2000 SUMMARY REPORT
of
Countryside Lake

Lake County, Illinois

Prepared by the

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

Joseph Marencik
Michael Adam
Mary Colwell
Mark Pfister

July 2001

TABLE OF CONTENTS

LAKE IDENTIFICATION AND LOCATION

Countryside Lake is located in unincorporated Fremont Township adjacent to the village of Mundelein (T44N, R11E, Section 27,34,35). Countryside Lake is a shallow 142-acre man-made impoundment. The current maximum water depth is 10 feet with an average depth of 6.3 feet (Integrated Lakes Management 1993 estimate). Lake volume is estimated to be approximately 895 acre feet (Lake Management Unit surface area * ILM average depth). Countryside Lake is part of the Indian Creek watershed, which is a drainage basin of the Des Plaines River watershed. There are no major lakes that drain into Countryside, with only Manning Slough and several small ponds upstream. The major tributary of the lake, Indian Creek, enters the lake at the west end in a small bay. There are two minor tributaries located in the southern end of the far western cove and in the small bay southeast of the islands. In addition, there is a network of storm water outlets, sump pump pipes, and curtain drains emptying into the lake (Figure 1). There is a large, 10-foot wide concrete overflow dam at the southeast end of the lake, which is the only outflow. This discharge continues the flow of Indian Creek, which eventually drains into the Des Plaines River.

BRIEF HISTORY OF COUNTRYSIDE LAKE

Bottom ownership is a combination of a few private residents and the Countryside Lake Association (Figure 2). The Countryside Lake Association owns the majority of the bottom. The Countryside Lake Association is the primary entity that deals with management of the lake. Samuel Insull, an energy mogul, had the lake constructed in 1926 as a recreational retreat. He also built a house on one of the lake's two islands, which is still in existence. The lake was constructed by damming Indian Creek, dredging marshland, and the subsequent flooding of the surrounding area by creek back up from damming and natural spring contribution.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Access to the lake is limited to lake residents and members of the Countryside Lake Association. There are two access points on the lake (Figure 1). One access point is located at the far east end of the lake near the dam. This access has the only boat ramp on the lake and is used by residents of the lake and members of the Association. In addition to the ramp, there are also eight boat slips used by residents of the community that do not have direct lake access. There is also storage space for rowboats and canoes of community residents. This area contains approximately ten parking spots in a nearby gravel lot. The other access point is located on the northeast shore of the lake and is the location of the beach. This area has six boat slips for community use as well as storage for rowboats and canoes. The beach at this access point is State licensed and is monitored by the Lake County Health Department on a bimonthly basis for fecal coliform bacteria per state law. There are approximately 30 parking spaces for use by residents at this access site.

The lake's main use is recreational boating, which is mainly by pontoon boat. The lake association allows gas powered motors but enforces a 15 horse power limit on pontoon boats and a 7 ½ horse power limit on rowboats. Fishing is also a major recreational use that is enjoyed by several lake and community residents. Nature presents several sources of enjoyment for residents of Countryside Lake. Numerous waterfowl and other birds can be viewed at different times of the year. In addition several other forms of life inhabit the lake and surrounding areas (see *Limnological Data-Wildlife Assessment*).

LIMNOLOGICAL DATA - WATER QUALITY

Water samples collected from Countryside Lake were analyzed for a variety of water quality parameters. Samples were collected at 3 feet and 7 feet depths from May through September at the deep hole location in the lake (Figure 1). Countryside Lake is not thermally stratified, which means the lake does not divide into warm upper water (epilimnion) and cool lower water (hypolimnion) but instead the lake stays well mixed. This is due to the shallow lake morphology and long fetches (the longest distance which wind blows across a lake). This mixing of water is reflected in the dissolved oxygen (D.O.) levels as well as other water quality data. D.O. concentrations were *good* in Countryside Lake. During the five-month study D.O. levels were fairly consistent from the surface to the bottom and show no cause for concern. The concentrations of most other parameters from shallow samples were very similar to the deeper sample data. Therefore, only the data from the epilimnetic samples will be discussed. The complete data set for Countryside Lake is in Table 1. Below is a discussion of highlights from the water quality data collected over the five-month study of Countryside Lake.

Secchi disk depth is a direct indicator of clarity as well as overall water quality. In general, the greater the Secchi disk depth, the clearer the water and better the water quality. Secchi disk readings in Countryside Lake consistently declined over the five-month study (Figure 3). In May, Secchi disk depth was "*good*" and was on the bottom of the lake (10 feet). In June, Secchi disk depth was still "*good*" at 8.6 feet May and June readings were well above the Lake County average of 5.0 feet. However, in subsequent months, readings decreased to well below the County average. July Secchi disk depth drastically decreased to 2.7 feet. This was followed by a further decrease in August to 1.4 feet. The cause of the decrease in Secchi disk depth was lakewide algal blooms. Algal blooms occurred as a direct result of the elimination of spring/early summer aquatic plant growth. A healthy aquatic plant population directly competes with algae for resources. Additionally, aquatic plants stabilize nutrient rich sediments. With a balanced, healthy aquatic plant population, which Countryside Lake does not have, nutrient resuspension is reduced, occurrence of nuisance algal blooms are reduced, and water clarity increases. With no aquatic plants, sediment bound nutrients may become available and nuisance blooms can occur.

Besides decreasing Secchi disk depth, lakewide algal blooms negatively impacted other water quality parameters. The average TSS during the study was 9.9 mg/L. The County average is 8.6 mg/L (1995-2000 samples). Total suspended solids (TSS) increased as algal blooms increased from 1.4 mg/L in May to as high as 22.0 mg/L in August, which is 2.5 times the Lake County average (Figure 3). Measurements of other types of solids, unaffected by algae growth, were below or near the County average. This further reinforces that the elevated TSS and decreased Secchi disk readings were due to algal blooms.

Another water quality parameter of some concern was the elevated pH values during May and August. The pH during these months was above 9.0, which is the level at which negative impacts to aquatic organisms can occur. The elevation in pH during these two months was caused by the wide spread plant cover in May and the lake wide algal blooms in August. Both aquatic plants and algae carry on many of the same biological processes. During periods of dense growth, these biological processes can cause pH to increase. Consequently, in months with decreased vegetation (June) and smaller algae blooms (July and September) pH values were near the Country median of 8.35.

Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that nutrients (N&P) are the limiting factors in algal growth. To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios <10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. Most lakes in Lake County are phosphorus limited. Countryside Lake had an average TN:TP ratio of 14:1. This means that neither nitrogen nor phosphorus was limiting. Of the two nutrients, phosphorus is of the biggest concern. Phosphorus levels in Countryside Lake were *high*. Consequently, as phosphorus levels in Countryside Lake increased so did the degree of algae growth with corresponding decrease in Secchi depth (Figure 4). With the exception of May and June, phosphorus levels were near double the County average (0.066 mg/L) or greater. Phosphorus levels started to drastically increase in June. This coincides with the over-removal of aquatic vegetation. Phosphorus levels were highest in August with 0.207 mg/L, which is 3.5 times the County average. This coincides with the greatest extent of algal blooms. Additionally, other water quality parameters, which are closely linked to phosphorus levels and algae growth such as pH, TSS, and Secchi disk readings, were also problematic in August (Table 1).

The source of this phosphorus originates from two sources. One source is from within the lake (internal). This is a common source of phosphorus in manmade lakes, which by their nature contain rich sediments. Biological and chemical processes release phosphorus from the anoxic sediments. Since Countryside Lake is not stratified, released phosphorous can mix though out the water. Additionally, sediment bound phosphorus is also mixed into the water column by wind/wave action and lack of aquatic plants (which stabilize sediments). The other main input of phosphorus is from sources outside of the lake (external). These external inputs consist of a variety of sources. They can include fertilizer runoff, failing septic systems and erosion. However, with regard to Countryside

Lake, these external sources are probably minor in comparison to internal sources. Rain data shows that during periods of elevated rainfall (spring) phosphorus levels were actually lower than when there was little rainfall (summer) (Figure 5). If phosphorus were coming from external sources the opposite would occur.

Another way to look at phosphorus levels and how they affect productivity of the lake is the use of a Trophic State Index (TSI) based on phosphorus. TSI is based on phosphorus levels, chlorophyll *a* concentrations, and Secchi disk depth to classify and compare lake productivity levels (trophic state). The phosphorus TSI is setup so the higher the phosphorus concentration the greater amount of algal biomass and as a result, a higher trophic state. Based on a TSI phosphorus value of 71.3, Countryside Lake is classified as hypereutropic (>70 TSI). This means that the lake is a highly productive system that has above average nutrient levels and high algal biomass (growth). Field observations reinforce that Countryside Lake is *hypereutrophic*. Most manmade lakes in the county are *eutrophic* (TSI values >50 <70). Out of all the lakes in Lake Country studied by the LMU since 1988, Countryside Lake ranks 73rd out of 87 lakes based on average TSI (Table 2). Based on lakes studied in 2000, Countryside Lake ranked 24th out of 32.

Another area of concern on Countryside Lake is sedimentation. Sedimentation can bring about negative impacts on the lake's fishery and aquatic plant community. Sedimentation can also bring about an increase in algae blooms and turbidity and an overall decrease in lake health. Dredging may reduce impacts from this ongoing problem. For overall lake health it is advisable to increase the depth so that 25% of the lake (35.5 acres) is greater than 10 feet deep. In order to accomplish this goal an estimated 1,000,000 cubic yards would have to be removed. This would be extremely expensive. Typically, dredging costs \$3-10/yd^3 and this 1,000,000 yd^3 would cost \$3,000,000 – \$10,000,000. These costs include plan design and execution. Additionally, a bathimetry study, sediment thickness survey and dewatering site construction and leasing would inflate costs further. The main question the Countryside Lake Association must ask themselves is *what do they want to achieve with dredging*. If it is fishery health, then increasing the lake depth so that 25% is deeper than 10 feet is an appropriate plan. On the other hand, if the goal of the association is to deepen the lake for navigational purposes, then dredging specific locations would be more appropriate. The topic of sedimentation and dredging will be further discussed with the Lake Association board and engineer in order to come up with a realistic dredging plan for Countryside Lake.

TSI values along with other water quality parameters can be used to make other analyses of Countryside Lake based on use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). Using IEPA indexes, Countryside Lake has *Moderate* overall use impairment based on phosphorus and pH levels (see above). However, most impairment assessments were listed as *None*. Based on swimming use guidelines, Countryside Lake is categorized as providing only *Partial* support. This is due to poor Secchi disk readings and high phosphorus levels. Additionally, Illinois Department of Public Health recommends at least 48" Secchi disk depth for safe swimming (Countryside Lake's average was 43"). Under the recreational use impairment index, Countryside Lake was categorized as providing only *Partial* support. This is due

to a high TSI value and high levels of suspended sediments, both of which result in poor visibility and contribute to an overall reduction in use of the lake. In the case of aquatic life use impairment, Countryside Lake was categorized as providing *Full* support for aquatic life. Overall, Countryside Lake was listed as providing *Partial* overall support.

LIMNOLOGICAL DATA - AQUATIC PLANT ASSESSMENT

Aquatic plant surveys were conducted every month for the duration of the study (*Appendix A* for methodology). Shoreline plants of interest were also observed (Table 3). However, no surveys were made of these shoreline species and all data is purely observational. The extent to which aquatic plants grow is largely dictated by light availability. Aquatic plants need at least 1% of surface light levels in order to survive. Based on the depth of the 1% light level, depth at which plant growth could occur in Countryside Lake varied on a monthly basis. Based on light penetration, aquatic plant coverage of the lake could have ranged from 100% (May[a]) to 21% (August). However, surveys show that plants did not completely grow in these areas (Table 3). Distribution of plants within these areas was sporadic. After May (and after Sonar treatments), Countryside Lake had only one area of true aquatic plant growth (Figure 1). This area of growth was poorly managed and consisted of nuisance growth of coontail and Eurasian water milfoil. Lack of a healthy plant population causes a variety of problems within the lake (see *Limnological Data-Water Quality*). Additionally, population diversity was low, consisting of only a few species (Table 4). Even the occurrence of these species was low. By September, plant diversity was even lower mainly consisting of spotty patches of *Chara* sp., which was found at 79% of sample sites.

There were two main aquatic plant species that occur in Countryside Lake. Until herbicide applications caused a die off in mid-May, curly leaf was the dominant plant in the spring (82% of sample sites in May). When dominated by curly leaf pondweed, water clarity, and light penetration, and overall water quality were high (see Limnological Data-Water Quality). Plant surveys show that vegetation was found as deep as 9 feet, the deepest sampling site. After herbicide treatment, the macro alga *Chara* became the dominant species in the lake (84% of sample sites in July). The 1% light level depth continually decreased from the bottom (10 feet) in May (and after the loss of curly leaf pondweed) to as little as 5 feet in August and September. As a result, depth at which plant growth occurred gradually decreased over the course of the study. In May, the average depth at which plants were sampled was 6.1 feet and decreased to 3.3 feet by August. Loss of clarity (and light penetration) was due to the increasing dominance of blue-green algae blooms. These blooms, dominated by the genera *Anabanea* and *Microcystis*, were consistently present from June through September with varying degrees of intensity with peak blooms occurring in August.

[a] The light meter reached the bottom of the lake before the 1% light level depth was recorded.

