2004 SUMMARY REPORT
of
BISHOP LAKE

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Bishop Lake, located within the Village of Kildeer, is a manmade lake, created in approximately 1926. The lake has a surface area of 7.12 acres and a maximum depth of 12 feet. Development around the lake began in the early to mid-1980's, and in 1992, an informal association, the Bishop Lake Property Owner's Association (BLPOA), was formed. The association has implemented some lake management activities such as fish stocking and the installation of an aeration system. They also treat the lake with herbicides and algicides on an annual basis. Association members primarily use the lake for aesthetic purposes, but fishing and non-motorized boating are allowed. Some homes have private beaches for swimming. Use of the lake is limited to the homeowners and their guests.

Bishop Lake is described as polymictic. The water column in a polymictic lake will thermally stratify and then mix periodically, or continuously mix during the season. During June and August, Bishop Lake experienced some oxygen loss below 10 feet deep. However, the lake apparently does not have a history of fish kills due to oxygen losses. The majority of the lake volume may have an adequate amount of dissolved oxygen, although it's not possible to determine this without a bathymetric map (depth contour map) and volume calculations. Bishop Lake has high nitrogen and phosphorus concentrations, two nutrients that are essential for algae growth. The total phosphorus concentrations averaged more than three times higher than the Lake County TP median. Total Kjeldahl nitrogen (TKN) was also elevated, averaging 1.5 times higher than the Lake County TKN median. Because of the nutrient concentrations, the lake did experience nuisance algae growth in July and August. The combination of algae growth and suspended sediment in the water column resulted in low water clarity during 2004.

We found only a few aquatic plants in just a handful of places in Bishop Lake. The lake does not have a good variety of plants since we identified only seven species. A positive aspect about this lake is that six of the seven species are beneficial native plants. The seventh plant, curlyleaf pondweed, is a nonnative, aggressive species that has been known to overpopulate in lakes and cause nuisance conditions. A well-balanced lake system has a mix of native aquatic plants. To maintain a healthy bluegill/bass fishery, the optimal plant coverage is 30% to 40% across the lake bottom.

Good habitat exists around the lake in the form of mature trees and some buffer strips of native plants near the shoreline, along with an undeveloped wooded parcel that comprises most of the southern shoreline. For the most part, we noted wildlife species common to this area. Grass carp were stocked in the lake on two separate occasions in an effort to control aquatic plants. It is unknown if any of these fish still exist in the lake, but it is possible. The Association also stocked 250 largemouth bass about 5-6 years ago. The condition of the fishery in this lake is also unknown, since no formal surveys have been done. About 80% of the shoreline is considered developed, with the majority typified as seawall. Other shoreline types are lawn, buffer and woodland. About 38% of the shoreline is eroding, all of it classified as slightly eroding.

LAKE IDENTIFICATION AND LOCATION

Bishop Lake is privately owned, and located in southwestern Lake County (T43N, R10E Section 28), within the Village of Kildeer. It is part of the Buffalo Creek drainage of the Des Plaines River water shed. The outlet of the lake is a dropbox culvert at the northeast part of the shoreline, which then drains east to Buffalo Creek and continuing to the Des Plaines River.

Bishop Lake is 7.12 acres with a maximum depth of 12 feet. It has an estimated average depth of 6 feet, with an estimated volume of 42.7 acre-feet, or 13.9 million gallons. The length of shoreline is 0.53 miles and the lake elevation is 812 feet above mean sea level. Based on the land uses in the watershed and the estimated volume of Bishop Lake, the approximate retention time of the lake is 51 days.

BRIEF HISTORY OF BISHOP LAKE

Bishop Lake was built in approximately 1926. Development of the homes around the lake began in the early to mid-1980’s, and an informal association, the Bishop Lake Property Owner’s Association (BLPOA), was formed in 1992. A few lake management activities were done shortly after the association formed. About 50 grass carp were stocked in the lake in 1992. Records state that this was a secondary stocking, but no information is available about the initial stocking numbers or dates. It is not certain if any of these fish still exist, but since their life span is 15-20 years, it’s possible that some are still present. The Association also stocked 250 largemouth bass about 5-6 years ago, but accurate records mentioning the date are not available. The condition of the fishery in this lake is unknown, since no formal surveys have been done.

An aeration system consisting of a 0.75 horsepower rotary vane compressor with 5 diffusers was installed in 1993 as recommended by a consultant. This system operates daily from April to November. The main reason for the aeration system was to add dissolved oxygen to the lake. Unfortunately, historical dissolved oxygen data are unavailable to compare with the 2004 data to see if there was an improvement in the lake.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

The use of Bishop Lake is limited to the homeowners and their guests. The residents primarily use the lake for aesthetic purposes, but fishing and non-motorized boating are allowed. Some homes have private beaches for swimming. The Association hires a consultant to treat the lake annually for algae and aquatic plants. Aquathol K® was used to treat aquatic plants each year during 2001 (eight gallons), 2002 (eight gallons), and 2003 (10 gallons). The target plant, in each of these years was curlyleaf pondweed. The plant densities and bottom coverage across the lake before treatments are unknown. Cutrine–Plus® was used to treat algae in 2003 (18 gallons) and 2004 (17.5 gallons).

