap (14%), and buffer (6%). The remaining three shoreline types (wetland, lawn, and seawall) all make up less than 5%, respectively.

Erosion was documented on 61% of the shoreline of the lake, however most of this was classified as slightly eroding. Approximately 16% or 1,926 feet of shoreline was moderately eroding and 14% or 1,644 feet was severely eroding.

Three state threatened or endangered bird species (pied-billed grebe, common tern, and an osprey) were seen using Lake Minear in 2002. While these species likely did not nest in the area, the lake did provide important migration habitat.

LAKE IDENTIFICATION AND LOCATION

Lake Minear (T44N, R11E, Sections 15 and 16) is located east of State Highway 21 and north of State Highway 176 in the Village of Libertyville (Libertyville Township). It is part of the Upper Des Plaines River drainage of the Des Plaines River watershed. Lake Minear was an old gravel pit and has no inlets or outlets. The lake receives water from rainfall and surface drainage. In addition, it may be groundwater fed and likely receives water from the Des Plaines River when it overflows its banks. The river is approximately 500 feet from the lake.

Lake Minear encompasses approximately 77.8 acres and has a shoreline length of 3.5 miles. Historically, the maximum depth was reported to be 24 feet. However, the Lake County Health Department – Lakes Management Unit (LCHD) determined the current maximum depth to be 22 feet, measured in April 2002. A 1970 bathymetric (depth contour) map of the main body of the lake indicates an average depth of 11.9 feet and the volume of the lake to be 892.5 acre-feet (Figure 1). Lake elevation is approximately 644 feet above sea level.

