2004 SUMMARY REPORT
of
LOCH LOMOND

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES
LAKES MANAGEMENT UNIT
3010 Grand Avenue
Waukegan, Illinois 60085

Mary Colwell
Michael Adam
Christina L. Brant
Mark Pfister
Jennifer Wudi

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EXECUTIVE SUMMARY

Loch Lomond is a privately owned, 75-acre manmade lake located in central Lake County, within the Village of Mundelein. The lake was created in 1955 by impounding Bull Creek, which enters the lake adjacent to the Loch Lomond Property Owner's Association (LLPOA) North Beach. This is a "flow through" system, with the water entering the lake from Bull Creek and then exiting on the east side over a spillway that eventually flows to St. Mary's Lake and Butler Lake before flowing into the Des Plaines River. Residents use Loch Lomond for swimming, fishing, non-motorized boating and aesthetics.

The water quality in Loch Lomond is poor, with low water clarity, and high total phosphorus (TP) concentrations that classify the lake as hypereutrophic. The lake ranked #152 out of 161 Lake County lakes based on average total phosphorus concentration. These high concentrations have been causing nuisance algae blooms for many years in Loch Lomond. The Association has an applicator use algicides to help control the algae. The dissolved oxygen concentrations within the water column were good during 2004, with adequate concentrations down to the bottom.

Ten species of aquatic plants were identified in the lake, scattered only along the near-shore areas. The two most commonly collected plants were sago pondweed and horned pondweed and both were collected in 10% of all samples over the season. The other aquatic plants were found infrequently over the season. A positive aspect about the plant community in this lake is that seven aquatic plant species were beneficial native plants. The other two plants, Eurasian water milfoil and curlyleaf pondweed are invasive nonnative plants, but there were very few of either.

One hundred percent of the shoreline is developed, with the majority riprap. The two other major shoreline types are seawall and lawn. Although very little of the shoreline was eroding, a highly developed shoreline usually does not offer quality wildlife habitat. However, some lots had shoreline buffer zones, which offered some habitat. Even though most of the birds that were seen were those common to residential settings, we did identify a juvenile black-crowned night heron, which is an Illinois endangered species.

Fisheries surveys were completed on Loch Lomond in 1994 and in 2002 by the Illinois Department of Natural Resources (IDNR). The IDNR states in 1994 that the fishery was in relatively good condition. The 2002 report states that Loch Lomond has a well-balanced bluegill/bass fishery, although there were concerns about the low amount of aquatic plant coverage. The limited access to this lake and the low harvest pressure at this time has allowed the fishery to develop to its present state.

LAKE IDENTIFICATION AND LOCATION

Loch Lomond is a privately owned, 75-acre manmade lake located in central Lake County, within the Village of Mundelein (T44, R10E S24). Although our bathymetric map created in 1988 notes an 8-foot deep hole, we were unsuccessful in finding this depth in 2004. In 2004, Loch Lomond had a maximum depth of 7.5 feet. The lake had an average depth of 5.04 feet, with a volume of 376 acre-feet, or 122.5 million gallons (see Appendix D). The length of shoreline is 2.18 miles. Loch Lomond was created by impounding Bull Creek in 1955 with an earthen dam and a concrete spillway. Eventually, the water flowing over the spillway from Loch Lomond enters St. Mary's Lake, and then Butler Lake as it travels to the Des Plaines River. Based on the land uses in the watershed and the volume of Loch Lomond, the approximate retention time of the lake is 0.45 years or 164 days.

BRIEF HISTORY OF LOCH LOMOND

Development around the Loch Lomond began in 1955, the same year Bull Creek was impounded to form the lake. Shortly after the lake formed and prior to the initial stocking of largemouth bass and bluegill, a fish toxicant was used to try to eliminate rough fish species. By 1960, aquatic plants in the lake were "of problem proportions" according to records from the Illinois Department of Natural Resources. It's unknown when the plants in the lake began to disappear, and were subsequently replaced by algae. The Loch Lomond Property Owner's Association (LLPOA) formed in 1961 to manage the lake. Several management techniques have been employed in the lake, including fish stocking, algicides, dredging, and aeration. Unfortunately, records for the aeration system and the dredging project are not available.

The LLPOA has stocked fish over the years. In 1990, about 600 grass carp were introduced in the lake in hopes of them controlling some of the algae. Unfortunately, aquatic plants, not algae are the preferred diet of grass carp, and the lake still suffers from algae blooms. Stocking rates for grass carp are aquatic plant species dependent. However, grass carp can no longer be stocked in glacial lakes and lakes with outlets such as Loch Lomond. In 1995, 2,270 largemouth bass and 25 channel catfish were stocked. The most recent fish stocking was in 2003, when 180 northern pike were added to the lake.

The LLPOA routinely treats the lake for algae with copper-based products, especially near the beaches. The Association has some concerns about the additional copper being added along with the fate of arsenic, cadmium, and lead that were found in the sediment in 1989. In 2004, we included sediment testing for these four metals. Results and discussion of this sampling can be found in Appendix D. We also sampled water quality in 1999, the results of which will be discussed in the water quality section of this report.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Development of the homes around Loch Lomond began in 1955. Loch Lomond is privately owned, open only to the residents within the LLPOA and their guests. Residents use the lake for swimming, fishing, non-motorized boating, and aesthetics.

There are currently two swimming beaches located on Loch Lomond. We annually monitor the beaches bimonthly for *E. coli* bacteria from early May to Labor Day. Results of the 2004 beach sampling will be discussed in the body of this report.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were collected each month, from May through September 2004, at the deepest location in the lake (see Figure 1). We sampled Loch Lomond at 3 feet below the surface. We also sampled Loch Lomond in 1999 and the results discussed and compared to the 2004 data. The water quality data can be found in Table 1, Appendix A. In addition, our beach sampling program has included both Loch Lomond Property Association (LLPOA) beaches since 1988.

