2002 SUMMARY REPORT
of
LAKE MATTHEWS

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Lake Matthews is a 9-acre lake in a residential setting with a channel for direct access to Pistakee Lake, and is one of the lakes within the Fox River Chain O'Lakes. Most of the homes on the lake set piers out each year to accommodate their motorboats for use on the larger lakes within the Chain O'Lakes waterway system. Lake Matthews has a maximum depth of five feet. It is located in Grant Township of unincorporated Lake County, about a mile southwest of the Village of Fox Lake. The lake was constructed in 1922, but development around the shoreline did not begin until 1935. The Pistaqua Heights Improvement Association now owns the lake bottom, and offers a small beach, boat launch, boat slips and a park for their members. The Chain O'Lakes Park Homeowner's Association also has a beach and park along the shore of Lake Matthews, but does not own any lake bottom.

Because of the shallow nature of Lake Matthews, the water clarity is poor, clouded by suspended sediment and algae. Sediment is easily resuspended in the water column of shallow lakes by wind, wave and carp action. Algae is able to thrive in Lake Matthews due to phosphorus concentrations in the water that are more than twice as high as the median phosphorus concentration of other lakes throughout Lake County. Another nutrient needed for algae growth in addition to phosphorus is nitrogen, which is also in high concentrations in Lake Matthews. A dissolved oxygen concentration of 5.0 milligrams per liter (mg/L) is considered an amount adequate to support aquatic life, since some aquatic life forms such as fish suffer oxygen stress below a concentration of 5.0 mg/L. Frequent mixing of the water through wind and wave action continually adds dissolved oxygen throughout the water column of shallow lakes. Lake Matthews is no exception, as concentrations of dissolved oxygen were plentiful throughout most of the season. Only on one occasion was the dissolved oxygen below 5.0 mg/L in the water just above the bottom at the deepest location. Because most of the remainder of the lake is three feet or shallower, it may be estimated that most of the lake still had an adequate supply of dissolved oxygen for aquatic life. However, since there is no recent, accurate bathymetric map with volume calculations of Lake Matthews, it is uncertain as to how much of the lake volume has an adequate oxygen supply.

Only four aquatic plants were identified in Lake Matthews, with white water lily as the most commonly found plant. The three other species, duckweed, watermeal and sago pondweed were only found once. A consultant hired by the Pistaqua Heights Improvement Association periodically harvests the lily plants. The lilies were scattered within the lake, and did not seem to pose any problems for boats passing through the lake. If combined, the lilies would cover an estimated 30% of the lake bottom, an amount recommended by the Illinois Department of Natural Resources for a healthy fishery.

Because Lake Matthews has a heavily developed shoreline within a residential setting, there is little wildlife habitat. Approximately 82% of the shoreline is developed. Nearly 60% of the shoreline is armored with either seawall or riprap, and 14% of the shoreline is mowed lawn to the water's edge. The wildlife species we noted were those tolerant of residential areas. Some habitat was noted along the channel leading to Pistakee Lake and on the island in the channel. If residents want to increase habitat for wildlife, they may want to plant native plants along the shoreline, even behind and in front of riprap and seawalls.

LAKE IDENTIFICATION AND LOCATION

Lake Matthews is a 9-acre manmade lake located about 1 mile southwest of the Village of Fox Lake in unincorporated Grant Township (T45N, R9E, S21). The lake was constructed by dredging in 1922. The lake is directly connected by a channel to Pistakee Lake, one of the lakes within the Fox River/Chain O'Lakes system. This shallow lake has a maximum depth of 5 feet and an average depth of 2.5 feet, which is estimated at half of the maximum depth. The estimated volume of the lake is 22.5 acre-feet,[1] or 7.3 million gallons. The length of the shoreline is 1.1 miles, which includes a portion of the channel that leads to Pistakee Lake. The surrounding watershed is dominated by residential land use.