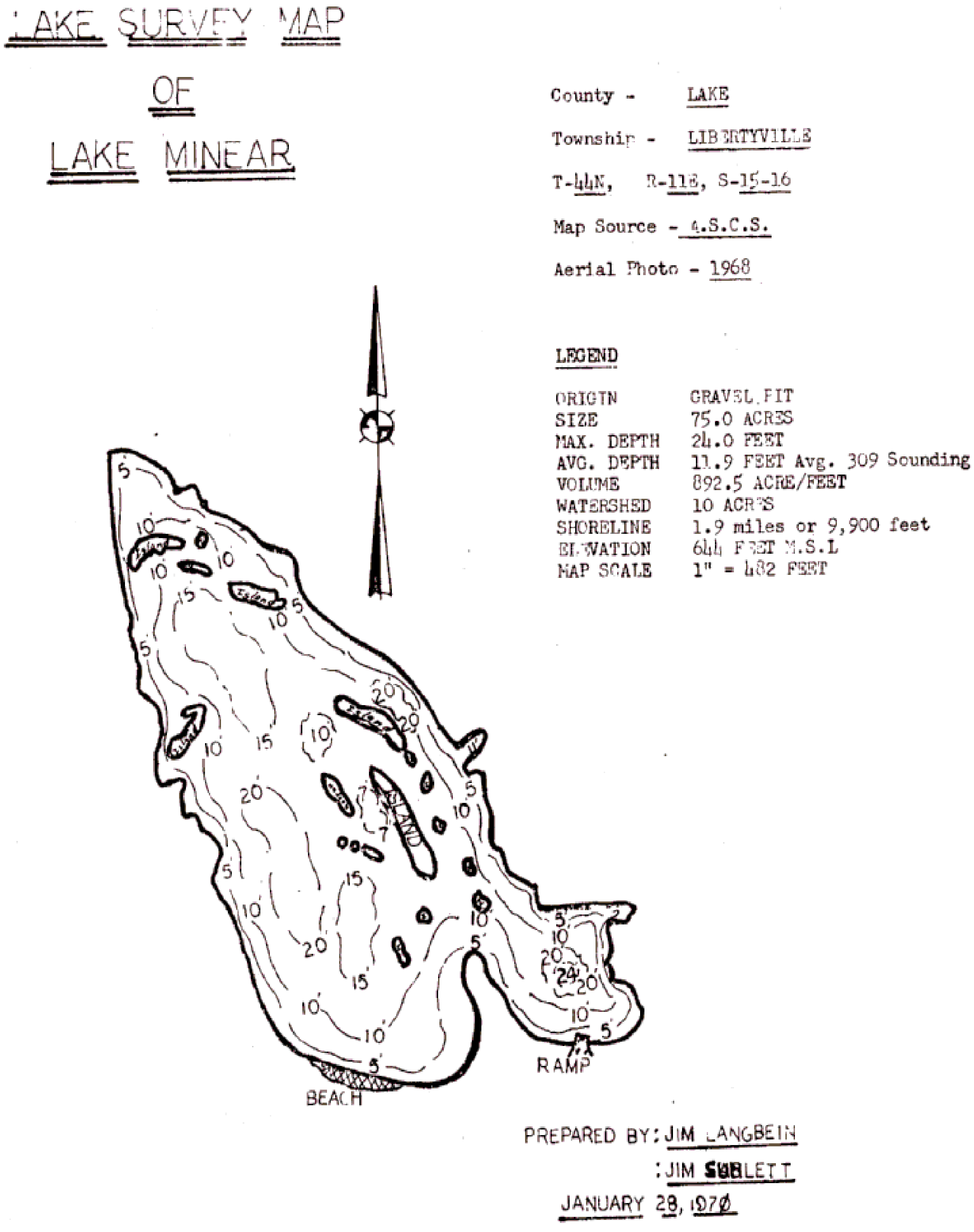
BRIEF HISTORY OF LAKE MINEAR

The filling of an abandoned gravel pit circa 1951 created Lake Minear. See Figure 2 in Appendix A for a 1939 aerial photograph. It has long been used by the Libertyville Boat Club (LBC) for both boating and swimming. The Illinois Department of Natural Resources (IDNR) has conducted several fishery studies over the years, most recently in 1998. LCHD has conducted water quality studies in 1988 and 1997 prior to 2002. Results of these reports will be included in the body of this report. A volunteer has participated in the Illinois Environmental Protection Agency's (IEPA) Volunteer Lake Monitoring Program (VLMP) measuring water clarity in Lake Minear since 1997 and collected water samples in 1999 and 2000. This has been a very successful program and should continue in the future.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Lake Minear is a private lake used by the members of the LBC as well has members of the Lake Minear Homeowners Association (LMHA). While some private residents do own small sections of the lake bottom along their shoreline, the Lake Minear Conservation Association owns most of the bottom. The lake has one boat launch that can be used year-round by members. There is also a beach that is open from Memorial Day to Labor Day. Swimming is permitted when a lifeguard is present and then only within designated areas. The beach is monitored bimonthly for *E. coli* bacteria by LCHD from Memorial Day to Labor Day. Results of the 2002 beach sampling will be discussed in the body of this report.

Figure 1. 1970 bathymetric map of Lake Minear.



The LBC has a 10 horsepower motor limit and a no wake rule for the entire lake, however, the LMHA does not have any limitations.

The LBC manages the beach, while the LMHA manages the rest of the lake. Dues are charged to members of the LBC for use of the lake during hours of operation (daytime, approximately Memorial Day to Labor Day). An extra membership can be purchased to fish on the lake year-round.

The management of the lake fishery is based on the recommendations of the IDNR. Fish stocking has taken place in the past, but not in the last three years.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were taken monthly from May - September at the deep-hole location near the eastern shoreline (Figure 3). See Appendix B for water sampling methods.

Lake Minear's water quality is better than most lakes in Lake County (Table 1 in Appendix A). All of the water quality parameters measured were below the averages or medians (where 50% of the lakes are above and below this value) of other lakes that LCHD has monitored. All water quality parameters measured in 2002 were very similar to 1997, the last year LCHD studied the lake. Several important findings were noted.

One of the most important findings in 2002 was the discovery by a lake resident of the presence of zebra mussels (*Dreissena polymorpha*) in Lake Minear. The Illinois Natural History Survey positively confirmed the identification of these mussels. Zebra mussels may impact the water quality of Lake Minear in the future. Signage should be posted at the boat launch and at the beach informing lake users of the mussel's presence in the lake to prevent its spread to other inland lakes.

Water clarity, as measured by Secchi disk transparency readings, averaged 10.06 feet for the season, which is well above the county median of 3.81 feet. Secchi disk readings were deepest in June (13.55 feet) and shallowest in May (7.97 feet). The 2002 Volunteer Lake Monitoring Program (VLMP) average for Lake Minear was 9.27 feet. In 1997 the Secchi disk readings averaged 7.53 feet. These good water clarity readings are likely the result of several factors including lake origin and morphology (i.e., gravel pit), substrate (i.e., rocky), aquatic plant populations, and minimal inflow from other sources (i.e., stormwater). Volunteers with the VLMP have been recording Secchi disk readings since 1997, which indicates some annual fluctuations (Figure 4, below; Table 2, Appendix A), but no discernable trend at this time.

Total phosphorus (TP) concentrations in Lake Minear were very low. The 2002 average TP concentration was 0.017 mg/L in the epilimnion (based on only four samples, since July's sample had concentrations below the detection limit of 0.001 mg/L) and 0.026 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

Figure 3.

Figure 4.

sufficient enough to cause nuisance algae blooms. In 1997, only two months had concentrations above the detection limit so the seasonal "average" (0.014 mg/L) is actually less than reported. Concisely, the TP concentrations have remained similar in the five years between the LCHD studies.