Table 4. Aquatic and Shoreline Plants on Countryside Lake.

Aquatic Plants	
Chara (Macroalgae)	*Chara* sp.
Coontail	*Ceratophyllum demersum*
American Elodea	*Elodea canadensis*
Eurasian Water Milfoil	*Myriophyllum spicatum*
Curlyleaf Pondweed	*Potamogeton crispus*
Leafy Pondweed	*Potamogeton foliosus*
Sago Pondweed	*Potamogeton pectinatus*
Flatstem Pondweed	*Potamogeton zosterifomis*
Horned Pondweed	*Zannichellia palustris*
Small Duckweed	*Lemna minor*
Giant Duckweed	*Spirodella polyrhiza*
Watermeal	*Wolffia columbiana*
Common Bladderwort	*Utricularia vulgaris*
Shoreline Plants	
Blue Flag Iris	*Iris Hexagona*
Purple Loosestrife	*Lythrum salicaria*
Reed Canary Grass	*Phalaris arundinacea*
Common Reed	*Phragmites australis*
Water Smartweed	*Polygonum amphibium*
Swamp Smartweed	*Polygonum coccineum*
Buckthorn	*Rhamnus cathartica*
Arum-Leaved Arrowhead	*Sagittaria cuneata*
Common Arrowhead	*Sagittaria latifolia*
Hardstem Bulrush	*Scirpus acutus*
Common Cattail	*Typha latifolia*

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

Shoreline assessments were conducted at Countryside Lake on May 18th, 2000. Shorelines were assessed for a variety of criteria (*Appendix A* for methodology). Based on these assessments several important generalizations can be made. A majority of Countryside Lake's shoreline is developed (81%). The majority of developed shoreline consists of rip-rap (29%) (Figure 6). Other major types of shoreline development

included buffer strips (22%), and wooded lots (32%) (Figure 6). The high occurrence of these types of desirable shorelines is encouraging. Furthermore, the condition of the man made structures (rip-rap) was of high quality. For a manmade lake there was a low occurrence of less desirable shoreline development: seawalls (8%) and manicured lawn (5%). Seawalls are undesirable because of their tendency to reflect wave action back into the lake. This can cause resuspension of near shore sediments, which can lead to a variety of water quality problems. Manicured lawn is a poor shoreline water interface. This is due to the poor root structure of turf grasses, which is unable to stabilize soils and may lead to erosion. It is our recommendation that Countryside Lake Association should promote the use of naturalized shoreline (native vegetation and buffer strips) and to minimize seawall and manicured lawns to the shoreline edge.

Another area of concern for shorelines was the extent of erosion (Figure 7). Overall, of developed and undeveloped shorelines, 26% was assessed to have *no* erosion. However, 36% had slight erosion, and 35% had *moderate* erosion. Only 3% of the shoreline on Countryside Lake were assessed as *severely* eroded. Within the developed shoreline, 31% has *no* erosion, 30% is slightly eroded, 35% is moderately eroded, and 4% is severely eroded. Interestingly, the shorelines that were not eroded mainly consisted of rip rapped shorelines and beach areas. Shoreline types that were likely to have eroded soils (*slight, moderate, and severe*) are wooded, poor condition buffer strips and seawalls, and lawns to the edge. Solutions to these eroded shorelines are discussed in detail in *Options for Achieving the Lake Management Plan Objectives*.

Recently approximately 715 feet of seawall was installed on Countryside Lake without a permit (Figure 2). Additionally, the resident installed the seawall on property that was not under his ownership. This property is owned by the Countryside Lake Community Association (CSA) (Figure 2). Some of this property was *slightly* eroded and could have easily been naturalized. Additionally, some of the impacted shoreline was of higher quality wildlife habitat. Tragically, this area was the location that a red shouldered hawk an Illinois endangered species was sighted (see *Limnological Data – Wildlife Assessment*). The Army Corps of Engineers is requiring that the seawall and all associated fill is to be removed and the shoreline is to be returned to “original” condition. Since restoring the shoreline to “original” condition is near impossible, an appropriate restoration plan should be drafted. It is the recommendation of the LMU that the shoreline should be regraded to a slope of no less than 3:1 and replanted with native vegetation in a buffer strip >30 feet wide.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Countryside Lake has an ongoing fish-stocking program. Fish species that are regularly stocked include black crappie, largemouth bass, northern pike, walleye, and yellow perch. As per IDNR recommendation, it would be advisable to stock channel catfish to compliment the predator population of the lake. Additionally, tiger muskie should no longer be stocked as they interfere with more beneficial predator species such as northern

pike. IDNR recommendation regarding take and size limits should also be followed. Furthermore, as was recommended by IDNR, a fishery survey should be conducted in 2001 to determine health of the fishery. Grass carp were stocked approximately 10 years ago. While stocking grass carp is not advantageous, these fish are near the end of their life span. Grass carp **SHOULD NOT** be stocked again. A fish kill involving black crappie occurred over several weeks in July. The LCHD-LMU and the IDNR examined this fish kill. It was determined that the fish kill was disease orientated and was specific to black crappie.

Wildlife observations were made on a monthly basis during water quality and plant sampling actives. All observations were visual. Several types of waterfowl were observed during the course of the study including the pied bill grebe, an Illinois threatened species (Table 5). Other species that were observed included turtles, mink, and groundhogs. There are healthy populations of mature trees that provide good habitat for a variety of bird species. The Illinois threatened species the red shouldered hawk, was observed in a tree in one of the more natural areas of the lake. Tragically this habitat has been lost due to careless shoreline development (see *Limnological Data - Shoreline Assessment*). Due to the alarmed actions of this bird towards LMU presence it is possible that this was its nesting spot. There are also a few large dead trees that provide excellent habitat for Double Crested Cormorants. Additionally, there are several shrub areas that provide habitat for smaller bird and mammal species. However, there are several areas for habitat improvement on Countryside Lake. There are two invasive species that should be controlled/eliminated, purple loosestrife and buckthorn. These species have been noted in several areas around the lake. These plants are seldom used by wildlife for food or shelter. They should be eliminated before they spread and displace other native and more desirable plant species (see *Objective VII: Eliminate or Control Invasive Species*). Additionally, shoreline habitat should be improved and should include buffer strips and more naturalized shoreline areas (*see Objective VI: Wildlife Habitat Improvement*).

Table 5. Observed Wildlife Species on Countryside Lake.

Birds	
Pied-billed Grebe+	*Podilymbus podiceps*
Double Crested Cormorant	*Phalacrocorax auritus*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Bufflehead	*Bucephala albeola*
Ring-billed Gull	*Larus delawarensis*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*

Table 5. Observed Wildlife Species on Countryside Lake (cont.).