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were collected each month, from May through September 2004, at the deepest location (see Figure 1). All samples were analyzed for a variety of parameters. The 2004 water quality data can be found in Table 1, Appendix A.

An aeration system consisting of a 0.75 horsepower rotary vane compressor with 5 diffusers was installed in the lake in 1993 as recommended by a consultant in order to introduce more dissolved oxygen (DO) to the lake. Calculations indicate that for a 7.12 acre lake, an aeration system employing between 0.45 – 0.73 horsepower would be properly sized. The present system for Bishop Lake is slightly higher, but very close to this range. The system operates daily from April to November. Bishop Lake was described as polymictic during 2004. The water column in a polymictic lake will thermally stratify and then mix periodically, or continuously mix during the season. Thermal stratification occurs when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold-water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically becomes hypoxic (dissolved oxygen <1 mg/L) by mid-summer. This phenomenon is a natural occurrence and is not necessarily harmful if enough of the lake volume remains well oxygenated.

The aeration system may have contributed to the polymixis since the diffusers are placed throughout the lake as various depths. One diffuser is located at a depth of 10 feet within 100 feet of the water sampling location and may have influenced the DO concentrations and stratification. In 2004, Bishop Lake was not stratified in May, and had DO concentrations > 1 mg/L were recorded down to the bottom. In June the lake had stratified very close to the bottom at 10 feet deep, below which DO concentrations were < 1mg/L. In July the lake was weakly stratified; DO concentrations were >1 mg/L throughout the water column. Mixing was apparent in much of the water column in August as evidenced by calculations determining the relative thermal resistance to mixing. Even so, hypoxia again occurred below 10 feet deep. The lake was fully mixed in September, with DO concentrations of at least 5.4 mg/L throughout the water column. It is difficult to determine the actual portion of the lake volume that had low DO because there is no recent accurate bathymetric map with volume calculations for this lake. However, according to the many depth readings we took during our investigation, the portion of the lake that was under hypoxic conditions (i.e., 10-12 feet deep) was very small. Our contact person with the Association did not indicate that the lake had experienced historical fish kills due to low DO conditions. With this information, it’s probable that the majority of the water volume in Bishop Lake has sufficient DO to support aquatic life with the current aeration system in place. Unfortunately, historical DO data is unavailable to make before and after comparisons of the system. For future reference, if measurements were collected by their consultant, the Association should

INSERT FIGURE 1

request this information for their files. To determine if Bishop Lake has sufficient DO without the aeration system, the system would need to be shut off and the DO/temperature profiles recorded for a season or two. It is recommended that the Association move the one diffuser from its current depth of 10 feet to the deep hole (12 feet) to maximize the efficiency of the system. This will prevent hypoxia from occurring throughout the entire water column and limit the polymictic stratification, which may help control some of the internal nutrient recycling in the lake. In addition, the air flow to each diffuser was variable. Maintenance or adjustments to the system may be needed to ensure proper air flow to all diffusers.

Water clarity, measured with a Secchi disk, is usually the first thing people notice about a lake, and typifies the overall water quality. In Bishop Lake, the Secchi disk readings were fair to poor, averaging 3.47 feet deep over the 2004 season, although this is slightly higher than the Lake County median of 3.08 feet deep. Heavy rains totaling 1.67 inches fell on the area prior to the May sampling date, which resulted in the season low clarity reading of 2.26 feet. A brown colored plume of stormwater was flowing into the lake from a pipe at the northwest corner as we were sampling. Inflows of stormwater like this can negatively affect the water quality of a lake, as it can deliver sediment and high nutrient loads that result in poor water clarity and can trigger nuisance algae blooms. This sediment suspended in Bishops Lake's water column is one reason the water clarity in this lake was low. Water clarity is a direct result of the amount of total suspended solids (TSS) concentration 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 TSS increases, the Secchi disk clarity readings usually decrease. Figure 2 illustrates this negative correlation in Bishop Lake during 2004. The 2004 seasonal TSS average in Bishop Lake was 14.3 mg/L, nearly twice as high as the county median of 7.9 mg/L. During July and August, algae also played a role in causing low water clarity. We noticed blue green algae blooms in the lake during both sample dates. All algae require nutrients such as nitrogen and phosphorus, which are two key ingredients for their growth. As total phosphorus (TP) concentrations increase or decrease corresponding with algae growth or reduction. This in turn, usually results in TSS concentrations following a pattern similar to that of TP (Figure 3).

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. Other resources necessary for plant and algae growth, such as light or carbon, are not normally in short supply. 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) from the surface waters (epilimnion) 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. Bishop Lake had an average overall TN:TP ratio of 8:1 in 2004. This indicates that the lake is nitrogen limited, and that algal growth could be

INSERT FIGURE 2, TSS/SECCHI

INSERT FIGURE 3 TSS/TP

hindered by a lack of nitrogen. However, nitrogen can come from a variety of external sources, and can also be taken from the atmosphere and "fixed" by blue-green algae, like that noticed in July and August in Bishop Lake. This makes nitrogen input virtually impossible to control. However, the monthly calculated TN:TP ratios for Bishop Lake help explain the data more clearly.