The 2002 average ratio between total nitrogen and total phosphorus for Lake Minear was 35:1, indicating a phosphorus-limited system. 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 Lake Minear 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 near the surface were above 5 mg/L. Anoxic conditions (where DO concentrations drop below 1 mg/L) did exist below 16 feet in July, August, and September. Since only an old bathymetric map of Lake Minear exists, an accurate assessment of the DO conditions cannot be made.

Lake Minear was stratified throughout the sampling season. The lake was weakly stratified in May at 12 feet, then more strongly stratified in June at 8 feet. In July and August the thermocline was at 12 feet and by September it had weakened and was located at 16 feet. The hypolimnion remained oxic throughout the season with the exception of the lake area below 16 feet in July, August, and September. This is not unusual for lakes that are mesotrophic (intermediate nutrient availability and biological productivity) due to low amounts of nutrients and sediment in the water.

Water levels in Lake Minear fluctuated throughout the season. The maximum change in water level occurred from May to June (a 10.1 inch decrease). This change was also the seasonal maximum for the duration of the study. Significant changes in water levels may have negative impact on water quality as well as aquatic and emergent plant populations. 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 (0.01 inches) as recorded at the Lake County Stormwater Management Commission rain gauge in Vernon Hills.

Based on data collected in 2002, standard classification indices compiled by the IEPA were used to determine the current condition of Lake Minear. 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, 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 Lake Minear in 2002 classified it as a mesotrophic lake (TSIp = 44.6). This is a slight increase from the 1997 TSIp of 42.2. Eutrophic lakes are the most common types of lakes throughout the lower Midwest, and they are particularly common among manmade lakes. See Table 3 in Appendix A for a ranking of average TSIp values for Lake County lakes (Lake Minear is currently #6 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.).

In Lake Minear, the IEPA aquatic life impairment index was low, indicating a full degree of support for all aquatic organisms in the lake. Similarly, the swimming index indicated a full degree of support. However, due to the high percentage of aquatic plants near the surface of the lake, the recreation use index showed a partial impairment.

LCHD has been testing the beach bimonthly for potentially harmful bacteria from early May to Labor Day each year since 1988. 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. All samples in 2002 indicated low levels of *E. coli* bacteria (range 0-6.3 colonies per 100 ml). Illinois Department of Public Health standards for *E. coli* bacteria are currently set at 235 colonies per 100 ml. Since LCHD began monitoring this beach in 1988, bacteria levels have not been found in high enough numbers to recommend beach closure.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Lake Minear were assessed monthly from May through September 2002 (see Appendix B for methods). Twelve aquatic plant species, one macro-algae, and several emergent shoreline plants were found (see Table 4, below).

Throughout the sampling season, the exotic Eurasian water milfoil (EWM) was the dominant plant comprising 76% of all samples (Table 5 in Appendix A). The next most common plants were slender naiad (18%) and watermeal (14%). All other plant species were found in < 10% of the samples. While EWM was found during each sampling period, slender naiad was found later in the summer. Another exotic, curlyleaf pondweed, was also present in the lake, although its numbers were relatively low.

Since Lake Minear has a boat launch, it is recommended that a sign be erected at the launch notifying users of the presence of EWM (and zebra mussels) in the lake, so they are not introduced into other lakes which do not already have it. The Exotic Species Advisory signs are available for $13.50 each to homeowner associations from the Illinois-Indiana Sea Grant Program at their internet site http://www.iisgcp.org/outrch/br/sign.htm or by calling 1-800-345-6087.

Readings at the water quality sampling point indicated that enough light sufficient for aquatic plants to photosynthesize (known as the 1% light level) was found at the bottom of the lake during the entire season. Based on this data, vegetative coverage of the lake bottom could theoretically be 100% during the entire season. However, no aquatic plants were found at the deep-hole sampling location or other areas deeper than 16 feet and areas around several of the islands where the substrate was hard gravel. Thus, the total aquatic plant coverage in the lake was estimated at 60% (note: this is plant coverage on the lake bottom and not an estimate of plants at the water's surface). An active aquatic plant management plan is needed on Lake Minear to control the EWM while maintaining water clarity and plant diversity. A whole lake treatment is not necessary at this time. If needed, spot treatments of EWM with an herbicide like diquat (e.g., Reward®) or 2,4-D could be done (see **Objective II: Aquatic Plant Management Options**).

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 Lake Minear in 2002.

In 2002, the LBC did not apply aquatic herbicides and algaecides to the lake. However, field inspection of the residential western shoreline suggests some residents may have treated areas of the lake immediately in front of their homes.

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, Lake Minear had a FQI of 18.8. The average FQI of lakes studied by LCHD from 2000-2002 is 14.2.

Table 4. Aquatic and shoreline plants on Lake Minear, May - September 2002.