Red-shouldered Hawk+	*Buteo lineatus*
Unknown Sandpiper	*Calidris* sp.
Belted Kingfisher	*Megaceryle alcyon*
Mammals	
Beaver	*Castor canadensis*
Woodchuck	*Marmota monax*
Reptiles	
Painted Turtle	*Chrysemys picta*
Snapping Turtle	*Chelydra serpentina*

+Threatened in Illinois

EXISTING WATER QUALITY PROBLEMS

- *Shoreline Erosion*

  As stated above, Countryside Lake has some form of erosion on 70% of its shoreline. This erosion is occurring for several reasons. These include lack of suitable shoreline vegetation, failing existing erosion control structures, ice damage, and water fluctuations. Erosion is contributing to other water quality problems such as sedimentation, nuisance algal blooms, and nutrient enrichment. If left unattended the problem will continue to worsen, further aggravating related issues such as nutrient loading and sedimentation.

- *Sedimentation*

  Sedimentation in Countryside Lake is becoming an increasing concern. The amount of sedimentation is directly linked to the above problem of shoreline erosion. Another contributor was the massive stands of aquatic vegetation that were present on Countryside Lake in the past. Upon plant death, tremendous amounts of organic matter were deposited on the bottom. Sedimentation is slowly filling in parts of the lake. Additionally, sedimentation has detrimental affects of fish spawning, aquatic plant growth, and invertebrates. A possible remedy to this problem is dredging. However, the amount of dredging that will be needed to bring about appreciable change will be *very* costly. The Countryside Lake Association, along with its

members, must determine what they want to accomplish with dredging and if this is a realistic goal for the lake as well as the Association's resources.

- *Algae Blooms*

  Algal blooms are wide spread in Countryside Lake starting in mid-June. Blooms largely consist of planktonic blue-green algae. Blooms are caused by the elimination of aquatic vegetation (which compete with algae) and high phosphorus levels. The increase in algal blooms over the course of the summer leads to the drastic decrease in water clarity, decrease in light penetration, increased TSS, and increased pH. With decreasing light levels, aquatic vegetation is no longer able to inhabit some areas of the lake. Thus the benefits they offer, such as sediment stabilization and competition with algae, are lost.

- *Poor Plant Diversity/Densities*

  One key to a healthy lake is a healthy aquatic plant population. Countryside Lake has poor plant densities as well as poor diversity. Lack of quality aquatic plants, and subsequent loss of water quality, is mainly the result of herbicide overuse in the spring and low light penetration caused by lakewide algae blooms (which itself is due to a lack of aquatic plants). After spring the only aquatic plant of any quantity in the lake is the macro alga *Chara*, which is considered desirable. However, as algal blooms intensify, *Chara* stands are drastically reduced and the depth at which they grow declined due to poor light penetration. The negative impacts associated with lack of quality aquatic plant communities are wide spread including those on water quality and fishery health.

- *Wildlife Habitat Improvement*

  Overall, wildlife habitat on Countryside Lake is *fair*. However, for a manmade, residential lake it is *above* average. The main problem is the lack of quality shoreline habitat. A large part of Countryside Lake's shoreline is developed and offers no/little habitat. This is a common problem on residential lakes with highly developed shorelines (rip-rap, seawall, lawns, etc.). Often, the only shoreline habitat consisted of invasive species or manicured lawns, which offer little/poor quality habitat. The condition of wildlife habitat on Countryside Lake could be greatly improved with the utilization of native vegetation in shoreline developments.

POTENTIAL OBJECTIVES FOR COUNTRYSIDE LAKE MANAGEMENT PLAN

I. Shoreline Erosion Control/Prevention Measures
II. Better Algae Management Plan
III. Better Aquatic Plant Management Techniques
IV. Wildlife Habitat Improvement
V. Eliminate or Control Invasive Species
VI. Create Bathymetric Map with Morphometric Table

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Shoreline Erosion Control/Prevention Measures

Erosion is a potentially serious problem on Countryside Lake. This erosion is the results of various factors including 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 exasperate the problem. Erosion not only results in loss of shoreline, but negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. This effect is felt throughout the food chain since poor water quality negatively affects everything from microbial life to sight feeding fish and birds to people who want to use the lake for recreational purposes. The resulting increased amount of sediment will over time begin to fill in the lake, decreasing overall lake depth and volume and potentially impairing various recreational uses.

Option 1: No Action

Under a no action management plan for shoreline erosion nothing would be done to rectify the shoreline erosion on Countryside Lake. The current status of shorelines would either remain the same or would continue to deteriorate. Soil would continue to be washed into the lake further contributing to the sedimentation. Valuable habitat would be lost on undeveloped shorelines. Many aspects of the lake's health would be negatively affected such as fish and wildlife.

Pros

There are no short-term costs to this option. However, extended periods of erosion may result in substantially higher costs to repair the shoreline in the future. Eroding banks on steep slopes can provide habitat for wildlife, particularly bird species (e.g., kingfishers and bank swallows) that need to burrow into exposed banks to nest. In addition, certain minerals and salts in the soils are exposed during the erosion process, which are utilized by various wildlife species.

Cons

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

Costs

In the short-term, cost of this option is zero. However, long-term implications can be severe since prolonged erosion problems may be more costly to repair than if

the problems were addressed earlier. As mentioned previously, long-term erosion may cause serious damage to shoreline property and in some cases lower property values.

Option 2: Install a Steel or Vinyl Seawall

Seawalls are designed to prevent shoreline erosion on lakes in a similar manner they are used along coastlines to prevent beach erosion or harbor siltation. Today, seawalls are generally constructed of steel, although in the past seawalls were made of concrete or wood (frequently old railroad ties). Concrete seawalls cracked or were undercut by wave action requiring routine maintenance. Wooden seawalls made of old railroad ties are not used anymore since the chemicals that made the ties rot-resistant could be harmful to aquatic organisms. A new type of construction material being used is vinyl or PVC. Vinyl seawalls are constructed of a lighter, more flexible material as compared to steel. Also, vinyl seawalls will not rust over time, as steel will. Seawalls should only be used to rehabilitate shorelines with *severely* eroded soils or steeply sloped areas (>2:1 slope). However, negative aspects associated with seawalls far out weigh any positive attributes. **Seawalls are a last resort.**

Pros

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

Cons

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

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

are important to the lake's overall water clarity since they can help filter some of the incoming sediment, prevent resuspension of bottom sediment, and compete with algae for nutrients. However, excessive sediment in the water and high turbidity may overwhelm these benefits.