BRIEF HISTORY OF LAKE MATTHEWS

Lake Matthews was constructed by dredging in 1922. Before the lake shoreline was developed, an attorney, Mr. Matthews, owned the lake. Development around the lake began in 1935. The Pistaqua Heights Improvement Association now owns the lake bottom. The park and beach owned by the Chain O'Lakes Park Homeowner's Association is also adjacent to Lake Matthews, but the association does not own any lake bottom.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Residents around Lake Matthews use the lake for access to the Chain O'Lakes, fishing from shore, and swimming. The Pistaqua Heights Improvement Association has a boat launch, a beach and a small park for their members' use on the south shore. The Chain O'Lakes Park Homeowner's Association has a boat launch, a beach, and a playground on the east shoreline. We collected water samples from both beaches for bacteria testing on a bimonthly basis from May through Labor Day. None of the bacteria samples warranted the closing of either beach during 2002. The Pistaqua Heights Improvement Association has contracted with a consultant to harvest some of the white water lilies in the lake during 2001 and 2002. The only concerns about Lake Matthews expressed by a representative of the Pistaqua Heights Improvement Association was about aquatic plants in the lake and homeowners of the Crockett's Estates subdivision adding sand to their private beaches. The homes in Crockett's Estates are along the northern channel to Lake Matthews, which is owned by the State of Illinois, not by the Pistaqua Heights Improvement Association (See Appendix D). Before adding sand to an individual or association beach, the owner is required to contact the Lake County Planning Building and Development department. Depending on the size of the site and the quantity of sand, a permit may be needed before any sand is added to the beach. Violations occur when too much sand is added, which may change the floodplain elevation. In addition, sand

[1] One acre-foot is one acre filled with one foot of water, or 325,900 gallons.

cannot be directly placed into the water. In this case, the U.S. Army Corps of Engineers would issue a violation for filling in the lake.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were collected each month, from May through September 2002, at the deep hole location (see Figure 1). Samples were collected at the surface and were analyzed for a variety of parameters (Table 1, Appendix A). The 2002 water quality data can be found in Table 1, Appendix A. The document, "Interpreting Your Water Quality Data" explains these parameters in detail. See Appendix B for water quality sampling and laboratory methods.

Water clarity is usually the first thing people notice about a lake, and typifies the overall lake quality. The Lake County median[2] clarity for 103 lakes is 3.81 feet deep. The Secchi disk readings in Lake Matthews during 2002 averaged lower, at 1.48 feet deep. In 2002, the best clarity reading was taken in June, with a depth of 2.43 feet. For the remainder of the season, the water clarity readings averaged about one foot deep. This low water clarity is a result of high concentrations of total suspended solids (TSS) in the water. TSS are composed of nonvolatile suspended solids (NVSS) such as non-organic clay or sediment materials, and volatile suspended solids (VSS) such as algae and other organic matter. TSS concentrations during 2002 in Lake Matthews averaged 21.2 milligrams per liter (mg/L), more than three times as high as the Lake County median (6.0 mg/L). Calculated NVSS concentrations averaged 14.3 mg/L during 2002, which constitutes 67% of the TSS. Therefore, sediment is the main cause of the water's low water clarity. Shallow lakes such as this one commonly suffer from turbid conditions due to sediment resuspension from wind, wave and carp action. Although suspended sediment is the main cause of the turbidity, algae also clouds the water in Lake Matthews. Algae is able to thrive with the elevated total phosphorus (TP) concentrations that were noted in 2002. Nuisance algal blooms can occur when TP concentrations are generally 0.05 mg/L. The surface sample TP concentrations in Lake Matthews averaged 0.144 mg/L during the 2002 season. This is 2.6 times higher than the Lake County median of 0.056 mg/L for TP. Based on average total phosphorus concentrations near the surface, Lake Matthews ranked #91 out of 103 Lake County lakes (See Table 2 in Appendix A). TP also plays a role in determining the trophic state index (TSI), which classifies lakes according to the overall level of nutrient enrichment. Using the average total phosphorus concentration from the epilimnion, the TSI score can be calculated. The score falls within the range of one of four categories: hypereutrophic, eutrophic, mesotrophic and oligotrophic. Mesotrophic and oligotrophic lakes are those with low and poor nutrient levels, respectively. These are very clear lakes, with little or no plant and/or algae growth. Most lakes in Lake County are classified as eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae and fish. Hypereutrophic lakes

[2] This is the median value, or the point at which half of the lake samples have clarity readings less than this value, and the other half have greater values. Median and average values were calculated using results of lakes sampled by the LCHD from 1998 through 2002.

INSERT FIGURE 1, SAMPLING, ACCESS LOCATIONS are those that have excessive nutrients, with nuisance algae growth reminiscent of "pea soup" and have a score greater than 70. The condition of Lake Matthews in terms of its phosphorus concentrations during 2002 was hypereutrophic with a value of 76.6.