In May and June of 2004, the lake was limited by *phosphorus*, not nitrogen, with TN:TP ratios of 19:1 and 20:1, respectively. TP concentrations were 0.052 mg/L and 0.046 mg/L, respectively. A dramatic switch occurred in the months afterward, when concentrations of TP increased significantly. By the July sampling date, the TP had increased over four times, with a concentration of 0.192 mg/L, coinciding with the blue-green algae bloom and TSS increase. The TN:TP ratio was 10:1, indicating the lake had changed to a nitrogen limited system. When nitrogen limitation occurs algae can not utilize the available phosphorus. This helps explain the dramatic increase in TP. By the August sampling date, the TP concentration had doubled to 0.434 mg/L, then dropped slightly to 0.354 mg/L in September. These TN:TP ratios were 7:1 and 6:1 respectively. In addition to nitrogen limitation, excessive TP in the water can come from phosphorus being released from sediment through biological processes, or from aquatic plant or algae cells as they die. These processes, called *internal loading* basically "recycles" TP within the lake. In addition, the rainfall (or lack of it) in the area may have played a role in how TP concentrations changed. In 2004, data from a Lake Zurich rain gage indicated that very little rainfall had occurred in the area later in the season, and by September, the area was in drought conditions. Some evaporation had taken place during this time as the lake's water elevation dropped by 6.9 inches between the July and August sampling dates, concentrating the phosphorus into a smaller lake volume. The smaller volume, internal loading from sediment resuspension, and nitrogen limitation are the probable factors that triggered the large TP increase over the 2004 season. Overall, Bishop Lake TP concentrations averaged 0.216 mg/L in 2004, which is over three times higher than the Lake County TP median of 0.063 mg/L for epilimnetic (near surface) samples. Soluble reactive phosphorus (SRP), the most readily available form of phosphorus for algal growth, is usually undetected in the surface waters since algae use it almost as quickly as it becomes available. However, SRP was detected in all of Bishop Lake's samples in 2004. The SRP concentrations each month displayed a pattern similar to that of the TP concentrations. The concentration was low early in May (0.005 mg/L), and then increased dramatically in the later months, to 0.174 mg/L in September. The months when SPR and TP concentrations were highest were also the months of nitrogen limitation. One of Bishop Lake's external sources of TP is the incoming stormwater from its 343-acre watershed (Figure 4). The two major land uses are residential and transportation (roads), comprising approximately 43% and 18% of the watershed, respectively (Figure 5). Table 2 in Appendix A lists all the land uses and their percentages within the Bishop Lake watershed. Developed land uses such as residential areas and roads can generate more stormwater per acre than undeveloped land uses such as grasslands or forests. This is because of the presence of impervious surfaces (e.g., asphalt, rooftops, parking lots) that do not allow rainwater to infiltrate into the ground. The stormwater then travels to the nearest body of water, carrying pollutants and

INSERT FIGURE 4, WATERSHED

INSERT FIG. 5, LAND USES

nutrients such as TP. Because of the effects of incoming stormwater, lakes with watershed to lake surface area ratios of 40:1 or larger are considered to be difficult to manage, especially when dominated by developed land uses. This is the case for Bishop Lake, for which about 76% of the watershed is developed, and which has a watershed to lake surface area ratio of 48:1.

TP can be used to calculate 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 Bishop Lake in terms of its phosphorus concentration during 2004 was hypereutrophic, with a TSIp score of 81.6. In comparison with 161 Lake County lakes based on average total phosphorus concentrations, Bishop Lake ranked #149 (Table 3, Appendix A). This ranking is only a relative assessment of the lakes in the county.

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. Bishop Lake fully supports aquatic life and swimming uses according to these guidelines. However, the lake is slightly impaired for recreational uses because of the high TP concentrations, suspended sediment in the water column and the resulting low water clarity. Bishop Lake has partial overall use support, when considering all aspects of these indices.

Conductivity is a measurement of water's ability to conduct electricity via total dissolved solids (TDS) and is made up of minerals and salts in the water column. Lakes with residential and/or urban land uses in their watersheds often have higher conductivity readings and higher TDS concentrations than lakes that are not surrounded by development 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 Bishop Lake were higher, averaging 1.1212 mS/cm. The readings were highest in May. This is typical of lakes that receive road salts, as spring rains flush through the watershed. Usually, the readings decrease as the season progresses, but in Bishop Lake, conductivity fluctuated slightly over the remainder of the season. This may be explained by the lack of rain and low water levels that prevented TDS from being "flushed" out of the lake. Chloride concentrations help determine road salt presence since most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. The seasonal average for chlorides in Bishop Lake in 2004 was calculated to be 221 mg/L. The IEPA standard for chloride is 500 mg/L. Once values exceed this standard the water body is deemed to be impaired, thus negatively impacting aquatic life. The impacts of road salt are a concern throughout the county and it appears that the road salt is compounding in many of the lakes. Some lakes in the county have seen a doubling of conductivity readings in the past 5-10 years. In a study by Environment Canada (equivalent to our USEPA), it was estimated that 5% of aquatic species such as fish, zooplankton and benthic invertebrates would be affected at chloride concentrations of about 210 mg/l, which is below the estimated Bishop Lake chloride average. Additionally, shifts in algae populations in lakes were associated with chloride concentrations as low as 12 mg/l.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