A dissolved oxygen (DO) concentration of 5.0 mg/L is considered an amount adequate to support a bluegill/bass fishery, since these fish can suffer oxygen stress below this amount. Concentrations of DO of at least 5.0 mg/L in Loch Lomond were recorded from the water's surface down to the lake bottom each month during 2004. The situation was similar in 1999, except that in June, the DO concentration dropped to 4.5 mg/L below 5 feet deep. Using volume calculations from the 1988 bathymetric map, approximately 84% of the lake volume had an adequate supply of DO for aquatic life in June of 1999. The lake did not experience any hypoxia (<1.0 mg/L) at any depth in either year, which commonly occurs in lakes that are deeper, and thermally stratified.

Severe algae blooms that cloud the water have been plaguing Loch Lomond for many years. The LLPOA routinely treats the lake with algicides annually. Because of these blooms and resuspended sediment from wind and wave action in this shallow system, the water clarity is poor, with Secchi disk readings averaging 3.27 feet during 2004, and 1.89 feet in 1999. The difference between these two seasonal averages may be due to several factors: the amount of algae growth, the variation in water quality of runoff, and the amount of sediment resuspension into the water column each year. Water clarity is impacted by the concentration of total suspended solids (TSS) in the water column. 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. As algae populations increase over the summer months, the water clarity usually decreases. Figure 2 illustrates the negative relationship between TSS and Secchi disk readings in Loch Lomond during 2004. The 2004 seasonal TSS average in Loch Lomond is 13.2 mg/L, which is higher than the Lake County median of 7.9 mg/L. In May and June of 2004, the water clarity was much better than for the remainder of the season,

INSERT FIGURE 1

INSERT FIGURE 2 TSS/SECCHI

which is common in many lakes. Although algae was present during these two months, severe blooms from July through September affected the water quality more. As the algae bloom began in July 2004 and intensified in August, we identified the major algal types in the water, as *Anabaena* and *Microcyctis*. Both are blue-green algae. Blue-green algae are normally associated with nuisance algae blooms, and typically have a mid- to late summer life cycle. Another factor is the amount of nutrients in the water. All algae require nutrients such as nitrogen and phosphorus, which are two key ingredients for their growth, and can regulate their populations. Typically, lakes are either phosphorus or nitrogen limited. This means that one of the nutrients is in short supply and that any addition of that nutrient to the lake will result in an increase of plant or algal growth. Most lakes in Lake County are phosphorus limited, but to compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting. Ratios greater than or equal to 15:1 indicate that phosphorus is limiting. Ratios greater than 10:1, but less than 15:1 indicate that there are enough of both nutrients to facilitate excess algal or plant growth. Loch Lomond had an average TN:TP ratio of 8:1 in 2004 and 7:1 in 1999. This indicates that the lake is nitrogen limited, and that certain algal species could be hindered by a lack of nitrogen. The concentrations of total Kjeldahl nitrogen increased overall during the season, averaging 1.71 mg/L, which is higher than the Lake County median of 1.22 mg/L. Nitrogen can come from a variety of external sources, and can also be taken from the atmosphere and "fixed," (transformed from an atmospheric form to an organic form) by blue-green algae, such as those identified in Loch Lomond. This makes nitrogen input virtually impossible to control. When the TN:TP ratios for Loch Lomond are calculated monthly, a more refined story emerges. In May and June of 2004, the lake was limited by *phosphorus*, not nitrogen, with TN:TP ratios of 25:1 and 26:1, respectively. TP concentrations were low at this time, at 0.041 mg/L and 0.037 mg/L, respectively. A dramatic switch occurred in the months afterward, when the lake was limited by nitrogen with ratios ranging from 9:1 to 5:1. From July through September, concentrations of TP increased tremendously, corresponding with the nuisance algae blooms, the increase in TSS and the subsequent decrease in water clarity. This nitrogen limitation may have caused the TP concentrations to increase from 0.037 mg/L in June to 0.160 mg/L in July and then increased again to 0.570 mg/L by September. When nitrogen is limited, aquatic organisms can not utilize the available phosphorus, and thus the concentrations increase. Overall, TP increased more than 15 times between the June and September sampling dates. Phosphorus can also be released from sediment through biological or mechanical processes, or from plant or algae cells as they die. This typically occurs in lakes like Loch Lomond that do not stratify, and the phosphorus attached to bottom sediment or released from dying algal/plant cells can be easily distributed throughout the water column. In addition, the rainfall in the area may have played a role in how TP concentrations changed. In 2004, data from a Vernon Hills rain gage indicates that the area experienced heavy rains between the May and June sample dates. Between two and four days prior to the June sample date, the area received 2.8 inches of rain. Some locations in Lake County were heavily flooded. This runoff could have flushed the lake since this is a "flow through" system. This may have also diluted or flushed some TP with it. Very little rainfall had occurred later in the season, and by September, the area was in drought conditions. Some evaporation had taken place during this time as the

INSERT FIG.3, TSS/TP

lake's water elevation dropped by 5.9 inches between the July and September sampling dates, concentrating the TP into a smaller lake volume. Although this can be a typical water elevation loss over a summer season for many lakes in this area, shallow lakes such as Loch Lomond may be affected more than deep lakes with larger lake volumes. In the case of Loch Lomond, the water loss equates to about 10% of the total lake volume. This loss, coupled with internal loading from sediment resuspension, and nitrogen limitation are the probable factors that triggered the large TP increase over the 2004 season. In 1999 the TP pattern was similar, with a 350% increase over the season. The monthly TP concentrations were different than those of 2004, although the seasonal averages were similar. In 1999, rainfall totaling 3.64 inches fell over four days prior to the June sample, which also could have flushed the lake. Rainfall in 2004 was less from June through August[1] than in 1999. This lower rainfall total, coupled with increased evapotranspiration could explain the difference between TP concentrations in the later months of these years. Loch Lomond TP concentrations in 2004 had a seasonal average of 0.245 mg/L, which is nearly four times higher than the Lake County median of 0.063 mg/L.