Aside from TP, another critical nutrient for algal growth is nitrogen. Ammonia nitrogen and nitrate nitrogen are the nitrogen forms most readily used for plant and algae growth. Frequently, these nitrogen forms are used for algal growth as quickly as they become available. For these reasons, ammonia and nitrate were detected only once in Lake Matthews, during May, with concentrations of 0.107 mg/L and 0.125 mg/L, respectively. Total Kjeldahl nitrogen (TKN), which was abundant, is a measure of organic nitrogen that is typically tied up in algae cells. TKN averaged 2.98 mg/L in Lake Matthews, which is more than twice as high as the Lake County median of 1.17 mg/L. The ratio of total nitrogen[3] (TN) to total phosphorus (TP) in a lake indicates if the lake is in shorter supply of nitrogen or phosphorus. Lakes with TN:TP ratios of more than 15:1 are usually limited by phosphorus. Those with ratios less than 10:1 are usually limited by nitrogen. Most lakes throughout Lake County are phosphorus limited. Although phosphorus was high in Lake Matthews, the TN:TP ratio during 2002 was 19.6:1, which indicates it is limited by phosphorus. Sources of both nutrients to Lake Matthews include the watershed and from sediment bound phosphorus that is mixed into the water column by wind/wave action. Because the lake is shallow and continually mixes, Lake Matthews did not thermally stratify for most of the 2002 sampling season. Wind and wave action frequently mix oxygen throughout the water column in shallow lakes such as this, usually allowing for adequate dissolved oxygen (DO) concentrations for aquatic life. A DO concentration of 5.0 mg/L is considered an amount adequate to support aquatic life, since some aquatic life forms suffer oxygen stress below a concentration of 5.0 mg/L. DO concentrations were above 5.0 mg/L from the surface to the bottom each month except for September, when 5.0 mg/L was measured from the surface to two feet deep. Although much of the lake is three feet deep or less, it is difficult to state how much of the lake volume was anoxic (lacking oxygen) at this time without a recent, accurate bathymetric map with volume calculations.

The Illinois Environmental Protection Agency (IEPA) has indices to classify Illinois lakes for their ability to support aquatic life, swimming, or recreational uses. The guidelines consider several aspects, such as phosphorus concentrations, water clarity and aquatic plant coverage. Lake Matthews fully supports aquatic life according to these guidelines. The lake was placed in the non-support category for in-lake recreational uses because of the low water clarity and high phosphorus concentrations. For these same reasons, the lake is classified as partially impaired for swimming use because of the low water clarity and high phosphorus concentrations. The lake was not considered impaired for swimming by high bacterial counts, however. None of the bacteria samples we collected during 2002 had counts high enough to warrant the closing of either of the two beaches. The overall use support category for Lake Matthews is that of partial support.

[3] Total nitrogen consists of the organic forms of nitrogen plus nitrate nitrogen.

During 2002, we measured water elevation of Lake Matthews each month. The maximum elevation change occurred between the August and September sampling dates, when the water level dropped about four inches. This is not a substantial change. However, winter draw down occurs every year at the Algonquin dam, resulting in a water level drop of 18 inches within the Chain O'Lakes.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

We randomly sampled locations in Lake Matthews each month for aquatic plants, and identified four species. Table 3 lists the four aquatic plants that were identified by their common and scientific names. Table 4 in Appendix A lists the aquatic plant species and the frequency that they were found. White water lily was the species found most frequently, in 66% of all samples during the 2002 season. They were scattered about the lake, but were not in dense plant beds. Sago pondweed, duckweed and watermeal were the other three species identified, but they were collected only once during the 2002 season, in September. Aquatic plants will not photosynthesize in water depths with less than 1% of the available sunlight. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a lake. The available light in Lake Matthews was at least 1% down to the bottom throughout the season. Therefore, plants could potentially cover 100% of the bottom although this was not the case. The Pistaqua Heights Improvement Association hires a consultant to harvest some lilies periodically during the summer. Because they were scattered, the lilies did not appear to be hindering boat traffic through Lake Matthews, and if combined into one plant bed would cover about 30% of the lake bottom. The Illinois Department of Natural Resources recommends that lakes have 20% - 40% plant coverage to provide for a healthy fishery. With this in mind, no increased removal of aquatic plants is recommended. However, if the lilies hinder boat traffic or if they begin to rapidly expand in the future, the Association may want to continue harvesting to create a boat lane to Pistakee Lake.