<u>*Aquatic Plants*</u>	
Coontail	*Ceratophyllum demersum*
Chara/Nitella	*Chara* sp./*Nitella* sp.
Small Duckweed	*Lemna minor*
Eurasian Water Milfoil	*Myriophyllum spicatum*
Slender Naiad	*Najas flexilis*
Curlyleaf Pondweed	*Potamogeton crispus*
Leafy Pondweed	*Potamogeton foliosus*
American Pondweed	*Potamogeton nodosus*
Small Pondweed	*Potamogeton pusillus*

Flatstem Pondweed	*Potamogeton zosterifomis*
Sago Pondweed	*Stuckenia pectinatus*
White Water Crowfoot	*Ranunculus longirostris*
Watermeal	*Wolffia columbiana*
<u>*Shoreline Plants*</u>	
Box Elder	*Acer negundo*
Silver Maple	*Acer saccharinum*
Swamp Milkweed	*Asclepias incarnata*
Common Milkweed	*Asclepias syriaca*
Bull Thistle	*Cirsium vulgare*
Dogwood	*Cornus sp.*
Crown-vetch	*Coronilla varia*
Hawthorn	*Crataegus* sp.
Queen Anne's Lace	*Daucus carota*
Spikerush	*Eleocharis sp.*
Ash	*Fraxinus* sp.
Jewelweed	*Impatiens pallida*
Blue Flag Iris	*Iris hexagona*
Honeysuckle	*Lonicera sp.*
White Sweet Clover	*Melilotus alba*
Virginia Creeper	*Parthenocissus quinquefolia*
Reed Canary Grass	*Phalaris arundinacea*
Common Reed	*Phragmites australis*
Cottonwood	*Populus deltoides*
Black Cherry	*Prunus serotina*
Red Oak	*Quercus rubra*
Buckthorn	*Rhamnus cathartica*
Poison Ivy	*Rhus radicans*
Multiflora Rose	*Rosa multiflora*
Black-eyed Susan	*Rudbeckia serotina*
Willow	*Salix sp.*
Elderberry	*Sambucus sp.*
River Bulrush	*Scirpus fluviatilis*
Softstem Bulrush	*Scirpus validus*
Bittersweet Nightshade	*Solanum dulcamara*
Canada Goldenrod	*Solidago candensis*
Prairie Cordgrass	*Spartina pectinata*
Basswood/Linden	*Tilia americana*
Cattail	*Typha sp.*
Elm	*Ulmus sp.*
Common Mullein	*Verbascum thapsus*
Blue Vervain	*Verbena hastata*
Wild Grape	*Vitis sp.*

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted in August 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 42% of the shoreline of Lake Minear was classified as developed. Several different shoreline types were identified. The most common shoreline type was woodland (36%) followed by shrub (18%), beach (15%), riprap (14%), and buffer (6%; Figure 5). The remaining three shoreline types (wetland, lawn, and seawall) all make up less than 5%, respectively. Buffer habitat is a strip of unmowed grass or native vegetation located along the water's edge.

Erosion was documented on 61% of the shoreline of Lake Minear (Figure 6), however most of this was classified as slightly eroding. Approximately 16% or 1,926 feet of shoreline was moderately eroding and 14% or 1,644 feet was severely eroding. All of the severely eroding sections were located on the islands, with the exception of a 116 foot section along the residential western shoreline. The moderately eroded sections were scattered along different areas of the lake, with the longest sections being along the eastern side of the southern peninsula and a section along the northern shoreline of the southeastern bay of the lake. Part of the problem with the erosion on the southern peninsula is the broken concrete slabs that have been used as riprap and are ineffective at absorbing wave energy, due in part to the flat surfaces of the concrete that actually deflect wave energy into the spaces between the slabs, eventually eroding the bank behind the concrete. It also appears that no filter fabric exists below the concrete.

Exotic plant species were common along the shoreline of Lake Minear. The most common exotic plants were buckthorn, honeysuckle, multiflora rose, and reed canary grass. Buckthorn and honeysuckle are particularly problematic as they outcompete native plants and offer little value in terms of shoreline stabilization or wildlife habitat. These plants are the dominant shrub species in the woodland areas along the eastern shoreline. Plants should be removed and replaced with native shoreline plants.

In addition to shoreline plants, emergent vegetation should be planted or encouraged to grow. These plants (arrowhead, bulrushes, spikerushes, etc.) help stabilize the shoreline by buffering wind and wave action. However, due to the hard rocky substrate along the shoreline and shallow water areas, it may be difficult for emergent plants to become established. Along the shoreline, buffer strips should be installed between the water and manicured lawns to reduce nutrient-rich runoff into the lake. Both emergent vegetation and buffer strips also provide habitat for fish and wildlife that use the lake. More information can be found in the section **Objective III: Shoreline Erosion Control**.

Figure 5.