Usually, soluble reactive phosphorus (SRP) is undetected in the near surface water since algae uses it almost as quickly as it becomes available. This form of phosphorus is most readily available for algal growth, and was detected in most of Loch Lomond's samples in both 1999 and 2004. SRP increased by about 38% over this time frame, with seasonal averages of 0.140 mg/L in 1999 and 0.193 mg/L in 2004. The SRP concentrations during both years displayed a pattern similar to that of the TP concentrations, which was low early in the season, then increasing dramatically in the later months. Loch Lomond has an excessive amount of TP and SRP. With this much TP and SRP, Loch Lomond will likely continue to be affected by nuisance algae populations. Once TP reaches a lake, it can be recycled by the processes of internal loading described previously. Loch Lomond also has external sources such as stormwater from the 1,439 acres within its watershed (Figure 4). Figure 5 shows the 2000 land uses within the watershed, with the four largest being single family (37%), agricultural (19%), wetland (10%) and public and private open space (10%). Table 2 in Appendix A lists the land uses and percentages within the watershed, all of which can contribute to external phosphorus loading. For Loch Lomond, the land uses contributing the highest percentages of estimated runoff are from single family and transportation (i.e., roads) areas, which are 46% and 23%, respectively. Even though it is the second largest land use, the agricultural areas within the Loch Lomond watershed contribute approximately 3% of the estimated runoff (Table 2, Appendix A). It is important to keep in mind, however, that although the amount of estimated runoff from certain areas may be low, it can deliver high concentrations of TSS or TP. Because Loch Lomond is within the St. Mary's Lake watershed, it's very likely that Loch Lomond is a source of some TP to St. Mary's Lake. St. Mary's Lake also has high TP and low water clarity.

Integrated Lakes Management (ILM) compiled a report in 2004 estimating the phosphorus budget with in the Loch Lomond watershed. ILM stated that internal

[1] The 1999 data included information only until August 19. Therefore a comparison with the 2004 rainfall includes information up until August 19, 2004.

INSERT FIG 4 WATERSHED

INSERT FIGURE 5, LAND USES

regeneration made up the highest proportion of the phosphorus budget with a range of 320-520 kg/year. The second highest input was from near shore runoff (range 74-190 kg/year). In addition, ILM identified a small pond directly north of the lake (upstream of Bull Creek) as a potential source of phosphorus. Additional sources that were identified include Canada geese and atmospheric deposition. All phosphorus sources ranged from 497-978 kg/year. ILM also estimates the phosphorus leaving Loch Lomond to range from 259-724 kg/year, for a net phosphorus gain of between 238-254 kg/year.

TP can be used for the trophic state index (TSI), which classifies lakes according to the overall level of nutrient enrichment. The TSI score falls within the range of one of four categories: hypereutrophic, eutrophic, mesotrophic and oligotrophic. Hypereutrophic lakes are those that have excessive nutrients, with nuisance algae growth reminiscent of “pea soup” and have a TSI score greater than 70. Lakes with a TSI score of 50 or greater are classified as eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae and fish. Mesotrophic and oligotrophic lakes are those with lower nutrient levels. These are very clear lakes, with little algae growth. Most lakes in Lake County are eutrophic. The trophic state of Loch Lomond in terms of its phosphorus concentration during 1999 was hypereutrophic, with a TSIp score of 82.9. In 2004, the TSIp score was a little higher, at 83.5, and ranked Loch Lomond #152 out of 161 Lake County lakes based on average total phosphorus concentrations (Table 3, Appendix A).

The IEPA has assessment indices to classify Illinois lakes for their ability to support aquatic life, swimming, or recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations (for the trophic state index) and aquatic plant coverage. Loch Lomond fully supports aquatic life uses according to these guidelines. However, the lake is slightly impaired for recreational and swimming uses, because of the high TP concentrations and sediment suspended in the water column that affected the water clarity.

Conductivity is a measurement of water’s ability to conduct electricity via total dissolved solids (TDS) made up of minerals and salts in the water column. Compared to lakes in undeveloped areas, lakes with residential and/or urban land uses in their watersheds often have higher conductivity readings and higher TDS concentrations because of the use of road salts. Stormwater runoff from impervious surfaces such as roads and parking lots can deliver high concentrations of these salts to nearby lakes and ponds. The median conductivity reading for near surface samples is 0.7652 milliSiemens/cm (mS/cm) for Lake County lakes. During 2004, the conductivity readings in Loch Lomond were slightly higher, at 0.8232 mS/cm. The readings were highest in May, with a decrease over the season. This is typical of lakes that receive road salts, as spring rains flush salts from the watershed. Because transportation land use delivers approximately 23% of the estimated runoff within Loch Lomond’s watershed, this is most likely the reason for this pattern. This pattern was not evident in 1999, though, as the readings fluctuated over the summer months, averaging 0.7076 mS/cm. The increase in the seasonal average since 1999 may have been due to an increase in impervious surfaces within the watershed – new development has occurred in the watershed since then. TDS concentrations in Loch Lomond were similar to the Lake County median of 454 mg/L during 2004, with a seasonal average of 457 mg/L in the epilimnion, and followed a pattern similar to that of the conductivity readings.

We have been testing the two beaches on Loch Lomond (Lomond Park Beach and North Beach) bimonthly for bacteria from early May to Labor Day annually since 1988. Prior to 2002, the beaches were tested for fecal coliform bacteria. Beginning in 2002, the testing protocol was changed to monitor *E. coli* bacteria, which is one species in the coliform group. The preseason samples at both beaches (May 20, 2004, prior to the beaches being open for swimming) were high (averages of 448 colonies [cfu] per 100 mL at Lomond Park Beach and 457 cfu/100mL at North Beach). The Illinois Department of Public Health standard for the bacteria is 235 cfu/100 mL. Beach closure is recommended when samples exceed this standard. After Memorial Day when the beaches were open, all subsequent summer samples in 2004 at these beaches indicated low levels of bacteria (range 0-119 cfu/100 mL). Both beaches have stormwater inlets near the swimming areas, which can add bacteria to the water after rain events. In addition, Canada geese and gulls are common at these beaches and can contribute nutrients and *E. coli* to the beaches and water.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

We randomly sampled locations in Loch Lomond each month for aquatic plants, and identified 10 species, including a macroalgae (*Chara*). We also recorded shoreline plants. Table 4 lists the plants that were identified by their common and scientific names. The aquatic plants were scattered beds only along the near-shore areas. Table 5 in Appendix A lists the aquatic plant species and the frequency that they were found. The two most commonly collected plants were sago pondweed and horned pondweed both of which were collected in 10% of all samples over the season. Curlyleaf pondweed was third, found in 8% of all samples over the season. The other aquatic plants were found just a handful of times over the season. To maintain a healthy bluegill/bass fishery, the optimal plant coverage is 30% to 40% across the lake bottom. Loch Lomond has far less than this (estimated 5% coverage), and did not have any defined plant beds; plants were found in a few scattered locations.