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

Costs

Depending on factors such as slope and shoreline access, cost of seawall installation ranges from $65-80 per linear foot for steel and $70-100 per linear foot for vinyl. Based on shoreline assessments, Countryside Lake would need approximately 600 linear feet of seawall to rehabilitate severely eroded shorelines. Based on the price ranges above, total costs would be approximately $39,000 - $60,000, depending on seawall material. If at all possible, other shoreline rehabilitation techniques should be employed before using seawalls. A licensed contractor installs both types of seawall. Additional costs may occur if the shoreline needs to be graded and backfilled, has a steep slope, or poor accessibility. Price does not include the necessary permits required. Additional costs will be incurred if compensatory storage is needed. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained. For seawalls, a site development permit and a building permit are needed. Costs for permits and surveys can be $1,000-2,000 for installation of a seawall. Contact the Army Corps of Engineers, local municipality, or the Lake County Planning and Development Department.

Option 3: Install Rock Rip-Rap

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. Rip-rap 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 fill will probably be needed to cover the rocks and provide an acceptable medium for plants to grow on. It is imperative that filter fabric be used under the rip-rap to provide quality, long lasting results. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained (see costs below). Rip-rap is best used for areas of *moderate* erosion and gentle to moderately sloped shores (<2:1).

Pros
Rip-rap 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 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 slight to moderate erosion problems may benefit from using rip-rap. 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 and prey upon many invertebrate species, including many harmful garden and lawn pests. Also, small fish may utilize the structure 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 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 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 way due to rising water levels or wave action. On the other hand, larger boulders are more expensive to haul in and install.

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

Costs
Cost and type of rip-rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $30-45 per linear foot. Based on assessed *moderately* eroded shoreline, Countryside Lake would need approximately 7,352 linear feet of rip-rap. Approximate cost would be $220,560 – $330,840. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. In addition, costs will

increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be $1,000-2,000 for installation of rip-rap, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

Option 4: Buffer Strips

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 shorelines with *slight* erosion and 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 more 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 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 6 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., 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 more highly eroded, willow posts may have to be used in conjunction with another erosion control technique such as biologs, A-Jacks®, or rip-rap. The use of buffer strips in conjunction with other methods such as rip-rap and seawalls is highly recommended.

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, quickly spread and help stabilize shorelines, however they can be aggressive and may pose a problem later. Other species, such as those listed in Table 6 should be considered for native plantings.

Pros

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

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

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

Many fish and wildlife species prefer the native shoreline vegetation habitat. This habitat is an asset to the lake's fishery since the emergent vegetation cover may be used for spawning, foraging, and hiding. Various wildlife species are even dependent upon shoreline vegetation for their existence. Certain birds, such as marsh wrens (*Cistothorus palustris*) and endangered yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) nest exclusively in emergent vegetation like cattails and bulrushes. Hosts of other wildlife like waterfowl, rails, herons, mink, and frogs to mention just a few, benefit from healthy stands of shoreline vegetation. Dragonflies, damselflies, and other beneficial invertebrates can be

found thriving in vegetation along the shoreline as well. Two invertebrates of particular importance for lake management, the water-milfoil weevils (*Euhrychiopsis lecontei* and *Phytobius leucogaster*), which have been shown to naturally reduce stands of exotic Eurasian water-milfoil (*Myriophyllum spicatum*). Weevils need proper over wintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Many species of amphibians, birds, fish, mammals, reptiles, and invertebrates have suffered precipitous declines in recent years primarily due to habitat loss. Buffer strips may help many of these species and preserve the important diversity of life in and around lakes.

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

Cons

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

Costs

If minimal amount of site preparation is needed, costs can be approximately $10 per linear foot, plus labor. Cost of installing willow posts is approximately $15-20 per linear foot. Based on assessment *slightly* eroded shoreline, Countryside Lake would need approximately 7,352 linear feet buffer strip. This would come to a cost of $78,830 for buffer strip and $157,660 for willow posts. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

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

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Once established, a buffer strip of native plants can be planted along side or on top of the roll (depending if rolls are made of synthetic or natural fibers). They are most effective in areas where plantings alone are not effective due to already severe erosion. These products are best used in areas on more *moderately* eroded shorelines or areas with *highly* erodable soil types.

Pros

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

Cons

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

Costs

Costs range from $25 to $35 per linear foot of shoreline, including plantings. Based on *slightly* and *moderately* eroded shorelines, Countryside Lake would need approximately 7,352 linear foot of one of the above products. Cost of this application would be approximately $183,800-$257,320. This does not include the necessary permits and surveys, which may cost $1,000 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.

Objective II: Better Algae Management Plan

Currently, the copper sulfate product K-Tea™ is used on Countryside Lake continuously from April through September. In May, Secchi disk readings were the clearest out of the span of the study. Corresponding color readings indicate that there was a very low occurrence of algae. Whether this was due to algicide treatments or to the widespread plant growth is unknown without further study. However, once the plants were killed off, algal blooms started and continued to increase in intensity throughout the study. This is a common outcome of over removal of aquatic vegetation. These blooms occurred despite continual algicide applications. Furthermore, the duration and increasing intensity of the blooms may be due to the algae developing a tolerance to copper (from overuse). This phenomenon is being experienced by many lake managers. Possible alternatives to better controlling nuisance algal growth are discussed below. With a better algal management plan, blooms should decrease and improvements in water quality can be achieved.

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 excessive algal growth. Normally, excessive 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 excessive algal growth involves treating the factors that cause the excessive growth not the algae it self. Long term solutions to excessive algae 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 not are very effective, or are too experimental to be widely used.

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

With a no action management plan nothing would be done to control the nuisance algae on Countryside Lake, regardless of type and extent. Planktonic algal blooms will continue to occur sometimes to epidemic proportions. Growth limitations of the algae and the characteristics of the lake itself (light penetration, nutrient levels.) will dictate the extent of infestation. Unlike aquatic plants, algae are not bound by physical factors such as substrate type. The areas in which filamentous and thick surface planktonic blooms (scum) occur can be affected by strong wind and wave action. However, under normal conditions, with no action, both planktonic and filamentous algal blooms could continue

to cover much of the lake. 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 take place. Use of the lake would continue as normal unless blooms worsened. In this case, activities such as swimming might have to be suspended due to an increase in health risks. Other problems such as strong odors (blue-green algae) might also increase in frequency.

Cons

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

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

In addition to ecological impacts, many physical lake uses will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick mats of filamentous algae. Swimming could also become increasingly

difficult and unsafe due to thick mats and reduction in visibility by planktonic blooms. Fishing could become more and more exasperating due in part to the thick mats and stunted fish populations. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by large green mats and/or blooms of algae and the odors that may develop, such as with large blue-green blooms. The combination of above events could cause property values on the lake to suffer. Property values on lakes with algae problems have been shown to decrease by as much as 15-20%.

