2004 SUMMARY REPORT
of
DOGBONE LAKE

Lake County, Illinois

Prepared by the

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

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

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EXECUTIVE SUMMARY

Dogbone Lake is a 28.6-acre private lake within the Wynstone Country Club Golf Course community in North Barrington. The lake was created by dredging a wetland in 1970 and has a maximum depth of feet. Residents in the surrounding homes use the lake primarily for aesthetic purposes.

Dogbone Lake's water quality is poor. Most of the water quality parameters measured were worse than many other lakes that we have monitored. The water clarity was very low, averaging only 0.94 feet, which is almost three times lower than the Lake County median of 3.08 feet. This was due to the high concentrations of total suspended solids, most of which was sediment. The lake also had high concentrations of nutrients such as nitrogen and phosphorus, which are key ingredients for algae growth. An abundant carp population exacerbated the water quality problems by resuspending the sediment (and attached nutrients) into the water column. Stormwater generated from the watershed can play a major role in delivering nitrogen and phosphorus to lakes. This may be especially important for Dogbone Lake since contributions of these nutrients are likely coming via run-off from portions of the golf course directly adjacent to the lake. In addition, the course is watered with effluent from the community's wastewater treatment plant, another possible source of nutrients.

Because of a combination of carp activity and low light conditions during some months, aquatic plants were nearly nonexistent in Dogbone Lake. Only five aquatic plant species could be found in just a handful of locations. All species were native beneficial plants.

Approximately 68% of the shoreline of Dogbone Lake was classified as developed. The most common shoreline types were lawn and seawall, which comprised about 33% and 20% of the shoreline, respectively. Approximately 35% of the shoreline around Dogbone Lake was classified as eroding. Most locations were either slightly (21% of the total shoreline) or moderately eroding (13%).

Several invasive, exotic plants were found growing along the shoreline, including buckthorn, reed canary grass, purple loosestrife, and multiflora rose. These invasive species are detrimental to the native plant ecosystems. One positive observation was the evidence of leaf eating beetles that had damaged many of the purple loosestrife plants. Removal of these invasive plant species and replacing them with native plants is recommended.

The lake offers little in terms of wildlife habitat, since there are virtually no aquatic plants. In addition, about half of the shoreline is developed with seawalls and manicured lawns, both of which have low habitat value. No known fishery assessment has been done on Dogbone Lake. It is unlikely that a balanced fishery can exist here because of the high turbidity and lack of aquatic plants.

LAKE IDENTIFICATION AND LOCATION

Dogbone Lake (T43N, R9E and 10E, Sections 1,6,7, and 12) formerly known as Lake Sheree, is a private 28.6 lake located in the Village of North Barrington, within the Wynstone Golf Course community. Water exits the lake and flows to a small tributary of Flint Creek, reaching Grassy Lake, and eventually the Fox River. Dogbone Lake's immediate watershed consists of approximately 692 acres. Utilizing estimated annual runoff amounts the residence time of the lake is 0.38 years, or 139 days. Residence time is the amount of time it takes for the entire volume of water to be replaced with "new" water.

Dogbone Lake has a shoreline length of 3.23 miles. The current maximum depth is only 5 feet, as measured in May 2004. Since no bathymetric (depth contour) map of Dogbone Lake is known to exist, the volume of the lake was estimated. Mean depth was estimated as half of the maximum depth. Volume was obtained by multiplying the mean depth by the lake surface area. Based on these calculations, Dogbone Lake has an estimated mean depth of 2.5 feet and an estimated volume of 71.5 acre-feet. Lake elevation is approximately 818 feet above sea level.

A sewage treatment plant is onsite at the Wynstone Golf Course, serving the surrounding homes in the golf course community and the golf course facilities. The plant is permitted to treat 189,000 gallons per day (daily maximum flow). The plant consists of aerated lagoons, chlorination facilities and a spray irrigation system that uses treated effluent to water the golf course, which is adjacent to the lake.

BRIEF HISTORY OF DOGBONE LAKE

The area of what is now Dogbone Lake was originally a wetland and was excavated to its present size in 1970. Development of the land surrounding the lake began as the Wynstone Golf Course community was built in 1987. The Wynstone Property Owner's Association formed shortly after, in 1987-1988. Neither the Association nor the golf course staff actively manages Dogbone Lake.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Dogbone Lake is primarily used for aesthetics for the homes surrounding the lake. Some people use the lake for fishing, as we spoke with one resident who periodically fishes from shore. No boating is allowed.