Aquatic plants will not photosynthesize at water depths with less than 1% of the available sunlight at the surface. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. During 2004, the depth of the 1% light level was at the bottom in May and June. The maximum depth at which a plant was found was 5.1 feet deep, collected in May. In July and August, the depth of the 1% light level was between 2.8 and 3.8 feet deep. The increasing algae growth extinguished some of the available light. This is one reason aquatic plant growth may be hindered in Loch Lomond. Another possibility is the presence of grass carp. If there are any still alive from the 1990 stocking, they could be restricting any aquatic plant growth.

Two positive things about the plant life in this lake are that eight of the 10 aquatic plant species are beneficial native plants and that there was very little Eurasian water milfoil and curlyleaf pondweed. Both Eurasian water milfoil and curlyleaf pondweed are invasive nonnative plants, and in many instances overpopulate a lake, causing nuisance conditions.

Table 4. Aquatic and shoreline plants on Loch Lomond, May – September, 2004.

Aquatic Plants	
Chara	*Chara* sp.
Eurasian Water Milfoil^	*Myriophyllum spicatum*
Slender Naiad	*Najas flexilis*
White Water Lily	*Nymphaea tuberosa*
Leafy Pondweed	*Potamogeton foliosus*
Curlyleaf Pondweed^	*Potamogeton crispus*
Small Pondweed	*Potamogeton pusillus*
Flatstem Pondweed	*Potamogeon zosteriformis*
Sago Pondweed	*Stuckinia pectinatus*
Horned Pondweed	*Zannechellia palustris*
Shoreline Plants	
Indian Hemp	*Apocynum cannabinum*
Burdock	*Arctium sp.*
Mustard	*Brassica sp.*
Jewelweed	*Impatiens capensis*
Ox-eye Daisy	*Chrysanthemum leucanthemum*
Canada Thistle^	*Cirsium arvense*
Bull Thistle^	*Cirsium vulgare*
Tickseed	*Coreopsis sp.*
Hedge Bindweed	*Convolvulus sepium*
Purple Prairie Coneflower	*Echinacea purpurea*
Spike rush	*Eleocharis* sp.
Joe-Pye Weed	*Eupatorium maculatum*
Horestail	*Equisetum arvense*
Ground Ivy^	*Glechoma hederacea*
Purple Loosestrife^	*Lythrum salicaria*
White Sweet Clover^	*Melilotus alba*
Catnip	*Nepeta cataria*
Virginia creeper	*Parthenocissus quinquefolia*
Reed Canary Grass^	*Phalaris arundinacea*
Curled Dock	*Rhumex crispus*
Multiflora rose	*Rosa Multiflora*
Common Arrowhead	*Sagittaria latifolia*
River Bulrush	*Scirpus fluviatilis*
Softstem Bulrush	*Scirpus validus*

Table 4. Aquatic and shoreline plants on Loch Lomond, May – September, 2004.

Bittersweet Nightshade	*Solanum dulcamara*
Goldenrod	*Solidago* sp.
Sow Thistle^	*Sonchus* sp.
Common Mullien	*Verbascum thapsus*
Wild Grape	*Vitis* sp.
<u>*Trees/Shrubs*</u>	
Box Elder	*Acer negundo L.*
Silver Maple	*Acer saccharinum*
White Birch	*Betula papyrifera*
Shagbark Hickory	*Carya ovata*
Dogwood	*Cornus* sp.
Green Ash	*Fraxinus pennsylvanica*
Locust	*Gelditsia* sp.
Black Walnut	*Juglans nigra*
Honeysuckle^	*Lonicera* sp.
Red Mulberry	*Morus rubra*
Mountain Ash	*Pyrus americana*
White Oak	*Quercus alba*
<u>*Trees/Shrubs*</u>	
Bur Oak	*Quercus macrocarpa*
Buckthorn^	*Rhamnus* sp.
Staghorn Sumac	*Rhus typhina*
Willow	*Salix* sp.
Siberian Elm	*Ulmus pumila*
Viburnum	*Viburnum* sp.

^Exotic species

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 150 lakes measured from 2000 through 2004 range from 0 to 37.2, with an average of 14.3. Loch Lomond has a floristic quality of 16.7, indicating a higher than average aquatic plant diversity. However, these numbers can be deceiving, as it only indicates the diversity of the plants found and does not take into account plant density. The plants found in Loch Lomond were at very low densities. This is not reflected in the FQI number, and the aquatic plant habitat is actually below average when plant density is considered.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

The shoreline was assessed at Loch Lomond on June 22, 2004 for a variety of criteria (See Appendix B for methods). Based on this assessment, several important observations could be made. One hundred percent of the shoreline is developed, with 42.3% typified as riprap (Figure 6). The two other major shoreline types are seawall (26.9%) and lawn (15.8%). Beach and buffer strips each make up less than 8% of the total shoreline. One positive aspect of this shoreline is that only about 14% is eroding (Figure 7). Approximately 11% of the eroding shoreline is classified as slightly eroding, with the remainder classified as moderately eroding (2.5%) and severely eroding (1%). Even though only a small percentage is eroding continued neglect of these shorelines could lead to further erosion, resulting not only in a loss of property, but additional soil inputs into the water that negatively affect water clarity.