Costs

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

Option 2: Algicides

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

Currently, Countryside Lake is using K-Tea™ to control planktonic algae blooms. These treatments are having limited success. This is typical when tying to treat algae blooms in large bodies of water such as Countryside. There is really nothing more that can be done using copper-based products.

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 are 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. In many instances, overuse of copper is leading to selection of species tolerant to copper. 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 sediments. This can cause problems for actives such as dredging. Due to large amount of copper in the sediments, special permits and disposal methods would have to be utilized.

Costs

Currently Countryside Lake is being treated with K-Tea™. The cost for season long application of copper sulfate (as needed) was $17,000/year. This price also includes a whole lake treatment of Sonar™ so the cost of the actual copper

application is difficult to estimate. However, copper sulfate products are very common and are all similarly priced. Rates of application are very similar between brands and vary based degree of control being achieved.

Option 3: Alum Treatment

A possible remedy to excessive algal growth on Countryside Lake 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, which 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 unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds, 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 are good candidates. This encompasses many lakes within Lake County. Lakes that are thermally stratified experience longer inactivation than non-stratified lakes due to isolation of the flocculent layer. Countryside Lake is not stratified so the longevity of an alum treatment might be of some concern. However, Countryside Lake has limited boat traffic, which would help keep disruption of the floc layer to a minimum. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited. Alum treatments must be carefully planned and carried out by an experienced professional. If not properly done, there may be many detrimental side effects.

Pros

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

Cons

There are several drawbacks to alum. External nutrient inputs must also be reduced or eliminated for alum to provide long-term effectiveness. With larger

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

Costs

Costs for alum treatments vary on a lake by lake basis as they are based on volume. To properly determine volume, a good quality bathymetric map and accompanying morphometric data is needed. Currently, Countryside Lake has a bathymetric map but no accompanying data. The consultant should have provided this when they did the initial mapping. Proper cost or application calculations cannot be determined without this valuable data. For comparison, a lake of approximately 300 acre feet would cost about $30,000. Countryside Lake is about 900 acre feet so costs would be significantly higher. Costs could be lowered by utilizing a lake drawdown, which lowers the volume of the lake thus decreasing the cost.

Option 4: Revegetation With 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. Countryside Lake would have a healthy aquatic plant population if it were not for heavy herbicide use. Fluridone use should be scaled back or abandoned all together in favor of a more selective herbicide. 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 Countryside Lake would be 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 as several factors would have to be taken into consideration. Table 6 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are aquatic shoreline vegetation (rushes, cattails, etc) and deeper water plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

Pros

By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. Once established, expanded native plant populations will help to control growth of nuisance algae by shading and stabilization of sediments. 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 increase due to the improvement in water quality and the suppression of weedy species.

Cons

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

Costs

Prices for Countryside Lake would vary on the extent of revegetation. An experienced aquatic nursery or consultant should design and preferably plant to ensure good results. See Table 6 for pricing on different species of aquatic plants suitable for revegetation.

Objective III: Better Aquatic Plant Management Techniques

All aquatic plant management techniques have both positive and negative characteristics. If used properly, they can all be beneficial to a lake's well being. If misused or abused, they all share similar outcomes - *negative impacts to the lake*. Putting together a good aquatic plant management plan should not be rushed. Plans should consist of a realistic set of goals well thought out before implementation. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. For an aquatic plant management plan to achieve long term success, follow up is critical. A good aquatic plant management plan considers both the short and long-term needs of the lake.

The management of the lake's vegetation does not end once the nuisance vegetation has been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and remove as necessary. An association or property owner should not always expect immediate results. A quick fix of the vegetation problems may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly solve the problem. The management options covered below are commonly used techniques that are coming into wider acceptance and have been used in Lake County. There are other plant management options that are not covered below as they not are very effective, or are too experimental to be widely used.

In the past, Countryside Lake has had a Eurasian Water Milfoil problem, which is now under control using herbicides. Additionally, Countryside Lake has lakewide growth of curly leaf pondweed in the spring. IDNR has recommended that the curly leaf pondweed be reduced in near shore areas to improve fishery habitat. Furthermore, total coverage by aquatic vegetation should be between 20-30%. Instead, Countryside lake has eliminated curly leaf pondweed throughout the lake not just near shore areas. Additionally, almost all other vegetation has been eliminated from Countryside Lake. This was not the goal of the IDNR recommendations. However, due to overuse of herbicide, and poor light penetration, aquatic plants are unable to inhabit large portions of the lake.

Option 1: No Action

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

This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

Pros

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

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

Cons

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

Water quality could also be negatively impacted with the implementation of the no action option. Deposition of large amounts of organic matter and release of nutrients upon the death of the massive stands of vegetation is a probable outcome of the no action option. These dead plants will contribute to the sediment load of

the lake and could accelerate its filling in. The large nutrient release when the plants die back in the fall could lead to lake-wide algae blooms and an overall increase of the internal nutrient load to the lake. In addition, the decomposition of the massive amounts of vegetation will lead to a depletion of the lakes dissolved oxygen. This can cause fish stress, and eventually, if the stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake's ecosystem.

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

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

Option 2: Aquatic Herbicides

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

There are two groups of herbicides: contact and systemic. Contact herbicides, like their name indicates, kill on contact. These herbicides affect only the above ground portion of the plant that they come into contact with and therefore do not kill the root system. An example of a contact herbicide is diquat. Systemic herbicides are taken up by the plant and disrupt cellular processes, which in turn cause plant death. These herbicides kill both the upper portions of the plant as well as the root system. An example of a systemic herbicide is fluridone. Both types of herbicides are available in liquid or granular forms. Liquid forms are concentrated and need to be mixed into water to obtain the desired concentration. The solution is then sprayed on the water's surface or injected into the water in the treatment areas. Granular herbicides are broadcast in a known rate over the treatment area where they sink to the bottom and slowly release the herbicide which is

then taken up by the plant. These are referred to as SRP formulations (Slow Release Pellet). Other granular herbicides come in crystal form and dissolve as they come in contact with water. This is typical of herbicides such as copper sulfate. Many herbicides come in both liquid and granular forms to fit the management needs of the lake. Herbicide applications can either be done as whole lake treatments or as more selective spot treatments. Multiple herbicides are often mixed and applied together. This is called a tank mix. This is done to save time, energy, and cost.

Aquatic herbicides are best used on actively growing plants to ensure optimal herbicide uptake. For this reason, herbicides are normally applied mid to late spring when water temperatures are above 60^0F. This is the time of year when the plants are most actively growing and before seed/vegetative propagule formation. Follow up applications should be done as needed. When choosing an aquatic herbicide it is important to know what plants are present, which ones are problematic, which plants are beneficial, and how a particular herbicide will act upon these plants. The herbicide label is very important and should always be read before use. Table 1 contains information on the different aquatic herbicides and which plants they affect, application rates, cost ranges, any restrictions on use, and any additional comments. There may be more than one herbicide for a given plant. The plants best controlled by a particular herbicide are in bold. As with other management options, proper usage is the key to their effectiveness, benefits, and disadvantages.