LIMNOLOGICAL DATA – WATER QUALITY

Water quality samples were collected from the surface of Dogbone Lake, and analyzed for a variety of parameters (Table 1, Appendix A). Methodologies can be found in Appendix B. The samples were collected monthly from May - September at the deepest location (Figure 1). Water clarity, measured with a Secchi disk, is usually the first thing people notice about a lake, and typifies the overall water quality. The water clarity was poor in Dogbone Lake, averaging only 0.94 feet deep during 2004. This is about three times lower than the Lake County median of 3.08 feet. The poor readings were due to high total suspended solid concentrations (TSS) in the water. The concentrations of TSS fluctuated as the season progressed, averaging 39.4 mg/L. This is about *five times* higher than the Lake County median (7.9 mg/L). Figure 2 illustrates how the Secchi disk readings decreased in Dogbone Lake as the TSS concentrations increased. The main reasons for the high TSS concentrations are the abundant carp population and wind and wave action in this shallow system, which resuspended sediment from the lake bottom.

Phosphorus and nitrogen are two key nutrients for algae growth. The nutrients in Dogbone Lake especially total phosphorus (TP) were very high. The TP concentrations averaged 0.199 mg/L, which is about three times higher than the Lake County median (0.063 mg/L). Total Kjeldahl nitrogen (TKN), which is a measure of the organic forms of nitrogen are typically tied up in algae cells. TKN concentrations in Dogbone Lake averaged 2.3 mg/L in 2004. This is nearly twice as high as the Lake County median (1.220 mg/L). There are a few reasons nutrient concentrations were high in this system. Phosphorus absorbed to the sediment can be resuspended from the bottom. This typically occurs in lakes like Dogbone Lake that do not stratify, and the phosphorus attached to bottom sediment can be easily distributed throughout the water column. TP and TKN also enter the lake from the watershed via stormwater runoff that drains to the lake. The watershed (Figure 3) encompasses about 692 acres. The two major land uses are residential and public and private open space, comprising approximately 45% and 18% of the watershed, respectively (Figure 4). Table 2 in Appendix A lists all the land uses and their percentages and the estimated stormwater runoff per year that flows toward Dogbone Lake watershed. The composition of land uses within a lake's watershed often influences its water quality. For instance, because of impervious surfaces such as roads, parking lots and rooftops, developed land uses can contribute more runoff (and more pollutants) per acre than undeveloped land uses. For example, the 315 acres of residential land contribute 50% of the estimated total runoff to Dogbone Lake. The 100 acres of agricultural land contributes about 5% of the estimated total runoff. It is important to keep in mind, however, that although the amount of estimated runoff from certain areas such as agricultural land might be low, these areas can still deliver high concentrations of TSS or nutrients. The golf course adjacent to the lake may be an important source of phosphorus and nitrogen within the watershed, since the use of fertilizers containing these nutrients is common on golf courses. In addition, treated effluent, which contains nutrients, is used to water the fairways. There are restrictions for spray irrigation of treated effluent, such as maximum irrigation rates and avoidance of watering during saturated soil conditions. However, even though these rules may be

INSERT FIG 1 SAMPLE LOCATION

INSERT FIGURE 2 SECCHI VS TSS

INSERT FIGURE 3, WATERSHED

INSERT FIGURE 4, LAND USE MAP

closely followed, there is no guarantee that nutrients will not enter the lake from this practice, especially when portions of the course are directly adjacent to the water.

Typically, lakes are either phosphorus or nitrogen limited. This means that one of the nutrients is in short supply and that any addition of that nutrient to the lake will result in an increase of plant or algae growth. Other resources necessary for plant and algae growth, such as light or carbon, are not normally in short supply. Most lakes in Lake County are phosphorus limited, but to compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting. Ratios greater than or equal to 15:1 indicate that phosphorus is limiting. Ratios greater than 10:1, but less than 15:1 indicate that there are enough of both nutrients to facilitate excess algal or plant growth. Dogbone Lake had enough of both nutrients with a TN:TP ratio of 13:1 in 2004. Even though Dogbone Lake has enough of both nutrients, algae was not in nuisance populations. One reason for this may be that the phosphorus could have been bound to the suspended sediment particles as mentioned previously, making it unavailable for algae to use.