It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. If these shorelines are repaired by the installation of a buffer strip with native plants, the benefits are twofold. First, the erosion is repaired and the new native plants can stabilize the shoreline to prevent future erosion. Second, the addition of native plants adds to a shoreline that is otherwise limited in habitat for wildlife to use. Although some people are hesitant about installing buffer strips along shore, buffer strips can be attractive and still allow lake access by adding a mowed path to the water. Some homeowners on Loch Lomond have installed buffer strips that include native plants, behind existing seawall or riprap. Buffer habitat can help filter pollutants and nutrients from the near shore areas. This may be important given the ILM phosphorus estimates of near shore areas. Similarly, ILM stated Canada geese feces to be a phosphorus source. Buffer habitats are not preferred by geese and gulls.

A few areas around Loch Lomond had some exotic shoreline plants such as reed canary grass, honeysuckle, and purple loosestrife (Figure 8). These plants are noted to be aggressively invasive and can crowd out beneficial native species. They do not offer ideal wildlife habitat and should be removed.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Table 6 lists the wildlife species staff noted around Loch Lomond. Because the lake is in the middle of a residential setting with the majority of the shoreline as riprap, seawall, or lawn, habitat for wildlife is limited. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones, which were noted on some lots, and are recommended as one aspect of shoreline protection. Most of the birds noted were those common in residential settings. We did

Insert fig 6 shoreline type

Insert figure 7, erosion

INSERT FIG. 8 INVASIVES

identify a juvenile black-crowned night heron, which is an Illinois endangered species. This bird may have come from nearby St. Mary's Lake, which had sightings of adult black-crowned night herons in 2003. These adults may have returned to the same area to breed in 2004, although we did not find a nest.

Loch Lomond has been stocked with grass carp, northern pike, largemouth bass and channel catfish in the past. As mentioned previously, about 600 grass carp were stocked in 1990 at the recommendation of a consultant. However, these fish are normally stocked to control excessive aquatic plants. It was unnecessary to stock these fish in this lake to control algae.

The Illinois Department of Natural Resources (IDNR) completed fisheries surveys on Loch Lomond in 1994 and in 2002. The IDNR reported in 1994 that the fishery was in relatively good condition. It was noted that there were few largemouth bass collected that were larger than 14", which means the population of breeding bass was limited. The 1994 report does not mention common carp as a problem. Of the 252 fish collected during the survey, only one carp was captured. One recommendation was that the LLPOA post length limits and creel limits to boost the rather small overall size of the largemouth bass. Creel limits have been posted, listing 3 largemouth bass per day with a 15" minimum, and 1 northern pike per day with a 30" minimum. The stocking recommendation in the 1994 report was to biennially add 222 8-12" northern pike. According to LLPOA information, this has not been followed. In 1995, the LLPOA stocked 2,000 6-10" bass, 2,701-3lb bass and 25 channel catfish of an unknown size.

In the 2002 fisheries survey, an improvement was noted for the bass. The comments from the 2002 report state that Loch Lomond has a well-balanced bluegill/bass fishery. However, concerns were noted about the low amount of aquatic plant coverage. The limited access to this lake and the low harvest pressure at this time has allowed the fishery to develop to its present state. The 2002 report does not mention common carp as a problem. Of the 320 fish collected in 2002, 15 were carp. Their populations could be larger given the fishery assessment methods (electrofishing) is not conducive to accurately assessing populations of this rough fish. The last stocking took place in the spring of 2003, when about 180 12-18" northern pike were introduced to the lake.

Table 6. Wildlife species observed on Loch Lomond, May – September 2004.

Birds	
Double-crested Cormorant	*Phalacrocorax auritus*
Mallard	*Anas platyrhnchos*
Greater Scaup	*Aythya marila*
American Coot	*Fulica americana*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Black-crowned Night Heron*	*Nycticorax nycticorax*
Solitary Sandpiper	*Tringa solitaria*
Red-bellied Woodpecker	*Melanerpes carolinus*
Downy Woodpecker	*Picoides pubescens*
Eastern Kingbird	*Tyrannus tyrannus*
Great Crested Flycatcher	*Myiarchus crinitus*
Barn Swallow	*Hirundo rustica*
Rough-wing Swallow	*Stelgidopteryx ruficollis*
Chimney Swift	*Chaetura pelagica*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
House Wren	*Troglodytes aedon*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow Warbler	*Dendroica petechia*
White-breasted Nuthatch	*Sitta carolinensis*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Mammals	
Eastern Chipmunk	*Tamias striatus*
Fish	
Black Bullhead	*Ameiurus melas*
Mussels	
Giant Floater	*Pyganodon grandis*

* Endangered in Illinois

EXISTING LAKE QUALITY PROBLEMS

- *Old 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 fish stocking, aquatic herbicide use, dredging, an alum treatment or aeration were part of a future overall lake management plan. Loch Lomond's bathymetric map was created in 1988, and is most likely outdated. 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.

- *Poor Water Clarity*

  Loch Lomond suffers from poor water clarity that is caused by high total suspended solid concentrations in the water, consisting of resuspended sediment and algae. Wind and wave action in this shallow lake resuspend sediment in the water by disturbing the bottom.

- *High Phosphorus Concentrations and Algae Blooms*

  In 2004, Loch Lomond had very high phosphorus concentrations, nearly five times higher than the concentration needed to support a nuisance algae bloom. The concentrations were nearly four times higher than the Lake County median. The TP seasonal average in 1999 was also very high. During both seasons, the TP concentrations increased as the season progressed. This is usually a sign of increased algae growth over the summer, which we noted from July through September. The majority of the algae types creating these heavy blooms in 2004 were identified as *Anabaena* and *Microcystis*, two bluegreen algae that can cause nuisance conditions. With the excessive amount of TP and SRP, Loch Lomond will likely continue to be affected by nuisance algae populations.

- *Shoreline Erosion*

  Approximately 11% of the Loch Lomond shoreline is classified as slightly eroding, with the remainder classified as moderately eroding (2.5%) and severely eroding (1%). Even though only a small percentage is eroding, most of it only, continued neglect of these shorelines could lead to further erosion, resulting not only in a loss of property, but additional soil inputs into the water that negatively affects water clarity.