We randomly sampled locations in Bishop Lake each month for aquatic plants, and identified seven species. We also recorded shoreline plants. Table 4 lists the plants that were identified by their common and scientific names. A positive aspect about the aquatic plant life in this lake is that six of the seven plants are beneficial, native species. However, the plants were in very low densities. During 2004, *Chara* was most commonly found in Bishop Lake, but only in 13 of 38 samples over the season. The other aquatic plants were found less often over the season. To maintain a healthy bluegill/bass fishery, the optimal plant coverage should be 30% to 40% across the lake bottom. Bishop Lake has far less than this, and did not have any defined plant beds; individual plants were found in a few scattered locations. Table 5 in Appendix A lists the species and the frequency that they were found. It is recommended that aquatic plant growth be allowed to expand in the lake. The benefits of aquatic plants include sediment stabilization, wildlife habitat and the ability to limit algae growth by competing for nutrients.

About 50 grass carp were stocked in Bishop Lake in 1992. These fish have been used to control nuisance aquatic plant beds, but they can destroy aquatic plant communities (both native and non-native species) with their voracious appetites. Records state that this was a secondary stocking, but no information is known about when the first stocking had taken place or how many grass carp were introduced. Stocking rates can vary depending on the types of plants that need to be controlled. The rates also depend on the acreage of the lake covered with vegetation. Historical information about plant community in Bishop Lake prior to stocking these fish is limited, with the only information known as "heavy curlyleaf pondweed" in the lake. Curlyleaf pondweed is an invasive species and in many instances can overpopulate a lake, causing nuisance conditions. Initial and secondary stocking rates for curlyleaf pondweed are 16 grass carp per vegetated acre, but the size of the curlyleaf plant beds in Bishop Lake at the time the grass carp were stocked is unknown. Because of this lack of information, it is uncertain whether the lake was stocked appropriately. If stocked appropriately, the addition of 50 fish would mean that the lake would have had about 3 acres of plant coverage. It's not certain if any grass carp still exist at this time, but since their life span is 15-20 years, it's possible that some are still present. If they were overstocked, this could be another reason that the plant density in the lake is low. Additional stocking of grass carp is not recommended at this time.

The Association also contracts with a licensed aquatic herbicide applicator to treat aquatic plants in the lake. Eight gallons of Aquathol K® were used to treat aquatic plants each year during 2001 and 2002. In 2003, 10 gallons of Aquathol K® were applied to the lake. The target plant, in each of these years was curlyleaf pondweed. The plant density and bottom coverage across the lake before treatment is unknown. In 2003, 18 gallons of Cutrine–Plus® was used to treat algae. Cutrine–Plus® was used again on two occasions in 2004 (June 11th -10 gallons, July 29th -7.5 gallons). Because of the low plant densities, it would be beneficial for the Association to discuss a new plant management plan with their applicator. This plan would entail focusing only on invasive aquatic plant beds if their populations begin to increase and avoiding the treatment of the native plants in the lake. Since curlyleaf pondweed is the target species, any plant treatments should occur early the season (early May) as curlyleaf pondweed is actively growing at this time while many of the native species are beginning to emerge.

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. In Bishop Lake during 2004, the 1% light level was deepest in June, at 8.25 feet deep. According to the many depth readings we took across the lake during our investigation, much of Bishop Lake is shallower than this. With this light availability, some plants should be able to grow. However, because of the herbicide treatments and the possible existence of grass carp still in the lake, plant growth is being inhibited. The light level decreased in the later months. In August and September, the depth of the 1% light level was the lowest, between 2.8 and 3.8 feet deep, coinciding with the algae blooms and high TSS concentrations.

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. Bishop Lake has a floristic quality of 13.4, indicating a lower than average aquatic plant diversity. This, coupled with the fact that the plants are in very low densities, result in a poor quality plant community in Bishop Lake.

Table 4. Aquatic and shoreline plants on Bishop Lake, May – September, 2004.