Currently, fluridone (Sonar™) is used on Countryside Lake in the spring to treat curly leaf pondweed and reduce any other weedy growths of aquatic plants. Fluridone is a nonselective herbicide, which means it kills both targeted and untargeted vegetation. . Application rate is at 15 ppb, which is considered a high rate of use. High rates such as these are commonly used to reduce widespread nuisance plant populations. Then Sonar rates are reduced to a "maintenance" level. Additionally, fluridone is currently being used at much lower rates even in initial applications. SePro, the company that manufactures Sonar, frequently discusses using rates as low as 3-4 ppb with 8-6ppb being the new standard. At these lower rates, fluridone has been shown to do less damage to native beneficial plants. If fluridone is used in future treatment, it is advisable to lower the rate to 6-8 ppb. This would not only be beneficial for lake health, it would also save money. A possible alternative to the use of fluridone is the use of diquat (Reward®). Diquat is also a nonselective contact herbicide. Due to chemical nature, diquat is only effective on the plants that it comes into immediate contact with. This allows for a degree of selectivity based on treatment area whereas fluridone is applied as a whole lake treatment thereby providing no selectivity based on treatment area. By using diquat, curly leaf pondweed could be selectively removed in the spring. In addition to diquat, 2,4-D could be used to selectively control Eurasian water milfoil and coontail. 2,4-D is a systemic herbicide that is selective for dioecious (broadleaf) plants such as milfoil and is usually not effective on monoecious (narrow-leaved) plants such as the pondweeds (*Potamogeton* sp.). With continued high rate Sonar applications, the poor state of aquatic plants on Countryside Lake will not improve and may further deteriorate. With proper planning by an experienced, knowledgeable applicator and use of herbicides, native plant

species that already exist in Countryside Lake, such as sago pondweed and leafy pondweed, could return in larger populations.

Pros

When used properly, aquatic herbicides can be a powerful tool in management of excessive vegetation. Often, aquatic herbicide treatments can be more cost effective in the long run compared to other management techniques. A properly implemented plan can often provide season long control with minimal applications. Ecologically, herbicides can be a better management option than using mechanical harvesting or grass carp. When properly applied aquatic herbicides may be selective for nuisance plants such as Eurasian watermilfoil but allow desirable plants such as the pondweeds to remain. This removes the problematic vegetation and allows native and more desirable plants to remain and flourish with minimal manipulation.

The fisheries and waterfowl populations of the lake would greatly benefit due to an increase in quality habitat and food supply. Dense stands of plants would be thinned out and improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed. Another environmental benefit of using aquatic herbicides over other management options is that they are organism specific. The metabolic pathways by which herbicides kill plants are plant specific which humans and other organisms do not carry out. Organisms such as fish, birds, mussels, and zooplankton are generally unaffected.

By implementing a good management plan with aquatic herbicides, usage opportunities of the lake would increase. Activities such as boating and swimming would improve due to the removal of dense stand of vegetation. The quality of fishing may recover because of improved habitat. In addition to increased usage opportunities, the overall aesthetics of the lake would improve, potentially increasing property values on the lake.

Cons

The most obvious drawback of using aquatic herbicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error can make them unsafe and bring about undesired outcomes. If not properly used, aquatic herbicides can remove too much vegetation from the lake. This could drastically alter the biodiversity and ecological balance of the lake. Total removal or over-removal of plants can cause a variety of problems lake-wide. The fishery of the lake may decline and/or become stunted due predation issues related to decreased water clarity. Other wildlife, such as waterfowl, which commonly forage on aquatic plants, would also be negatively impacted by the decrease in vegetation.

Another problem associated with removing too much vegetation is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. The increase in turbidity can cause a decrease in light penetration, which can further aggravate the aquatic plant community. The resuspension of nutrients will contribute to the overall nutrient load of the lake, which can lead to an increased frequency of noxious algal blooms. Furthermore, the removal of aquatic vegetation, which compete with algae for nutrients, can directly contribute to an increase in blooms.

After the initial removal, there is a possibility for regrowth of vegetation. Upon regrowth, weedy plants such as Eurasian watermilfoil and coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiveristy. Additionally, these dense stands of nuisance vegetation can lead to an overpopulation of stunted fish due to a decrease in predation of forage species by predatory fish. This disruption in the fisheries can have negative impacts throughout the ecosystem from zooplankton to higher organisms such as waterfowl and other wildlife. Additionally, some herbicides have use restrictions regarding their use in relation to fish, swimming, irrigation, etc.

Possible growth of nuisance algae that may follow could drastically impair recreational use of the lake. Swimming could be adversely affected due to the likelihood of increased algal blooms. Swimmers may become entangled in large mats of filamentous algae. Blooms of planktonic species, such as blue-green algae, can produce harmful toxins as well produce noxious odors. If regrowth of nuisance vegetation were to occur, motors could become entangled making boating difficult. Fishing would also be negatively impacted due to the decreased health of the lake's fishery. The overall appearance of the lake would also suffer due to an increase in unsightly algal blooms and massive stands of vegetation. This in turn could have an unwanted effect on property values. Studies have shown that problematic algal blooms can decrease property values by 15-20%.

Costs

Currently Sonar is used on Countryside Lake at a rate of 15 ppb as part of a season long control program. The cost of this program is $17,000/year. If the rate of application was lowered this would substantially lower costs. It is difficult to compare cost of current Sonar™ application on Countryside Lake with lower rates due to the season long control price currently being paid since this price is not broken down into individual costs for the different treatments (Sonar vs. copper sulfate costs). However, based on estimates, a 15ppb treatment of Sonar on Countryside Lake should cost approximately $11,500. At a reduced rate of 8 ppb the cost would be $8,700 a difference of $2,800. Besides reducing costs, lowering the rate would greatly improve the health of the aquatic plant community. 2,4-D could be used as a spot treatment to control nuisance growth of Eurasian water milfoil to maintain at least 20-25% coverage. The costs for 2,4-D application would vary and depend on extent of use.

Option 3: Hand Removal

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

Countryside Lake could greatly benefit from the use of this management technique. Hand removal could be utilized around piers and boatlifts as well as beach areas. Hand removal of spring stands of curlyleaf pondweed could be used in areas that contain desirable vegetation. This might be a more acceptable way to control this weedy plant instead of over using aquatic herbicides such as fluridone, which is nonselective and can also remove desirable vegetation. Hand removal might also be used in conjunction with other options such as proper use aquatic herbicides.