- *Lack of Aquatic Plants*

  According to floristic quality calculations, Loch Lomond has a higher than average aquatic plant diversity for Lake County lakes. However, these numbers can be deceiving, as it only indicates the diversity of the plants found and does not take into account plant density. The plants found in Loch Lomond were at very low densities in only a handful of places. This is not reflected in the floristic quality calculations. The aquatic plant community is actually below average when plant density is considered. The root systems of aquatic plants can assist in stabilizing the sediment, making it less likely that it will be swept into the water column from wind and wave action.

- *Limited Wildlife Habitat*

  Because the lake is in the middle of a residential setting with the majority of the shoreline as riprap, seawall, or lawn, habitat for wildlife is limited. Enhancing habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of shoreline buffer zones, which were noted on some lots, and are recommended as one aspect of shoreline protection. Most of the birds that were seen were those common to residential settings.

- *Invasive Shoreline Plant Species*

  Invasive shoreline plants around Loch Lomond are not in large populations at this time. However, they can cause problems if they expand. Their removal now would curtail their expansion. The invasive plant species include reed canary grass, honeysuckle, and purple loosestrife.

POTENTIAL OBJECTIVES FOR
LOCH LOMOND MANAGEMENT PLAN

I. Create a New Bathymetric Map Including a Morphometric Table
II. Illinois Volunteer Lake Monitoring Program
III. Nuisance Algae Management Options
IV. Reestablish Native Aquatic Plants
V. Enhance Wildlife Habitat Conditions
VI. Shoreline Erosion Control
VII. Eliminate or Control Exotic Species

Objective I: Create a New Bathymetric Map Including a Morphometric Table

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Loch Lomond does have a map we created for them in 1988, but it would be beneficial if the map were updated. Maps can be created by agencies like the Lake County Health Department - Lakes Management Unit or other companies.

Objective II: Participate in the Volunteer Lake Monitoring Program

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection agency (Illinois EPA) to gather fundamental information on Illinois inland lakes, and to provide an educational program for citizens. Annually, approximately 165 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 300 citizen volunteers. The volunteers are primarily 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 Secchi disk transparency or Secchi depth. Analysis of the Secchi disk measurement provides an indication of the general water quality condition of the lake, as well as the amount of usable habitat available for fish and other aquatic life.

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

The LLPOA has participated in this program in previous years, but is not doing so currently. The Association should participate in this program.

VLMP Regional Coordinator:
Holly Hudson
Northeastern Illinois Planning Commission
233 S. Wacker Drive, Suite 880
Chicago, IL 60606
(312) 386-8700

Objective III: Nuisance Algae Management Options

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

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

The Loch Lomond Property Owner's Association has battled algae blooms for several years, as they treat the lake annually with algicides. The option to control these blooms with algicides is a choice that many lake managers use. The LLPOA does have concerns about the amount of copper that is being applied to the lake, though. Another option that could be considered is the use of alum, a chemical that makes phosphorus inactive and unavailable for algae use. However, there are some factors concerning Loch Lomond that could make this lake unsuitable for an alum treatment. First, because Bull Creek flows through this lake, it's possible that phosphorus loading into the lake from the creek could negate the effects of alum very quickly. Second, wind and wave action can disturb the floc layer on the bottom, which could happen in this shallow system since its orientation is aligned with the predominating wind direction. On the other hand, if the cost of an alum treatment is similar to what the LLPOA is spending on algicides, an alum treatment could be worth a closer look. The lake could receive algae control for a few or more years, which would also prevent additional copper from entering the lake. If the Association would still want to pursue this option, other information is needed for this management procedure such as an updated bathymetric map and a detailed phosphorus budget to determine both internal and external loading to the lake system. This information is needed to accurately calculate the amount of alum and the costs.

Option 1: No Action

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

Pros

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

Cons

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

Birds and waterfowl will have difficulty finding quality plants for food or in locating prey within the turbid green waters. Additionally, some species, such as blue-green algae, are poor sources of food for zooplankton and fish.

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

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

Costs

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

<u>Option 2: Algicides</u>

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

Pros

When used properly, algicides can be a powerful tool in management of nuisance algae growth. A properly implemented plan can often provide season long control with minimal applications. Another benefit of using algicides is their low costs. The fisheries and waterfowl populations of the lake would greatly benefit due to a decrease in nuisance algal blooms. By reducing the algae, clarity would increase. This in turn would allow the native aquatic plants to return to the lake. Newly established stands of plants would improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed (*Potamogeton amplifolius*) and sago pondweed (*Potamogeton pectinatus*). Additionally, copper products, at proper dosages, are selective in the sense that they do not affect aquatic vascular plants and wildlife.

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

Cons

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

Costs

Costs for the use of a copper sulfate product are approximately $7.50/gallon, with an application rate of 2.7 gallons per acre-foot. With an estimated volume in Loch Lomond of 376 acre-feet, this would be about $7,614. Frequently, additional spot treatments have sometimes been deemed necessary in Loch Lomond as summer progresses, which could increase this cost.

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

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

There are some factors concerning Loch Lomond that would make this lake an unlikely candidate for a successful alum treatment. First, because Bull Creek flows through this lake, it's possible that phosphorus loading into the lake from the creek would negate the effects of alum very quickly. Wind and wave action can disturb the floc layer on the bottom, which is likely in this shallow system since its orientation is aligned with the predominating wind direction. If, however, the cost of an alum treatment is similar to what the LLPOA is spending on algicides, an alum treatment could be worth a closer look. The lake could receive algae control for more than one year, which would not only cut down on copper sulfate costs but also prevent additional copper from entering the lake, a concern voiced by the LLPOA. It's very likely additional alum treatments would need to be applied after an initial treatment.

Pros

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

Cons

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

Costs

Costs and corresponding rates for aluminum sulfate use should be calculated by an experienced professional. Morphometric data and an extensive phosphorus budget are required to make proper calculations.