Aquatic Plants	
Coontail	*Ceratophyllum demersum*
Chara	*Chara*, sp.
Curlyleaf Pondweed#	*Potamogeton crispus*
Sago Pondweed	*Potamogeton pectinatus*
Small Pondweed	*Potamogeton pusillus*
White Water Crowfoot	*Ranunculus longirostris*
Horned Pondweed	*Zannichellia palustris*
Shoreline Plants	
Swamp Milkweed	*Asclepias incarnata*
Beggar Ticks	*Bidens* sp.
Enchanter's Nightshade	*Ciracaea quadrisulcata*
Canada Thistle#	*Cirsium arvense*
Hedge Bindweed	*Convolvulus sepium*
Spikerush	*Eleocharis* sp.
Eastern Joe-Pye Weed	*Eupatorium dubium*
Jewelweed	*Impatiens pallida*
White Sweet Clover#	*Melilotus alba*
Sensitive Fern	*Onoclea sensibilis*
Virginia Creeper	*Parthenocissus quinquefolia*
Reed Canary Grass#	*Phalaris arundinacea*
Common Cinquefoil	*Potentilla simplex*
Multiflora Rose#	*Rosa multiflora*
Dock#	*Rumex* sp.
Bittersweet Nightshade#	*Solanum dulcamara*
Goldenrod	*Solidago* sp.
Sow Thistle#	*Sonchus* sp.
Wild Grape	*Vitis* sp.
Trees/shrubs	
Box Elder	*Acer negundo*
White Birch	*Betula papyrifera*
Shagbark Hickory	*Carya ovata*
Red Osier Dogwood	*Cornus sericea*
Honeysuckle#	*Lonicera* sp.
Red Mulberry	*Morus rubra*
Red Pine	*Pinus resinosa*
White Pine	*Pinus strobes*
Cottonwood	*Populus deltoides*
American Plum	*Prunus americana*

Table 4. Aquatic and shoreline plants on Bishop Lake, May – September, 2004, cont'd.

Black Cherry	*Prunus serotina*
Crabapple	*Pyrus* sp.
Black Oak	*Quercus velutina*
Bur Oak	*Quercus macrocarpa*
Common Buckthorn#	*Rhamnus cathartica*
Staghorn Sumac	*Rhus typhina*
Currant	*Ribes* sp.
Black Locust	*Robinia pseudo-acacia*
Black Raspberry	*Rubus occidentalis*
Willow	*Salix* sp.
Elderberry	*Sambucus* sp.
Northern White Cedar	*Thuja occidentalis*
Viburnum	*Viburnum* sp.

 # Exotic species

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

The shoreline was assessed at Bishop Lake on June 30, 2004 for a variety of criteria (See Appendix B for methods). Based on these assessments, several important observations could be made. Nearly 80% of the shoreline is developed, with the majority classified as seawall (Figure 6). Other major shoreline types are buffer, lawn and woodland. The buffer and wooded shorelines offer some habitat for wildlife, a positive aspect of the shoreline. About 38% of the shoreline is eroding, all of it classified as slight (Figure 7). Although no portion of the shoreline is moderately or severely eroding, the continued neglect of these shorelines could lead to further erosion. This can result not only in a loss of property, but also add soil to the water that negatively affects water clarity. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. It is recommended that a buffer strip, consisting of native plants, be established around the lake at the water/land interface. Buffer strips are beneficial by stabilizing the shoreline to prevent future erosion and adding more habitat to the shoreline. In addition, buffer strips are not favored habitat by nuisance resident Canada geese. 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.

Figure 8 shows the extent of the shoreline with nonnative invasive plant species such as buckthorn and honeysuckle shrubs. 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 and replaced with native plants.

INSERT FIGURE 6 TYPES

NSERT FIG 7 EROSION

INSERT FIGURE 8 INVASIVES

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Table 6 lists the wildlife species we noted at Bishop Lake. Most of the wildlife we noted were those tolerant of an urbanized setting. However, of interest was the active redtail hawk nest on one of the lots, and the sighting of a mink. The buffer and wooded shorelines offer some habitat for wildlife, a positive aspect of the shoreline. Further enhancement of the habitat for terrestrial wildlife such as birds and small mammals can be accomplished through the addition of more shoreline buffer zones and the removal of invasive shoreline plants.

The condition of the fishery in this lake is unknown, since no formal surveys have been done. The Association stocked 250 largemouth bass about 5-6 years ago, but accurate records mentioning the date are not available. If the Association plans to stock more fish in the future, it is advisable to obtain a survey of the fishery to obtain a recommended list of species and stocking amounts. The BLPOA should always maintain accurate records for fish stocking for future reference. Stocking dates, the number of each fish species and their length are important information, as well as who did the stocking, and their contact information.

Table 6. Wildlife species observed on Bishop Lake, May – September, 2004.

<u>*Birds*</u>	
Double-crested Cormorant	*Phalacrocorax auritus*
Mute Swan	*Cygnus olor*
Mallard	*Anas platyrhnchos*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Spotted Sandpiper	*Actitis macularia*
Red-tailed Hawk	*Buteo jamaicensis*
Mourning Dove	*Zenaida macroura*
Common Flicker	*Colaptes auratus*
Downy Woodpecker	*Picoides pubescens*
Eastern Kingbird	*Tyrannus tyrannus*
Eastern Pewee	*Contopus virens*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
Rough-wing Swallow	*Stelgidopteryx ruficollis*
Chimney Swift	*Chaetura pelagica*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
White-breasted Nuthatch	*Sitta carolinensis*
Catbird	*Dumetella carolinensis*

Table 6. Wildlife species observed on Bishop Lake, May – September, 2004 (cont'd).