Figure 6.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Good wildlife populations, primarily birds, were found on and around Lake Minear (see Appendix B for methods). Several of the species listed in Table 6 (below) were seen during spring or fall migration and were assumed not to be nesting around the lake. Current habitat is fair to good. Many species of wildlife, including many of the bird species were seen along the wooded eastern shorelines.

Habitat around Lake Minear supports several amphibian and reptile species. One of the more interesting findings was the presence of an eastern spiny softshell turtle in the lake. This species is uncommon in Lake County and is the first recorded by LCHD in the past three years.

Three state threatened or endangered bird species were seen using Lake Minear in 2002. A pied-billed grebe (threatened) and a common tern (endangered) were seen migrating early in the year and an osprey (endangered) was seen migrating in September. While these species likely did not nest in the area, the lake did provide important migration habitat. Good water quality and habitat are important for migrating birds as they rest and replenish energy reserves lost during migration.

Beaver activity was seen during the 2002 season. Due to the lake's proximity to the Des Plaines River, beaver will likely be a continuing management concern. More information can be found in **Objective VI: Beaver Management**.

No fish surveys were conducted by LCHD. However, the IDNR has studied the fish in the lake in years past, most recently in 1998. At that time the IDNR stated that the lake consisted of too many stunted panfish due mostly to the dense stands of EWM. The report concluded that the lake had potential to maintain a balanced fishery and recommended management of EWM, establishing a 15-inch minimum length limit and one per day catch of largemouth bass, stock bass and other predatory gamefish, and remove carp and yellow bass through fishing harvest.

Table 6. Wildlife species observed on Lake Minear, April – September 2002.

<u>Birds</u>	
Pied-billed Grebe+	*Podilymbus podiceps*
Double-crested Cormorant	*Phalacrocorax auritus*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Blue-winged Teal	*Anas discors*
Red-breasted Merganser	*Mergus serrator*
Ring-billed Gull	*Larus delawarensis*
Common Tern*	*Sterna hirundo*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Virginia Rail	*Rallis limicola*
Spotted Sandpiper	*Actitis macularia*
Cooper's Hawk	*Accipiter cooperii*
Red-tailed Hawk	*Buteo jamaicensis*
Osprey*	*Pandion haliaetus*
Belted Kingfisher	*Megaceryle alcyon*
Common Flicker	*Colaptes auratus*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villocus*
Eastern Kingbird	*Tyrannus tyrannus*
Great Crested Flycatcher	*Myiarchus crinitus*
Tree Swallow	*Iridoprocne bicolor*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
Catbird	*Dumetella carolinensis*
Eastern Bluebird	*Sialia sialis*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Warbling Vireo	*Vireo gilvus*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow Warbler	*Dendroica petechia*
Magnolia Warbler	*Dendroica magnolia*
Common Yellowthroat	*Geothlypis trichas*
Red-winged Blackbird	*Agelaius phoeniceus*
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*

Table 6. Wildlife species observed on Lake Minear, April – September 2002 (cont'd).

White-throated Sparrow	*Zonotrichia albicollis*
Song Sparrow	*Melospiza melodia*
Mammals	
Beaver	*Castor canadensis*
Amphibians	
American Toad	*Bufo americanus*
Bull Frog	*Rana catesbeiana*
Western Chorus Frog	*Pseudacris triseriata triseriata*
Reptiles	
Painted Turtle	*Chrysemys picta*
Snapping Turtle	*Chelydra serpentina*
Eastern Spiny Softshell Turtle	*Apalone spinifera*
Insects	
Cicadas	Cicadidae
Dragonfly	Anisoptera
Buckeye Butterfly	*Junonia coenia*
Red Admiral Butterfly	*Vanessa atalanta*
Sulphur Butterfly	Pieridae
Monarch Butterfly	*Danaus plexippus*
Skipper Butterfly	Hesperiidae

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

EXISTING LAKE QUALITY PROBLEMS

- *Shoreline Erosion*

  Erosion was documented on 61% of the shoreline of Lake Minear, however most of this was classified as slightly eroding. Approximately 16% or 1,926 feet of shoreline was moderately eroding and 14% or 1,644 feet was severely eroding. These areas should be rehabilitated in the near future.

- *Invasive Exotic Plant Species*

  In the water, Eurasian water milfoil (EWM) and curlyleaf pondweed were found in Lake Minear. EWM is dominant and has been reported to be a problem in the lake for some time. An active aquatic plant management plan should be created to control this exotic.

  Several other exotic species were found along Lake Minear's shoreline. Buckthorn and honeysuckle were dense along the wooded area. These exotics have the potential to become a significant problem and should be removed or kept in control to prevent their spread.

- *Zebra Mussels*

  Zebra Mussels were identified for the first time in Lake Minear in 2002. Their presence may have significant impacts on water quality in the lake in the future. Signage should be posted to inform lake users of the mussel's presence and prevent the spread of this exotic to other inland water bodies.