Objective IV: Reestablish Native Aquatic Plants

A healthy native plant population can reduce algal growth. Many lakes with long-standing algal problems have a very sparse plant population or none at all. This is due to reduction in light penetration brought about by years of excessive algal blooms and/or mats. Revegetation should only be done when existing nuisance algal blooms 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. If aquatic herbicides are being used to control what vegetation does exist their use should be scaled back or abandoned all together. This will allow the vegetation to grow back, which will help in controlling the algae in addition to other positive impacts associated with a healthy plant population.

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 algae. 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. Because of Loch Lomond's turbidity, emergent plants might be the best to start with.

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 algae by shading and competition for resources. This provides a more natural approach as compared to other management options. In addition, using established native plants to control excessive invasive plant growth is less expensive 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 improve 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 were used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

Costs

See Table 7 in Appendix A for plant pricing. Costs will be higher if a consultant/nursery is contracted for design and labor. Additional costs will include herbivory protection materials such as metal posts and protective wire mesh (chicken wire).

Objective V: Enhance Wildlife Habitat Conditions

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

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

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

<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

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 7 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 7 in Appendix A should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily (*Nuphar* spp. and *Nymphaea tuberosa*), sago pondweed (*Stuckenia pectinatus*), largeleaf pondweed (*Potamogeton amplifolius)*, and wild celery (*Vallisneria americana*) to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

Providing a natural food source in and around a lake starts with good water quality. Water quality is important to all life forms in a lake. If there is good water quality, the fishery benefits and subsequently so does the wildlife (and people) who prey on the fish. Insect populations in the area, including beneficial predatory insects, such as dragonflies, thrive in lakes with good water quality.

Dead or dying plant material can be a source of food for wildlife. A dead standing or fallen tree will harbor good populations of insects for woodpeckers, while a pile of brush may provide insects for several species of songbirds such as warblers and flycatchers.

Supplying natural foods artificially (i.e., birdfeeders, nectar feeders, corn cobs, etc.) will attract wildlife and in most cases does not harm the animals. However, “people food” such as bread should be avoided. Care should be given to maintain clean feeders and birdbaths to minimize disease outbreaks.

Pros
Providing food for wildlife will increase the likelihood they will use the area. Providing wildlife with natural food sources has many benefits. Wildlife attracted to a lake can serve the lake and its residents well, since many wildlife species (i.e., many birds, bats, and other insects) are predators of nuisance insects such as mosquitoes, biting flies, and garden and yard pests (such as certain moths and beetles). Effective natural insect control eliminates the need for chemical treatments or use of electrical “bug zappers” that have limited effect on nuisance insects.

Migrating wildlife can be attracted with a natural food supply, primarily from seeds, but also from insects, aquatic plants or small fish. In fact, most migrating birds are dependent on food sources along their migration routes to replenish lost energy reserves. This may present an opportunity to view various species that would otherwise not be seen during the summer or winter.

Cons
Feeding wildlife can have adverse consequences if populations become dependent on hand-outs or populations of wildlife exceed healthy numbers. This frequently happens when people feed waterfowl like Canada geese or mallard ducks.

Feeding these waterfowl can lead to a domestication of these animals. As a result, these birds do not migrate and can contribute to numerous problems, such as excess feces, which is both a nuisance to property owners and a significant contribution to the lake's nutrient load. Waterfowl feces are particularly high in phosphorus. Since phosphorus is generally the limiting factor for nuisance algae growth in many lakes in the Midwest, the addition of large amounts of this nutrient from waterfowl may exacerbate a lake's excessive algae problem. In addition, high populations of birds in an area can increase the risk of disease for not only the resident birds, but also wild bird populations that visit the area.

Finally, tall plants along the shoreline may limit lake access or visibility for property owners. If this occurs, a path leading to the lake could be created or shorter plants may be used in the viewing area.

Costs

The costs of this option are minimal. The purchase of native plants and food and the time and labor required to plant and maintain would be the limit of the expense.

Option 4: Increase Nest Availability

Wildlife are attracted by habitats that serve as a place to raise their young. Habitats can vary from open grasslands to closed woodlands (similar to Options 2 and 3).

Standing dead or dying trees provide excellent habitat for a variety of wildlife species. Birds such as swallows, woodpeckers, and some waterfowl need dead trees to nest in. Generally, a cavity created and used by a woodpecker (e.g., red-headed or downy woodpecker, or common flicker) in one year, will in subsequent years be used by species like tree swallows or chickadees. Over time, older cavities may be large enough for waterfowl, like wood ducks, or mammals (e.g., flying squirrels) to use. Standing dead trees are also favored habitat for nesting wading birds, such as great blue herons, night herons, and double-crested cormorants, which build stick nests on limbs. For these birds, dead trees in groups or clumps are preferred as most herons and cormorants are colonial nesters.

In addition to allowing dead and dying trees to remain, erecting bird boxes will increase nesting sites for many bird species. Box sizes should vary to accommodate various species. Swallows, bluebirds, and other cavity nesting birds can be attracted to the area using small artificial nest boxes. Larger boxes will attract species such as wood ducks, flickers, and owls. A colony of purple martins can be attracted with a purple martin house, which has multiple cavity holes, placed in an open area near water.

Bat houses are also recommended for any area close to water. Bats are voracious predators of insects and are naturally attracted to bodies of water. They can be enticed into roosting in the area by the placement of bat boxes. Boxes should be constructed of rough non-treated lumber and placed >10 feet high in a sunny location.

Pros

Providing places were wildlife can rear their young has many benefits. Watching wildlife raise their young can be an excellent educational tool for both young and old.

The presence of certain wildlife species can help in controlling nuisance insects like mosquitoes, biting flies, and garden and yard pests. This eliminates the need for chemical treatments or electric “bug zappers” for pest control.

Various wildlife species populations have dramatically declined in recent years. Since, the overall health of ecosystems depend, in part, on the role of many of these species, providing sites for wildlife to raise their young will benefit not only the animals themselves, but the entire lake ecosystem.

Cons

Providing sites for wildlife to raise their young have few disadvantages. Safety precautions should be taken with leaving dead and dying trees due to the potential of falling limbs. Safety is also important when around wildlife with young, since many animals are protective of their young. Most actions by adult animals are simply threats and are rarely carried out as attacks.