American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo	*Vireo olivaceus*
Yellow-rumped Warbler	*Dendroica coronata*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Song Sparrow	*Melospiza melodia*
Mammals	
Eastern Chipmunk	*Tamias striatus*
Gray Squirrel	*Sciurus carolinensis*
Mink	*Mustela vison*

EXISTING LAKE QUALITY PROBLEMS

- *Lack of a 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, or dredging were part of a future overall lake management plan. Bishop Lake does not have a recent bathymetric map. Maps can be created by the Lake County Health Department – Lakes Management Unit or other agencies for costs that vary from $2,000-$10,000, depending on lake size.

- *Low water clarity*

  Overall, Bishop Lake has poor water clarity. The high concentration of total suspended solids in the water, which consists of resuspended sediment and algae is the cause. Wind and wave action, aeration, and carp activity in this shallow lake resuspend sediment in the water by disturbing the bottom. Stormwater inputs are also a source of total suspended solids and nutrients, which can produce nuisance algae blooms that cloud the water.

- *High Phosphorus Concentrations and Algae Blooms*

  In 2004, Bishop Lake had phosphorus concentrations over three times higher than the Lake County median. During July and August, blue green algae blooms occurred in the lake as a result of these high phosphorus levels. Algae blooms and resuspended sediment negatively affect water clarity. Sources of phosphorus include stormwater runoff from the watershed, and internal loading.

- *Lack of Aquatic Plants*

  According to floristic quality calculations, Bishop Lake has a lower than average aquatic plant diversity. The plants are in very low densities also results in a low quality plant community. One key to a healthy lake is a healthy plant community.

- *Shoreline Erosion*

  About 38% of the shoreline is eroding. Even though it is classified as slightly eroding, continued neglect of these shorelines could lead to further erosion. This could result in a loss of property and soil inputs into the water that negatively affects water clarity. It's much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion.

- *Invasive Shoreline Plant Species*

  About 40% of the shoreline hosts aggressive, invasive shoreline plants such as buckthorn and honeysuckle shrubs. These species are detrimental as they do not offer good wildlife habitat and can crowd out native beneficial plants. They should be removed and replaced with beneficial native species.

- *Lack of Fishery Information*

  At this time, no formal information about the fishery in Bishop Lake is known. It is recommended that a fishery assessment be completed. If future plans include stocking the lake with fish, this information would be important to have obtain a recommended list of species and stocking amounts.

- *Lack of Historical Lake Management Information*

  The Bishop Lake Property Owner's Association does not have records about some lake management practices that have been conducted in their lake, such as fish stocking, aquatic plant coverage and dissolved oxygen data. This is essential to have for future reference. Information such as the date, costs, the amount of plant coverage, and fish stocking information (species, numbers stocked) should be recorded and filed in an organized fashion.

POTENTIAL OBJECTIVES FOR THE BISHOP LAKE MANAGEMENT PLAN

I. Create a New Bathymetric Map Including a Morphometric Table
II. Illinois Volunteer Lake Monitoring Program
III. Reestablish Native Aquatic Plants
IV. Selective Aeration System Operation
V. Nuisance Algae Management Options
VI. Shoreline Erosion Control
VII. Eliminate or Control Exotic Species
VIII. Conduct a Fisheries Assessment

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

No recent, accurate bathymetric map with volume calculations exists for Bishop Lake. A bathymetric map (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. 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, about 300 citizen volunteers sample approximately 165 lakes (out of 3,041 lakes in Illinois). 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.

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Objective III: 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.

One key to a healthy lake is a healthy plant community. Bishop Lake has would benefit from additional native plants. Very few plants could be found in the lake during 2004, and yet the Association still had an applicator use aquatic herbicides to kill the few native, beneficial plants that were left. The Association should also discuss a different plant management plan with their aquatic herbicide applicator. This plan would entail focusing only on invasive aquatic plant beds such as the curlyleaf pondweed if it begins to increase to nuisance conditions. In addition, the applicator could avoiding treating the native plants in the lake.

If additional native plants are installed, they may need to have protective caging until they become established. This is because grass carp may still exist in the lake, and may eat them soon after planting.