Because Dogbone Lake is a shallow system, it is subject to fluctuations in water quality. In June 2004, high concentrations of TP, nitrate nitrogen, and ammonia nitrogen were found, which were likely the result of heavy spring rains. In the three weeks prior to the June sampling date, approximately seven inches of rain fell in the area (as recorded in a rain gage in Lake Zurich. Another peak was observed in September when high concentrations of TKN, TP, and TSS were found. These high concentrations can be attributed, in part, to the lower water levels (and thus lower water volume) occurring in the lake at this time that exacerbated the negative impacts of carp. In addition, the lake was nearly nitrogen-limited during this month (10.7:1), which may have prohibited microorganisms (particularly algae species) from utilizing the available nutrients.

TP can be used to calculate the trophic state index (TSI), which classifies lakes according to the overall level of nutrient enrichment. The TSI score falls within the range of one of four categories: hypereutrophic, eutrophic, mesotrophic and oligotrophic. Hypereutrophic lakes are those that have excessive nutrients, often with nuisance algae growth reminiscent of “pea soup” or sediment-laden water, and have a TSI score greater than 70. Lakes with a TSI score of 50 or greater are classified as eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae and fish. Mesotrophic and oligotrophic lakes are those with lower nutrient levels. These are very clear lakes, with little algae growth. Most lakes in Lake County are eutrophic. The trophic state of Dogbone Lake in terms of its phosphorus concentration during 2004 was hypereutrophic, with a TSIp score of 80.5. This ranked Dogbone Lake #146 out of 161 Lake County lakes based on average total phosphorus concentrations (Table 3, Appendix A). This ranking is only a relative assessment of the lakes in the county.

The IEPA has assessment indices to classify Illinois lakes for their ability to support aquatic life, swimming, and recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentration (for the trophic state index) and aquatic plant coverage. Dogbone Lake partially supports aquatic life uses according to these guidelines because of its low water clarity and virtual lack of aquatic plants. Although it is not used for swimming or boating, the lake does not support swimming or recreational uses because of the high TP concentrations and low water clarity. Due to these impairments in Dogbone Lake, the overall use index indicated a level of nonsupport.

Conductivity is a measurement of water's ability to conduct electricity via total dissolved solids (TDS) made up of minerals and salts in the water column. The conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, and evaporation and bacterial activity. Conductivity has been shown to be highly correlated (in urban areas) with chloride ions found in road salt mixtures. Water bodies most subject to the impacts of road salts are streams, wetlands or lakes draining major roadways. The median conductivity reading for near-surface samples is 0.7652 milliSiemens/cm (mS/cm) for Lake County lakes. During 2004, the conductivity readings in Dogbone Lake were higher, averaging 0.9328 mS/cm. Conductivity decreased as the season progressed. This is typical of lakes that receive road salts as spring rains flush through the watershed. TDS concentrations in Dogbone Lake were also higher than the Lake County median of 454 mg/L during 2004, with a seasonal average of 528 mg/L. Conductivity changes can occur seasonally and even with depth, but over the long term, increased conductivity can be a good indicator of potential watershed or lake problems or an increase in pollutants entering the lake if the trend is noted over a period of years. High conductivity (which often indicate an increase in sodium or potassium chloride) can eventually change the plant community, as more salt tolerant plants take over. Sodium, potassium and chloride ions can bind substances in the sediment, preventing their uptake by plants and reducing native plant densities. Algae population and species composition may also be negatively affected. Additionally, juvenile aquatic organisms may be more susceptible to high chloride concentrations.

Due to the shallow nature of Dogbone Lake, the water column did not thermally stratify, and dissolved oxygen concentrations were adequate throughout the water column in 2004. Generally concern arises when DO concentrations fall below 5 mg/L in the epilimnion. This amount is considered adequate to support a bluegill/bass fishery since these fish can suffer from oxygen stress below this level. Except for a measurement of 4.69 mg/L close to the bottom in August, all measurements were above 5 mg/L in the water column throughout the season. It's difficult to determine the actual portion of the total water volume that had low DO because there is no recent accurate bathymetric map with volume calculations for this lake.