Floristic quality index (FQI) is a measurement designed to evaluate the closeness of the flora (plants species) of an area to that with 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 floating and submersed aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). These numbers are then used to calculate the FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake, and better plant diversity. Nonnative species are included in the FQI calculations for Lake County lakes. The FQI scores of 86 lakes measured from 2000 through 2002 range from 0 to 37.2, with an average of 14.2. Lake Matthews has a floristic quality of 12, indicating a slightly lower than average aquatic plant diversity. Fortunately, none of the four aquatic plants found were invasive exotic species. All four are native plants that are important to lake ecosystems.

Table 3. Aquatic and Shoreline Plants in Lake Matthews, May – September, 2002

<u>Aquatic Plants</u>	
White Water Lily	*Nymphaea tuberosa*
Sago Pondweed	*Stuckinia pectinatus*
Duckweed	*Lemna sp.*
Watermeal	*Wolffia sp.*
<u>Shoreline Plants</u>	
Box Elder	*Acer negundo*
Reed Canary grass	*Phalaris arundinacea*
Purple loosestrife	*Lythrum salicaria*
Buckthorn	*Rhamnus sp.*

We did note the presence of invasive, aggressive shoreline plant species (Figure 2). One is a shrub species – buckthorn (*Rhamnus sp*.), and two were herbaceous plants – purple loosestrife (*Lythrum salicaria*) and reed canary grass (*Phalaris arundinacea*). These aggressive plants can crowd out native, beneficial plants such as those that are used in buffer strips to curtail erosion. The purple loosestrife and reed canary grass were both scattered around the shoreline, most commonly within the buffer areas. The buckthorn was heaviest around the island in the channel. The removal of these species is recommended. Removal options can be found within **Objective V: Eliminate or Control Exotic Species**. Some of the shoreline on which the buckthorn grows is eroding. If these shrubs are removed, a plan needs to be in place to address shoreline protection. If possible, the shoreline should be planted with deep-rooted native plants as soon as the buckthorn is removed.

INSERT FIGURE 2. EXOTIC PLANT LOCATIONS

LIMNOLOGICAL DATA - SHORELINE ASSESSMENT

In July 2002, LCHD staff assessed the shoreline of Lake Matthews. The shoreline that was assessed surrounded the parcel owned by Pistaqua Heights. This included the main body of the lake, part of the channel leading out to Pistakee Lake and the island within this channel. See Appendix B for a discussion of the methods used. Approximately 82% (4,680 feet) of the shoreline is classified as being developed. The undeveloped shoreline is the island. Figure 3 shows the three most common shoreline types around Lake Matthews: riprap (33% or 1,911 feet of the total shoreline), seawall (26% or 1,477 feet of the total shoreline) woodland (18% or 1,041 feet of the total shoreline). The seawall and riprap represent a total of 59% (3,387 feet) of shoreline. Approximately 25% (1,437 feet) of the total shoreline is eroding, with 584 feet severely eroding. Approximately 237 feet of shoreline is moderately eroding, while 616 feet is slightly eroding. Most of the eroding shoreline is occurring around the wooded island (which is privately owned), and on private properties with manicured lawns mowed to the water's edge. Although the island is heavily wooded and offers some wildlife habitat, most of the trees are invasive buckthorn shrubs. Buckthorn heavily populated the island. The removal of this species is always recommended, since buckthorn shrubs exude a chemical that discourages other plant growth. We noted bare soil under these shrubs along the shoreline, from which sheet erosion is occurring. Because the shoreline is already eroding, mitigation of this area to curtail further erosion should be done as soon as the buckthorn is removed, by planting deep-rooted native vegetation. This will only protect the shoreline, but also offer better wildlife habitat. The eroding shorelines with manicured lawns will continue to erode since turfgrass has root systems too short to stabilize the shoreline. People can protect their shorelines by installing buffer strips of taller (2'-3') deep-rooted native vegetation. They can still access the lake by mowing a path not less than 6 inches tall through these plants to the shoreline.

INSERT FIGURE 3, SHORELINE TYPES

- INSERT FIGURE 4, EROSION

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Table 5 lists the wildlife species we noted around Lake Matthews. Because the lake is in the middle of a residential setting with the majority of the shoreline as seawall, lawn or riprap, habitat for wildlife is limited. Although the island in the channel offers some habitat, most of the birds that were seen were those tolerant of residential settings. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones, which are recommended as one aspect of shoreline protection.