Parental wildlife may chase off other animals of its own species or even other species. This may limit the number of animals in the area for the duration of the breeding season.

Costs

The costs of leaving dead and dying trees are minimal. The costs of installing the bird and bat boxes vary. Bird boxes can range in price from $10-100.00. Purple martin houses can cost $50-150. Bat boxes range in price from $15-50.00. These prices do not include mounting poles or installation.

Objective VI: 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.

There are few areas that are eroding on Loch Lomond's shoreline. Those that are, however, should be mitigated before further damage occurs. Because the shoreline here is dominated with riprap, seawall and lawn, all of which offer little in the way of wildlife habitat, a naturalized shoreline would be best. This way, the shoreline would benefit not only from protection against erosion, but also from the addition of habitat for wildlife.

Option 1: No Action

Pros

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

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

Cons

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

Costs

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

Option 2: Install a Seawall
Seawalls are designed to prevent shoreline erosion on lakes in a similar manner they are used along coastlines to prevent beach erosion or harbor siltation. Today, seawalls are generally constructed of steel, although in the past seawalls were made of concrete or wood (frequently old railroad ties). Concrete seawalls cracked or were undercut by wave action required routine maintenance. Wooden seawalls made of old railroad ties are not used anymore since the chemicals that made the ties rot-resistant could be harmful to aquatic organisms. A new type of construction material being used is vinyl or PVC. Vinyl seawalls are constructed of a lighter, more flexible material as compared to steel. Also, vinyl seawalls will not rust over time as steel will.

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

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

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

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

Costs

Depending on factors such as slope and shoreline access, cost of seawall installation ranges from $85-100 per linear foot for steel and $95-110 per linear foot for vinyl. This would mean $850-1000 for a 100-foot length of shoreline for Loch Lomond. A licensed contractor installs both types of seawall. Additional costs may occur if the shoreline needs to be graded and backfilled, has a steep slope, or poor accessibility. Price does not include the necessary permits required. Additional costs will be incurred if compensatory storage is needed. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained. For seawalls, a site development permit and a building permit are needed. Costs for permits and surveys can be $1,500-2,000 for installation of a seawall. Contact the Army Corps of Engineers, local municipality, or the Lake County Planning and Development Department.

<u>Option 3: Install Rock Rip-Rap or Gabions</u>

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

Pros

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

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

Cons

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

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

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

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

Costs

Cost and type of rip-rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $35-50 per linear foot. This would mean $350-500 for a 100-foot length of shoreline for Loch Lomond. This would mean Costs for gabions are approximately $70-100 per linear foot when filled with rocks. This would mean $700-1000 for a 100-foot length of shoreline for Loch Lomond. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be $1,500-2,000 for installation of rip-rap or gabions, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

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. Table 7 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 Table 7 in Appendix A should be considered for native plantings.

Pros

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

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

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

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

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

Cons

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

Costs

If minimal amount of site preparation is needed, costs can be approximately $15 per linear foot, plus labor. Cost of installing willow posts is approximately $20-25 per linear foot. This would mean approximately $150 for a 100-foot length of shoreline for Loch Lomond for the buffer strip, and approximately $200-250 for the installation of willow posts. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as $1,500-2,000 depending on the types of permits needed.

Option 5: Install A-Jacks®

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

Pros

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

Cons

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

Costs

The cost of installation is approximately $50-75 per linear foot, but does not include permits and surveys, which can cost $1,500-2,000 and must be obtained prior to any work implementation. Additional costs will be incurred if compensatory storage is needed. This would mean $500-750 to install A-Jacks® along a 100-foot length of shoreline at Loch Lomond.

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

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

Pros

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

Cons

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

Costs

Costs range from $40 to $45 per linear foot of shoreline, including plantings. This would mean approximately $400-450 for a 100-foot length of shoreline for Loch Lomond. This does not include the necessary permits and surveys, which may cost $1,500 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.

Objective VII: Eliminate or Control Exotic Species

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

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

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

Loch Lomond does not have large stands of exotic species, but if left unchecked, they could spread, making their control very difficult. Their removal now is recommended.

Option 1: No Action

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

Pros

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics whenever possible. Table 7 in Appendix A lists several native plants that can be planted along shorelines.

Cons

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

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

Costs

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

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 leaf beetles (*Galerucella pusilla* and *G. calmariensis*) and two weevils, one a root-feeder (*Hylobius transversovittatus*) and one a flower-feeder (*Nanophyes marmoratus*) have offered some hope to control purple loosestrife by natural means.

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

Because there are not large stands of purple loosestrife along Loch Lomond's shoreline, this option is not recommended 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 plant (i.e., the beetles and weevils and the purple loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while bio-control measures target specific plant species. This technique is beneficial to the ecosystem since it preserves, even promotes, biodiversity. As the exotic plant dies back, native vegetation can reestablish the area.

Cons

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

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

Costs

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

Option 3: Control by Hand

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

This option may be the best for the Loch Lomond shoreline, since these plants are in low numbers.

> ***Pros***
>
> Removal of exotics by hand eliminates the need for chemical treatments. Costs are low if stands of plants are not too large already. Once removed, control is simple with yearly maintenance. Control or elimination of exotics preserves the ecosystem's biodiversity. This will have positive impacts on plant and wildlife presence as well as some recreational activities.
>
> ***Cons***
>
> This option may be labor intensive or prohibitive if the exotic plant is already well established. Costs may be high if large numbers of people are needed to remove plants. Soil disturbance may introduce additional problems such as providing a seedbed for other non-native plants that quickly establish disturbed sites, or cause soil-laden run-off to flow into nearby lakes or streams. In addition, a well-established stand of an exotic like purple loosestrife or reed canary grass may require several years of intense removal to control or eliminate.
>
> ***Costs***
>
> Cost for this option is primarily in tools, labor, and proper plant disposal.

Option 4: Herbicide Treatment

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

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

Pros

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

Cons

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

Costs

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