The options available for improving the water quality of Dogbone Lake are minimal. Removal of carp and deepening the lake by dredging would be the two most effective means to improve the water quality. The removal of carp would require using a fish poison, rotenone, to kill all the fish in the lake. Because the lake flows directly to a tributary that feeds Flint Creek, the rotenone could harm fish downstream, unless the lake was drawn down or a barrier was erected to inhibit flow to waters beyond Dogbone Lake. Only a district fisheries biologist from the Illinois Department of Natural Resources can apply the rotenone, and in cases like this, the biologist may not deem this practice possible or appropriate. Dredging is generally very costly due to the expense of removing the sediment and identifying a disposal site. Costs can be between $15-30/yd^3. Deepening Dogbone Lake by one foot would require the removal of about 46,000 yd^3, with costs dependent on the type of dredging and the location of a disposal site.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Dogbone Lake were assessed from May-September in 2004. (see Appendix B for methods). Terrestrial shoreline plants were also noted, but not quantified. The aquatic plant community in Dogbone Lake was poor. Table 4 lists the five aquatic plant species that were identified. Of 92 samples taken over the season, only 15 (16.3%) had aquatic plants. Duckweed, a small floating plant, was found most often, in 6 samples. Table 5 in Appendix A lists the aquatic plant species and the frequency that they were found. Aquatic plants were very scarce, probably due to a combination of carp activity in the lake and low water clarity during some months. To maintain a healthy bluegill/bass fishery, the optimal plant coverage is 30% to 40% across the lake bottom. Dogbone Lake has far less than this, and did not have any defined plant beds; individual plants were found in a few scattered locations.

Aquatic plants will not photosynthesize at water depths with less than 1% of the available sunlight at the surface. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. In Dogbone Lake during 2004, the 1% light level was deepest in May, being extinguished between 2.8 and 3.8 feet. This could indicate that carp activity may be the major reason for the low density of plants. In July and September, the depth of the 1% light level was the lowest, being extinguished between about 0.8 and 1.8 feet. Of the few plants that were found, three of species, small duckweed, slender riccia and watermeal, are free floating plants, whose leaves float at or near the surface. Although it is anchored to the bottom by rhizomes (root-like structures), white water lily also has leaves that are at or near the surface. These four species are not as affected by low light conditions, since their leaves can reach the sunlight at the surface. The addition of native aquatic plants could add more habitat and also help stabilize the sediment. It would be best to start with species that are not hindered as much by low light conditions in the water. Emergent plants, such as rushes, or those with floating leaves, such as the water lily are some examples. Plants would need protective caging until they have become established to prevent damage from carp or other wildlife such as muskrats.

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

Aquatic Plants	
Small Duckweed	*Lemna minor*
White Water Lily	*Nymphaea tuberosa*
Slender Riccia	*Riccia fluitans*
Common Bladderwort	*Urticularia vulgaris*
Watermeal	*Wolffia columbiana*
Shoreline Plants	
White Yarrow	*Achillea millefolium*
Common Ragweed	*Ambrosia artemisiifolia*
Dog Bane	*Apocynum* sp.
Burdock#	*Arctium minus*
Swamp Milkweed	*Asclepias incarnata*
Common Milkweed	*Asclepias syriaca*
Lady Fern	*Athyrium filix-femina*
Sedges	*Carex* sp.
Oxeye Daisy	*Chrysanthemum leucanthemum*
Chicory#	*Cichorium intybus*
Canada Thistle#	*Cirsium arvense*
Queen Anne's Lace#	*Daucus carota*
Daisy Fleabane	*Erigeron annuus*
Joe-Pye Weed	*Eupatorium maculatum*
True Boneset	*Eupatorium perfoliatum*
Prairie Smoke	*Geum tiflorum*
Jerusalem Artichoke	*Helianthus tuberosus*
St. John's Wort	*Hypericum* sp.
Jewelweed	*Impatiens pallida*
Blue Flag Iris	*Iris* sp.
Rushes	*Juncus* sp.
Blazing Star	*Liatris* sp.
Birdsfoot Trefoil#	*Lotus corniculatus*
Purple Loosestrife#	*Lythrum salicaria*
Yellow Sweet Clover#	*Melilotus officinalis*
Peppermint	*Mentha spicata*
Sensitive Fern	*Onoclea sensibilis*
Virginia Creeper	*Parthenocissus quinquefolia*
Reed Canary Grass#	*Phalaris arundinacea*
Common Cinquefoil	*Potentilla simplex*
Heal All	*Prunella vulgaris*
Multiflora Rose#	*Rosa multiflora*
Black Raspberry	*Rubus occidentalis*
Softstem Bulrush	*Scirpus validus*

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

River Bulrush	*Scirpus fluviatilis*
Bittersweet Nightshade#	*Solanum dulcamara*
Sow Thistle#	*Sonchus* sp.
Red Clover#	*Trifolium pratense*
Shoreline Plants	
Blue Vervain	*Verbena hastata*
Common Mullein#	*Verbascum thapsus*
Wild Grape	*Vitis* sp.
Trees/shrubs	
Box Elder	*Acer negundo*
Red Osier Dogwood	*Cornus sericea*
Dogwood	*Cornus* sp.
American Plum	*Prunus americana*
Cottonwood	*Populus deltoides*
Common Buckthorn#	*Rhamnus cathartica*
Glossy Buckthorn#	*Rhamnus frangula*
Elderberry	*Sambucus* sp.
Willow	*Salix sp.*
Elm	*Ulmus* sp.