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 IV: Selective Aeration System Operation

The present aeration system in Bishop Lake consists of a 0.75 horsepower rotary vane compressor with 5 diffusers was installed in Bishop Lake in 1993 as recommended by a consultant in order to introduce more dissolved oxygen (DO) to the lake. Calculations indicate that for Bishop Lake, an aeration system employing between 0.45 – 0.73 horsepower would be properly sized. The present system for Bishop Lake is slightly higher, but very close to this range. The system is in operation daily from April to the beginning of November. In 2004, Bishop Lake did experience hypoxic conditions on two occasions according to our data, but the volume of water with low DO may not have been significant. It's difficult to determine the actual portion of the total water volume that had low DO during the times hypoxia was recorded because there is no recent accurate bathymetric map with volume calculations for this lake. However, according to the many depth readings we took during our investigation, the portion of the lake that was under hypoxic conditions (i.e., 9.9-12 feet deep) was very small. Our contact person with the Association did not indicate that the lake had experienced historical fish kills due to low DO conditions. With this information, it's probable that the majority of the water volume in Bishop Lake has sufficient DO to support aquatic life with the current aeration system in place. It may also be possible that Bishop Lake has sufficient DO without the aeration system. Unfortunately, historical DO data is unavailable to make comparisons of DO data before and after the system was installed. To determine if Bishop Lake has sufficient DO without the aeration system, the system would need to be shut off and the DO/temperature profiles recorded for a season or two. If it is determined that Bishop Lake has sufficient dissolved oxygen within, the aeration system could be shut off, saving the Bishop Lake Property Owner's Association money in electric bills and maintenance.

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

This would simply mean the operation of the aeration system would remain the same.

> ***Pros***
>
> There is no history of fish kills due to anoxic conditions since the system has been installed. During summer use, if constantly running, the guesswork is eliminated as to whether or not the fishery would have an adequate supply than if the aerators were turned off.
>
> ***Cons***
>
> Running the system as is costs the BLPOA approximately $500 per year in electricity and maintenance. The BLPOA could use this money for other lake management activities.

<u>Option 2: Shut Off the System</u>

It may also be possible that Bishop Lake has sufficient DO without the aeration system. Unfortunately, historical DO data is unavailable to make comparisons of DO data before and after the system was installed. To determine if Bishop Lake has sufficient DO without the aeration system, the system would need to be shut off and the DO/temperature profiles recorded for a season or two. If it is determined that Bishop

Lake has sufficient dissolved oxygen within, the aeration system could be shut off, saving the BLPOA money in electric bills and maintenance. Several small lakes without aerators do not have problems with fish kills due to DO loss, and Bishop Lake does not have a history that proves otherwise. The money saved in operating and maintenance expenses could be used for other lake management options. One thing the BLPOA needs to keep in mind in the summer is that they need to work closely with their contractor during algae and herbicide treatments. The applicator *should* measure the DO in the water column before applying to be sure there is enough oxygen in the system to handle DO loss due to algae decomposition after the treatment. The applicator also needs to avoid treatments on very hot, still days when DO may be low. Further discussion on this is within the Nuisance Algae Management Objective.

Pros
The money saved in operating and maintenance expenses could be used for other lake management options.

Cons
Bishop Lake experienced hypoxic conditions on two occasions according to our data. If the system is shut off, the lake could potentially have a smaller volume of DO for aquatic life when these conditions occur.

Objective V: 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 Bishop Lake Association hires a certified applicator to apply algicides on a yearly basis. Unfortunately, the products used and their amounts are unavailable. In the future, the Association needs to request this information from any applicator they hire to keep for their records for future reference.

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

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 widespread 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

Cutrine–Plus®, which is the product BLPOA has been using since 2001, is about \$35-40/gallon, with an application rate of 0.5 – 1.5 gallons per acre-foot. The use of this product in Bishop Lake is estimated at $747 – $2562 . Any additional spot treatments would increase these costs. The BLPOA estimates they spent about $1,700 for algae control in 2003. Amounts and costs for applications in 2004 were not available.

Option 3: Alum Treatment

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum does not directly kill algae as copper sulfate does. Instead, alum binds phosphorus making it unavailable, thus reducing algal growth. Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom. This floc layer can then prevent sediment bound phosphorus from entering the water column. Phosphorus inactivation using alum has been in use for 25 years. However, cost and sometimes unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds and small lakes, and its use in larger lakes is increasing. Alum treatment typically lasts 1 to 20 years depending on various parameters. Lakes with low mean depth to surface area ratio benefit more quickly from alum applications, while lakes with high mean depth to surface area ration (thermally stratified lakes) will see more longevity from an alum application due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited. 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 Bishop Lake that would make this lake an unlikely candidate for a single successful alum treatment. First, because it is a systems with a large lake:watershed ratio, it's possible that phosphorus loading into the lake from stormwater would negate the effects of alum very quickly. In addition, wind and wave action can disturb the floc layer on the bottom.

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

An experienced professional should calculate costs and corresponding rates for aluminum sulfate use. Morphometric data and an extensive phosphorus budget are required to make proper calculations.

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.

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.

The erosion along Bishop Lake is only classified as slight, in which the use of seawalls would be “overkill.” In addition, the seawalls would negatively affect some of the good wildlife habitat that exists along some areas of the shoreline.

Pros

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

Cons

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

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

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

Costs

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

For Bishop Lake, the costs for installing a steel seawall along the areas of slightly eroding shoreline would total approximately $92,055-108,300. A vinyl seawall would total approximately $102,885-119,130.

Option 3: Install Rock Rip-Rap or Gabions

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

The erosion along Bishop Lake is only classified as slight, in which the use of riprap may be "overkill." In addition, the riprap could negatively affect some of the good wildlife habitat that exists along some areas of the shoreline.