Table 5. Wildlife species observed on Lake Matthews, May – September, 2002

Birds	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
Green Heron	*Butorides striatus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Eastern Phoebe	*Sayornis phoebe*
Barn Swallow	*Hirundo rustica*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
House Wren	*Troglodytes aedon*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo	*Vireo olivaceus*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Mammals	
Mink	*Mustela vison*
Reptiles	
Soft-shelled Turtle	*Apalone spp.*

EXISTING LAKE QUALITY PROBLEMS

- *Poor Water Clarity*

  Lake Matthews has poor water clarity due to sediment and algae suspended in the water. Sediment, however, is the main cause of the water's low water clarity. Shallow lakes such as these tend to be turbid because of sediment resuspension from the bottom by wind, wave and carp action.

- *High Nutrient Concentrations*

  Averages of total phosphorus and total Kjeldahl nitrogen concentrations in Lake Matthews are both more than twice as high as the Lake County medians. Although algae is not excessive in Lake Matthews, the potential for intense blooms exists because of the high levels of nutrients especially phosphorus. Sources of these nutrients include inputs from the watershed and disturbance of the sediment on the bottom from wind, wave and carp action.

- *Limited Wildlife Habitat*

  Although the area has mature trees in the neighborhood, because of the suburban setting, Lake Matthews has limited habitat to support wildlife, except for the wooded island in the channel. Improvements such as the addition of a buffer zone of native vegetation should be implemented around the lake to increase wildlife species diversity.

- *Shoreline Erosion*

  Approximately 25% of the shoreline surrounding Lake Matthews is eroding to some extent. Approximately 73% of the eroding shoreline is the wooded island, and 18% is manicured lawn to the water's edge. The buckthorn growing along the island's shoreline exudes a chemical that prevents understory growth, leaving bare soil to erode. It is recommended that the buckthorn be removed, but a plan needs to be in place to mitigate this eroding shoreline soon after the buckthorn shrubs are gone to prevent further erosion. These shorelines will continue to erode if protective measures are not taken.

- *Invasive Shoreline Plant Species*

  We noted a heavy buckthorn infestation around the island. The removal of buckthorn shrubs is always recommended. Other invasive shoreline plants such as purple loosestrife and reed canary grass are scattered around the main portion of Lake Matthews, but not in large populations at this time. However, they can cause problems in large numbers. Their removal now would curtail their expansion.

- *Lack of a Quality Bathymetric Map*

  A bathymetric (depth contour) map is an essential tool in effective lake management since it provides information on the morphometric features of the lake, such as depth, surface area, volume, etc. The knowledge of this morphometric information would be necessary if lake management practices such as aquatic herbicide use, fish stocking, dredging, an alum treatment or aeration were part of a future overall lake management plan. Lake Matthews does not have a recent bathymetric map. Maps can be created by the Lake County Health Department – Lakes Management Unit or other agencies for costs that vary from $3,000-$10,000, depending on lake size.

POTENTIAL OBJECTIVES FOR LAKE MATTHEWS MANAGEMENT PLAN

I. Bathymetric Map
II. Illinois Volunteer Lake Monitoring Program
III. Shoreline Erosion Control
IV. Enhance Wildlife Habitat Conditions
V. Eliminate or Control Exotic Species

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. There is no known bathymetric map of Lake Matthews. 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: Illinois Volunteer Lake Monitoring Program

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

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

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

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

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

Objective III: 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 also 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.

In the case of Lake Matthews, about 25% of the shoreline is eroding, all of it on private properties. Most of the eroding shoreline is around the wooded island in the channel and manicured lawn that has been mowed to the water's edge. Because of its short root system, turfgrass will not withstand wave action, and will simply continue to erode. Replacing the lawn at the shoreline with a buffer strip containing native deep-rooted plants can not only help with erosion, but also add wildlife habitat. However, in areas already severely or moderately eroding such as the shoreline around the island, a buffer strip of native plants may need to be bolstered with the addition of willow posts or biologs.

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

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 some 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. Along Lake Matthews, all of the eroding property is privately owned. For every 100 feet of shoreline property, the cost for a steel seawall would be approximately $6,500-$8,000. Costs for a vinyl seawall would be $7,000-10,000. 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 Riprap or Gabions

Riprap 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. Riprap can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the riprap, 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). This method may prove to be difficult to install around the island since heavy equipment is needed.

Pros

Riprap 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, riprap will last for many years. Maintenance is relatively low, however, undercutting of the bank can cause sloughing of the riprap and subsequent shoreline. Areas with severe erosion problems may benefit from using riprap 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 riprap 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 riprap 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 riprap absorbs 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 riprap 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 riprap 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.