- *Beaver*

  Beaver activity was observed during the 2002 season. Due to the lake's proximity to the Des Plaines River, beaver will likely be a continuing management concern. Beaver can significantly impact the shoreline plants around a lake. Some form of beaver management is advisable on Lake Minear.

POTENTIAL OBJECTIVES FOR THE LAKE MINEAR MANAGEMENT PLAN

I. Bathymetric Map
II. Aquatic Plant Management Options
III. Shoreline Erosion Control
IV. Control Exotic Plant Species
V. Zebra Mussels
VI. Beaver Management
VII. 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 1970 bathymetric map of Lake Minear 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: 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.

Option 1: No Action

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

Pros

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

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

Cons

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

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

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

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

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

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

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

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 watermilfoil 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%.

As mentioned previously, at this time a whole-lake treatment is not needed in Lake Minear. Spot-treating areas of EWM may be needed to control this exotic and enhance the diversity and abundance of the native plants. If spot-treating is done an herbicide like diquat (Reward®) or 2,4-D should be used. Granular 2,4-D pellets would be the preferred option since 2,4-D is a systemic herbicide and would provide longer control than diquat which is a contact herbicide. The 2,4-D products are also selective for dicots, like EWM, and not monocots like many of the native pondweeds. If EWM increases in coverage and density a whole-lake treatment with fluridone may need to be addressed.

Costs

To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's aquatic plant management plan. Diquat is applied at 1-2 gallons/SA at $425/SA, granular 2,4-D is applied at 100 lbs/SA at $350-425/SA. Fluridone is applied based on volumetric calculations ($11.75/AF at 10 ppb).

Option 3: Mechanical Harvesting

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

Pros

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

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

Cons

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

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

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

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

Cost

Depending on the type of the harvester (cutting width, payload capacity, hull material, HP of the motor, trailer options, etc) prices range from $50,000 to $150,000. Operational and maintenance cost typically range from $161.00-$445.00/acre.

Option 4: 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 5: 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^{o}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.

While no weevils were found in Lake Minear in 2002, the EWM beds in the lake are substantial enough to support a weevil population, either natural or introduced. The shoreline of Lake Minear, particularly the undeveloped eastern shore, appears to be adequate for supporting overwintering weevils. However, other factors, such as water chemistry or fish predation may be prohibiting natural populations from occurring (or only occurring in undetectable numbers) in the lake.

Pros

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

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

Cons

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

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

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

Costs

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

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

Option 6: Reestablishing Native Aquatic Vegetation

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

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake are allowed to naturally expand into adjacent areas thereby filling the niche left by the nuisance plants. Another technique utilizing existing plants is to transplant vegetation from one area to another. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 7 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

Pros

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

Cons

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

Costs

See Table 7 for plant pricing. Additional costs will be incurred if a consultant/nursery is contracted for design and labor.

Objective III: Shoreline Erosion Control

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

Option 1: No Action

Pros

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

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

Cons

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

Costs

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

Option 2: Install a Steel or Vinyl Seawall

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

Pros

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

Cons

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

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

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

Costs

Depending on factors such as slope and shoreline access, cost of seawall installation ranges from $65-80 per linear foot for steel and $70-100 per linear foot for vinyl. To install a seawall along the moderately eroded shoreline (1,926 feet) of Lake Minear would cost approximately $125,190 – 154,080 for steel and $134,820 – 192,600 for vinyl. The severely eroded sections (1,644 feet) would cost approximately $106,860 – 131,520 for steel and $115,080 – 164,400 for vinyl. A licensed contractor installs both types of seawall. Additional costs may occur if the shoreline needs to be graded and backfilled, has a steep slope, or poor accessibility. Price does not include the necessary permits required. Additional costs will be incurred if compensatory storage is needed. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained. For seawalls, a site development permit and a building permit are needed. Costs for permits and surveys can be $1,000-2,000 for installation of a seawall. Contact the Army Corps of Engineers, local municipality, or the Lake County Planning and Development Department.

Option 3: Install Rock Rip-Rap or Gabions

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

Pros

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

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

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

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

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

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

Costs
Cost and type of rip-rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $30-45 per linear foot. Costs for gabions are approximately $20-30 per linear foot, and approximately $60-100 per linear foot when filled with rocks. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be $1,000-2,000 for installation of rip-rap or gabions, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

To repair the moderately eroding areas on Lake Minear with rip-rap would cost approximately $57,780 – 86,670. The severely eroded areas would cost approximately $49,320 – 73,980 to repair.