Pros

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

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

Cons

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

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

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

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

Costs

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

For Bishop Lake, the costs for installing a riprap along the areas of slightly eroding shoreline would total approximately $37,905-90,150.

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

The installation of native plants along the slightly eroding shoreline on Bishop Lake is recommended.

Pros

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

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

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

Many fish and wildlife species prefer the native shoreline vegetation habitat. This habitat is an asset to the lake's fishery since the emergent vegetation cover may be used for spawning, foraging, and hiding. Various wildlife species are even dependent upon shoreline vegetation for their existence. Certain birds, such as marsh wrens (*Cistothorus palustris*) and endangered yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) nest exclusively in emergent vegetation like cattails and bulrushes. Hosts of other wildlife like waterfowl, rails, herons, mink, and frogs to mention just a few, benefit from healthy stands of shoreline vegetation. Dragonflies, damselflies, and other beneficial invertebrates can be found thriving in vegetation along the shoreline as well. Two invertebrates of particular importance for lake management, the water-milfoil weevils (*Euhrychiopsis lecontei* and *Phytobius leucogaster*), which have been shown to naturally reduce stands of exotic Eurasian water-milfoil (*Myriophyllum spicatum*).

Weevils need proper over wintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Many species of amphibians, birds, fish, mammals, reptiles, and invertebrates have suffered precipitous declines in recent years primarily due to habitat loss. Buffer strips may help many of these species and preserve the important diversity of life in and around lakes.

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

Cons

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

Costs

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

For Bishop Lake, the costs for installing native plants along the areas of slightly eroding shoreline would total approximately $16,425. Willow posts would total approximately $21,600-27,075.

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.

The installation of A-Jacks® along the Bishop Lake shoreline is not recommended at this time since there are no areas that are severely eroding.

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

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

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

For Bishop Lake, the costs for installing A-Jacks® along the areas of slightly eroding shoreline would total approximately $54,150-81,225.

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.

Since there are no areas of severe erosion along Bishop Lake at this time, these methods would not be necessary.

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

amount of nutrients available for algae growth and by reducing the sediment that flows into a lake.

Cons

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

Costs

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

For Bishop Lake, the costs for these methods along the areas of slightly eroding shoreline would total approximately $43,320-48,735.

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.

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

Pros

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

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.

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

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

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

Option 4: Herbicide Treatment

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

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

Proper use of these products is critical to their success. Always read and follow label directions.

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

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

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

Objective VIII: Conduct a Fisheries Assessment

Many lakes in Lake County have a fish stocking program in which fish are stocked every year or two to supplement fish species already occurring in the lake or to introduce additional fish species into the system. However, very few lakes that participate in stocking check the progress or success of these programs with regular fish surveys. Lake managers should have information about whether or not funds delegated to fish stocking are being well spent, and it is very difficult to determine how well stocked fish species are surviving and reproducing or how they are affecting the rest of the fish community without a comprehensive fish assessment.

A simple, inexpensive way to derive direct information on the status of a fishery is to sample anglers and evaluate the types, numbers and sizes of fish caught by anglers actively involved in recreational fishing on the lake. Such information provides insight on the status of fish populations in the lake, as well as a direct measure of the quality of fishing and the fishing experience. However, the numbers and types of fish sampled by anglers are limited, focusing on game and large, catchable-sized fish. Thus, in order to obtain a comprehensive assessment of the fish community status, including non-game fish species, more quantitative methods must be employed. These include gill netting, trap netting, seining, trawling, angling (hook and line fishing) and electroshocking. Each method has its advantages and limitations, and frequently multiple gear and approaches are employed. The best gear and sampling methods depend on the target fish species and life stage, the types of information desired and the environment to be sampled.

Typically, fish populations are monitored at least annually. The best time of year depends on the sampling method, the target fish species and the types of data to be collected. In many lakes and regions, the best time to sample fish is during the fall turnover period after thermal stratification breaks down and the lake is completely mixed because (1) YOY and age 1+ (one year or older) fish of most target species should be present and vulnerable to most standard collection gear, including seines, trap nets and electroshockers; (2) species that dwell in the hypolimnion during the summer may be more vulnerable to capture during fall overturn; and (3) lower water temperatures in the fall can help reduce sampling-related mortality. Sampling locations are also species-, life stage-, and gear-dependent. As with sampling methods and time, locations should be selected to maximize capture efficiency for the target species of interest and provide the greatest gain in information for the least amount of sampling effort.

The Illinois Department of Natural Resources (IDNR) will perform a fish survey at no charge on most public and some private water bodies. In order to determine if your lake is eligible for a survey by the IDNR, contact Frank Jakubecik, Fisheries Biologist, at (815) 675-2319. If a lake is not eligible for an IDNR fish survey or if a more comprehensive survey is desired, two known consulting firms have previously conducted fish surveys in Lake County: EA Engineering, Deerfield, IL, (847) 945-8010 and Richmond Fisheries, Richmond, IL, (815) 675-6545.