Riprap may be a concern 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 riprap 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. Along Lake Matthews, all of the eroding property is privately owned. For every 100 feet of shoreline property, the cost for riprap would be approximately $3,000-4,500. 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 riprap, 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.

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 riprap.

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. Table 6 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 A-Jacks ®, or riprap. This combination of techniques may be necessary to curtail the erosion around the island in Lake Matthews.

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or riprap. 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 Table 6 in Appendix A should be considered for native plantings.

On Lake Matthews, the installation of buffer strips can be done on the shorelines edged with eroding manicured lawns, or those behind already existing riprap or seawall. If people are concerned about being unable to approach the lake on their property, a smaller mowed path to the shoreline will allow access and not interrupt the integrity of the buffer strip. The mowed path should be kept at not less than 6 inches tall and more than 6 feet wide. The newly planted vegetation will need protection from grazing wildlife until it is established.

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. Along Lake Matthews, all of the eroding property is privately owned. For every 100 feet of shoreline property, the cost for a buffer strip would be about $100. Willow posts would cost about $1,500-2,000. 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, such as a portion of the island. However, because of the need for heavy equipment for installation, this may prove to be a difficult option for mitigation of the island.

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® cannot be seen. They provide many of the advantages that both riprap 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 riprap, 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. Along Lake Matthews, all of the eroding property is privately owned. For every 100 feet of shoreline property, the cost for A-Jacks® would be approximately $4,000 – 7,500. Additional costs will be incurred if compensatory storage is needed.

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 grading, or the necessary permits and surveys, which may cost $1,000 – 2,000 depending on the type of earthmoving that is being done. Along Lake Matthews, all of the eroding property is privately owned. For every 100 feet of shoreline property, the costs for this method would be approximately $2,500-3,500. Additional costs may be incurred if compensatory storage is needed.

Objective IV: Enhance Wildlife Habitat Conditions

The key to increasing wildlife species in and around a lake can be summed up in one word: habitat. Wildlife needs 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).

At Lake Matthews, installing native vegetation along the shoreline can improve wildlife habitat. This can be done by replacing lawn with a native buffer strip along the shoreline, or by planting similar plants above the riprap or seawall.

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

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

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

Cons

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

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

Costs

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

Option 2: Increase Habitat Cover

The buffer strip of native vegetation to combat shoreline erosion as suggested in Objective II would also increase the wildlife habitat around the lake. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see Table 6 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 – not less than 6 inches) 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. This type of habitat already exists near the island in Lake Matthews.

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 is areas that have short grass up to the edge of the lake. If a buffer is allowed to grow tall, geese may choose to move elsewhere.

Cons

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

Costs

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

Option 4: Increase Natural Food Supply

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 Table 6 in Appendix A could be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as 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 are 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 5: 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. The installation of the buffer strip as suggested above in Option 2 of this section will assist in this endeavor.

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. Purple martin houses can cost $50-150. Bat boxes range in price from $15-50. These prices do not include mounting poles or installation.

Objective V: Eliminate or Control Exotic Species

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

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

Some areas of the shoreline around Lake Matthews have scattered invasive plants such as purple loosestrife and reed canary grass. Because these plants have a tendency to germinate and thrive in disturbed areas, they could become a problem in the beginning stages of shoreline stabilization projects. Periodic checks should be conducted to identify and remove unwanted invasive plants while they are young, and easily removed. The island has a heavy population of buckthorn shrubs. It is always recommended that these shrubs be removed. Because the shoreline is eroding in this location, a plan should be in place to curtail further erosion shortly after the buckthorn is removed

Option 1: No Action
No control will likely result in the expansion of the exotic species and the decline of native species. This option is not recommended if possible.

Pros
There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. This is not to recommend allowing these exotic species to grow, however. Native plants should take precedent over exotics when possible. Table 6 in Appendix A lists several native plants that can be planted along shorelines.

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

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

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

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

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

Because the purple loosestrife is scattered around Lake Matthews and not in large enough densities, their control by this method may not be efficient at this time.

Pros

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

Cons

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

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

Costs

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

Option 3: Control by Hand

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

Because the purple loosestrife and reed canary grass plants are scattered around Lake Matthews, this may prove to be an efficient method for their control.

Pros

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

Cons

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

Costs

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

Option 4: Herbicide Treatment

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

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

Because the invasive plants are scattered around Lake Matthews, this may prove to be an efficient method for their control. Control of the buckthorn shrubs on the island can be done using this method. The shrubs should be identified as buckthorn shrubs before being treated in order not to harm any beneficial trees.

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.