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

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

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

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

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

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

Pros

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

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

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

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

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

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

Costs
If minimal amount of site preparation is needed, costs can be approximately $10 per linear foot, plus labor. Cost of installing willow posts is approximately $15-20 per linear foot. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

Option 5: Install A-Jacks®

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

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

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

Costs
The cost of installation is approximately $40-75 per linear foot, but does not include permits and surveys, which can cost $1,000-2,000 and must be obtained prior to any work implementation. Additional costs will be incurred if compensatory storage is needed.

To repair the moderately eroding areas on Lake Minear with A-Jacks® would cost approximately $77,040 – 144,450. The severely eroding areas would cost approximately $65,760 – 123,300 to repair.

Option 6: Install Biolog, Fiber Roll, or Straw Blanket with Plantings
These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Once established, a buffer strip of native plants can be planted along side or on top of the roll (depending if rolls are made of synthetic or natural fibers). They are most effective in areas where plantings alone are not effective due to already severe erosion. In areas of severe erosion, other techniques may need to be employed or incorporated with these products.

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

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

Costs
Costs range from $25 to $35 per linear foot of shoreline, including plantings. This does not include the necessary permits and surveys, which may cost $1,000 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.

To repair the moderately eroding areas on Lake Minear with biologs would cost approximately $48,150 – 67,410. The severely eroding areas would cost approximately $41,100 – 57,540 to repair. However, on the severely eroded areas biologs may need to be used in conjunction with another erosion control product like A-Jacks®.

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

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

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

Pros

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

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

Cons

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

Costs

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

Objective IV: Eliminate or Control Exotic Species

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

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

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

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

Pros

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

<u>Option 3: Herbicide Treatment</u>

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

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

Pros

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

Cons

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

Costs

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

Objective V. Zebra Mussels

Since Lake Minear has a boat launch, it is recommended that a sign be erected at the launch notifying users of the presence of exotic species in the lake, so they are not introduced into other lakes which do not already have them. The Exotic Species Advisory signs are available for $13.50 each to homeowner associations from the Illinois-Indiana Sea Grant Program at their internet site http://www.iisgcp.org/outrch/br/sign.htm or by calling 1-800-345-6087.

Zebra mussels get their name from the alternating black and white stripped pattern on their shells. They have spread extensively in the Great Lakes region in the past decade. They attach themselves to any solid underwater object such as boat hulls, piers, intake pipes, plants, other bivalves (mussels), and even other zebra mussels. Zebra mussels originated from Eastern Europe, specifically the Black and Caspian Seas. By the mid 18^{th} and 19^{th} centuries they had spread to most of Europe. The mussels were believed to have been spread to this country in the mid 1980s by cargo ships that discharged their ballast water into the Great Lakes. They were first discovered in Lake St. Clair (the body of water that connects lakes Erie and Huron) in June of 1988. The mussels then spread to the rest of the Great Lakes. The first sighting in Lake Michigan was in June 1989. By 1990, zebra mussels had been found in all of the Great Lakes. By 1991 zebra mussels had made their way into the adjacent waters of the Great Lakes such as the Illinois River, which eventually led to their spread into the Mississippi River and all the way down to the Gulf of Mexico. Other states in the Midwest have also experienced zebra mussel infestations of their inland lakes. Southeastern Wisconsin has about a dozen lakes infested with zebra mussels. The state of Michigan has about 100 infested lakes.   Even though they are a fresh water mussel they have also been found in brackish (slightly saline) water and they can even live out of the water for up to 10 days at high humidity and cool temperatures. At average summer temperatures, zebra mussels can survive out of water for an average of five days.

The zebra mussel=s reproductive cycle allows for rapid expansion of the population. A mature female can produce up to 40,000 eggs in a cycle and up to one million in a season. Eggs hatch within a few days and young larvae (called veligers) are free floating for up to 33 days, carried along on water currents. This allows for the distribution of larvae to uninfected areas, which accelerates their spread. The larvae attach themselves by a filamentous organ (called a byssus) near their foot. Once attached to a solid surface, larvae develop into a double shelled adult within three weeks and are capable of reproduction in a year. Zebra mussels can live as long as five years and have an average life span of about 3.5 years. The adults are typically about the size of a thumb nail but can grow as large as 2 inches in diameter. Colonies can reach densities of 30,000 - 70,000 mussels per square meter.

Due to their quick life cycle and explosive growth rate, zebra mussels can quickly edge out native mussel species. Negative impacts on native bivalve populations include interference with feeding, habitat, growth, movement, and reproduction. Some native species of bivalves have been found with 10,000 zebra mussels attached to them. Many of these native, rare, threatened and endangered bivalve species may not be able to survive if zebra mussels populations continue to expand. The impact that the mussels have on fish populations is not fully understood. However, zebra mussels feed on phytoplankton (algae) which is also a major food source for planktivorous fish, such as bluegills. These fish, in turn, are a food source for piscivorus fish (fish eating fish), such as largemouth bass and northern pike. Concern has also arisen over the concentration of pollutants found in zebra mussels. Since mussels are filter feeders, that take up water and sediment containing pollutants, which then build to high concentrations in their tissue (bioaccumulation). Due to the large number of mussels that are consumed by fish that feed on the mussels, concentrations of pollutants are even higher in the fish (biomagnification), which are potentially consumed by humans.