Pros

Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. Hand removal is an activity in which all lake residents could participate. The work involved in removing plants can provide a rewarding sense of accomplishment. By removing excess vegetation, use of beaches and piers would be improved. Wildlife habitat, such as fish spawning beds, could be greatly improved. This in turn would benefit other portions of the lake's ecosystem. Harvested plant material is often used as fertilizer and compost in gardens.

Cons

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

Costs

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

Option 4: Revegetation With Native Aquatic Plants
See *Objective II: Option: 4*

Objective IV: Wildlife Habitat Improvement

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

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

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

Option 1: No Action
This option means that the current land use activities will continue. No additional techniques will be implemented. Allowing a field to go fallow or not mowing a manicured lawn would be considered an action.

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

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

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

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

Option 2: Increase Habitat Cover
This option can be incorporated with *Option 3*. One of the best ways to increase habitat cover is to leave a minimum 25 foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see *Table 6* for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species out-compete native plants and provide little value for wildlife.

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

Brush piles make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be place at least 10 feet away from the shoreline to prevent any debris from washing into the lake. Trees that have fallen on the ground or into the water are beneficial by harboring food and providing cover for many wildlife species. In a lake,

fallen trees provide excellent cover for fish, basking sites for turtles, and perches for herons and egrets. Additionally, increasing habitat cover should not be limited to the terrestrial environment. Native aquatic vegetation, particularly along the shoreline, can provide cover for fish and other wildlife.

Pros

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

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

Cons

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

Costs

The cost of this option would be minimal. The purchase of native plants can vary depending upon species and quantity. Based upon 100 feet of shoreline, a 25-foot buffer planted with a native forb and grass seed mix would cost between $165-270 (2500 sq. feet would require 2.5, 1000 sq. feet seed mix packages at $66-108

per package). This does not include labor that would be needed to prepare the site for planting and follow-up maintenance. This cost can be reduced or minimized if native plants are allowed to grow. However, additional time and labor may be needed to insure other exotic species, such as buckthorn, reed canary grass, and purple loosestrife, do not become established.

Option 3: Increase Natural Food Supply

This can be accomplished in conjunction with *Option 2*. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Plants found in Table 6 should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily, sago pondweed, largeleaf pondweed, and wild celery to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

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

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

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

Pros

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

Migrating wildlife can be attracted with a natural food supply, primarily from seeds, but also from insects, aquatic plants or small fish. In fact, most migrating birds are dependent on food sources along their migration routes to replenish lost

energy reserves. This may present an opportunity to view various species that would otherwise not be seen during the summer or winter.

Cons

Feeding wildlife can have adverse consequences if populations become dependent on hand-outs or populations of wildlife exceed healthy numbers. This frequently happens when people feed waterfowl like Canada geese or mallard ducks. Feeding these waterfowl can lead to a domestication of these animals. As a result, these birds do not migrate and can contribute to numerous problems, such as excess feces, which is both a nuisance to property owners and a significant contribution to the lake's nutrient load. Waterfowl feces are particularly high in phosphorus. Since phosphorus is generally the limiting factor for nuisance algae growth in many lakes in the Midwest, the addition of large amounts of this nutrient from waterfowl may exasperate a lake's excessive algae problem. In addition, high populations of birds in an area can increase the risk of disease for not only the resident birds, but also wild bird populations that visit the area.

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

Costs

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

Option 4: Increase Nest Availability

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

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

In addition to allowing dead and dying trees to remain, erecting bird boxes will increase nesting sites for many bird species. Box sizes should vary to accommodate various species. Swallows, bluebirds, and other cavity nesting birds can be attracted to the area using small artificial nest boxes. Larger boxes will attract species such as wood ducks,

flickers, and owls. A colony of purple martins can be attracted with a purple martin house, which has multiple cavity holes, placed in an open area near water.

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

Pros

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

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

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

Cons

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

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

Costs

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

Objective V: Eliminate or Control Invasive 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. Exotic aquatic plants are addressed under *Option III: Better Aquatic Plant Management Techniques*.

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 per plant), and high seed germination rate, purple loosestrife spreads quickly. Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants and is quick to become established on disturbed soils. Reed canary grass is an aggressive plant that if left unchecked will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

Exotic species were observed on 11% of the parcels surveyed (10 out of 89). These occurrences mainly consisted of purple loosestrife and buckthorn. Presence of exotic species along a lakeshore is by no means a death sentence for the lake or other plant and animal life. If controlled, many exotic species can perform many of the original functions that they were brought here for. For example, reed canary grass was imported for its erosion control properties. It still contributes to this objective (offering better erosion control than commercial turfgrass), but needs to be isolated and kept in control. Many exotics are the result of garden or ornamental plants escaping into the wild. One isolated plant along a shoreline will probably not create a problem by itself. However, problems arise when plants are left to spread, many times to the point where treatment is difficult or cost prohibitive. A monitoring program should be established, problem areas identified, and control measures taken when appropriate. This is particularly important in remote areas of lake shorelines where the spread of exotic species may go unnoticed for some time.

Option 1: No Action

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

Pros

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in

some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics when possible. Table 6 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 effected.

Costs

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

Option 2: Hand Removal

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 excavated. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored. Many exotic species, such as purple loosestrife, buckthorn, and garlic mustard are proficient at colonizing disturbed sites.

Pros

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

Cons

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

Costs

Cost for this option is primarily in tools, labor, and proper plant disposal. On Countryside Lake, these invasive are not widespread or dense and could easily be removed. By simply educating residents on negative impacts associated with invasive species and how to remove them by hand, this problem could be easily (and cheaply) solved.

Option 3: Herbicide Treatment

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

Herbicides are commonly used to control nuisance shoreline vegetation such as buckthorn and purple loosestrife. Herbicides are applied to green foliage or cut stems. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. The herbicide solution is wiped on foliage, bark, or cut stems using a herbicide soaked device. Trees are normally treated by cutting a ring in the bark (called girdling). Herbicides are applied onto the ring at high concentrations. Other devices inject the herbicide through the bark. It is best to apply herbicides when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions. Table 7 contains herbicides that are approved for use near water for control of nuisance vegetation. Included in this table are rates, costs, and restrictions on use.

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
See *Table 7* for herbicide rates, prices, and related information. A Hydrohatchet®, a hatchet that injects herbicide through the bark, is about $300.00. Another injecting devise, E-Z Ject® is $450.00. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. Based on the extent of infestation on Countryside Lake, minimal herbicide application would be needed. If herbicides were used costs would be relatively low and would not necessitate the use of expensive application equipment. However, on Countryside Lake it would be more cost effective to remove them by hand.

Objective VI: Create Bathymetric Map with Morphometric Table.

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some lakes in Lake County do have a bathymetric map, 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. Costs vary, but can range from $3,000-10,000 depending on lake size.