In addition to the ecological impacts, there are also may economical concerns. Zebra mussels have caused major problems for industrial complexes located on the Great Lakes and associated bodies of water. Mussels can clog water intakes of power plants, public water supplies, and other industrial facilities. This can reduce water flow (by as much as two-thirds) to heat exchangers, condensers, fire fighting equipment, and air conditioning systems. Zebra mussels can infest inboard motor intakes and can actually grow inside the motor, causing considerable damage. Navigational buoys have sunk due to the weight of attached mussels. Corrosion of concrete and steel, which can lead to loss of structural integrity, can occur from long-term mussel attachment. A Michigan-based paper company recently reported that it had spent 1.4 million dollars in removing only 400 cubic yards of zebra mussels. It has been estimated that billions of dollars have been incurred in removal efforts and in damage to factories, water supply companies, power plants, ships, and the fishing industry. There are several methods of control which include both removal and eradication. Many are site specific, so control methods are often dictated by the situation. These control methods include chemical molluscicides, manual removal, thermal irritation, acoustical vibration, toxic and non-toxic coatings, CO_2 injection, and ultraviolet light. Additionally, several biological controls are being investigated. However, there is currently no widespread/whole lake control practice that would be effective without harming other wildlife.

Surprisingly, some positive impacts have been observed from zebra mussels infestations. Zebra mussels are capable of filtering one liter of water per day. This water often contains sediment and phytoplankton, which contribute to turbidity. As a result, large infestations of zebra mussels have brought about significant improvements in water clarity in some lakes. Due to severe mussel infestations, Lake Erie water clarity has increased four to six times what it was before zebra mussels invaded the lake (in addition to improvements as a result of pollution control measures). This has resulted in deeper penetration of light and an expansion of aquatic plant populations, something that has not been seen for decades. In turn, the increased plant growth is providing better fish habitat and better fishing. Unfortunately, the negative ecological and economical impacts associated with zebra mussels far out-weigh any positive benefits.

Here are some tips from the Great Lakes Sea Grant Network that can help prevent the spread of zebra mussels.

-Flush clean water (tap) through the cooling system of your motor to rinse out any larvae.

-Drain all bilge water, live wells, bait buckets, and engine compartments. Make sure water is not trapped in your trailer.

-Always inspect your boat and boat trailer carefully before transporting.

-In their earlier stages, attached zebra mussels may not be easily seen. Pass your hand across the boat=s bottom - if it feels grainy, it=s probably covered with mussels. Don=t take a chance; clean them off by scraping or blasting.

-Full grown zebra mussels can be easily seen but cling stubbornly to surfaces. Carefully scrape the hull (or trailer), or use a high pressure spray (250 psi) to dislodge them. Or leave your boat out of the water for at least 10-14 days, preferably two weeks. The mussels will die and drop off.

-Dispose of the mussels in a trash barrel or other garbage container. Don=t leave them on the shore where they could be swept back into the lake or foul the area.

-Before you leave the boat launch site, remove from the boat trailer any plant debris where tiny zebra mussels may be entangled.

-Always use extra caution when transporting bait fish from one lake to another. You could be carrying microscopic veligers. To be safe, do not take water from one lake to another.

-Certain polymer waxes discourage zebra mussels from attaching. But check your hull periodically because the mussels cling to drain holes and speedometer brackets.

Objective VI: 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.

Option 1: No Action

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 VII: Enhance Wildlife Habitat Conditions

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

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

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

Option 1: No Action

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

Pros

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

Cons

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

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

Costs
The financial cost of this option may be zero. However, due to continual loss of habitats many wildlife species have suffered drastic declines in recent years. The loss of habitat affects the overall health and biodiversity of the lake's ecosystems.

Option 2: Increase Habitat Cover
This option can be incorporated with Option 3 (see below). One of the best ways to increase habitat cover is to leave a minimum 25 foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see the table in Appendix A for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species outcompete native plants and provide little value for wildlife.

Occasionally high mowing (with the mower set at its highest setting) may have to be done for specific plants, particularly if the area is newly established, since competition from weedy and exotic species is highest in the first couple years. If mowing, do not mow the buffer strip until after July 15 of each year. This will allow nesting birds to complete their breeding cycle.

Brush piles make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be place at least 10 feet away from the shoreline to prevent any debris from washing into the lake.

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

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

Pros

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

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

Cons

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

Costs

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

<u>Option 3: Increase Natural Food Supply</u>

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.