 # Exotic species

Floristic quality index (FQI) is a measurement designed to evaluate the closeness of the flora (plants species) of an area to that with undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long term floristic trends, and 4) monitor habitat restoration efforts. Each floating and submersed aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). These numbers are then used to calculate the FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake, and better plant diversity. Nonnative species are included in the FQI calculations for Lake County lakes. The FQI scores of 150 lakes measured from 2000 through 2004 range from 0 to 37.2, with an average of 14.3. Dogbone Lake has a floristic quality of 15.7, indicating a higher than average aquatic plant diversity. However these numbers can be deceiving, as it only indicates the quality of the plants found and does not take into account plant density. The plants found in Dogbone Lake were at very low densities in only a handful of places. This is not reflected in the FQI number, and the plant community is actually below average when plant density is considered.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

The shoreline was assessed at Dogbone Lake on August 2, 2004 for a variety of criteria (See Appendix B for methods). Based on these assessments, several important observations could be made. Nearly 68% of the shoreline is developed, with about 33% typified as manicured lawn (Figure 5). The two other major shoreline types are wetland and seawall, both of which comprise about 20% of the total shoreline. A positive aspect of the shoreline is that the undeveloped areas have some native beneficial plants that offer wildlife habitat. Shorelines typified as lawn and seawall usually offer very little shoreline habitat. A few homes, though, had some native plants growing behind their seawalls. About 35% of this shoreline (5623 feet) is eroding (Figure 6), most of which is classified as slightly eroding. Approximately 13% of the shoreline is classified as moderately eroding, and 1.5% is classified as severely eroding. These areas could be repaired with properly graded slopes and the addition of deep-rooted native plants. This and other suggestions can be found in **Objective IV: Shoreline Erosion Control** in this report. Continued neglect of these shorelines could lead to further erosion, resulting not only in a loss of property, but additional soil inputs into the water that negatively affects water clarity. The installation of a buffer strip of deep-rooted native plants in areas that are eroding can have multiple benefits. They can stabilize the shoreline, add wildlife habitat, and serve as an aesthetic addition to the landscape. If desired, lake access through the buffer strip can be added with a mowed path to the water. A buffer strip will also help filter pollutants and nutrients washed into the lake from the surrounding land. This is particularly important since the effluent from the wastewater treatment plant is used to irrigate the golf course.

Some exotic invasive shoreline plants such as purple loosestrife, buckthorn and reed canary grass were found growing scattered along the Dogbone Lake shoreline (Figure 7). These species are detrimental to the native plant ecosystems since they crowd out the beneficial plants. This results in lower quality wildlife habitat. On a positive note, we noticed evidence of leaf beetles that are known to feed on purple loosestrife. Many purple loosestrife plants on Dogbone Lake had sustained substantial damage, and were unhealthy. The other invasive plants, such as the buckthorn and reed canary grass were also in scattered locations. The invasive plants should be removed before they spread.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Table 6 lists the wildlife species we saw on our visits to Dogbone Lake. Of note was a common tern, an Illinois endangered species that was spotted flying overhead in August. We did not see a nest, however. A good variety of birds were either seen or heard.

It is unknown what the lake's fishery is like since no known fishery assessment has been completed. The carp that infest the lake cause many problems within. However, their removal would require using a fish poison, rotenone, to kill all the fish in the lake.

INSERT FIGURE 5, TYPES

INSERT FIGURE 6, EROSION

Insert figure 7, invasives

It is likely that besides the carp, the major species in this lake are other rough fish that can tolerate low water quality such as that in Dogbone Lake. Due to the high concentrations of suspended sediment, low water clarity and lack of aquatic plants needed for habitat, Dog Bone Lake would not support a high quality fishery.

Table 6. Wildlife Species observed on Dogbone Lake May – September, 2004.

Birds	
Double-crested Cormorant	*Phalacrocorax auritus*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
Common Tern*	*Sterna hirundo*
Great Blue Heron	*Ardea herodias*
Sora Rail	*Porzana carolina*
Red-tailed Hawk	*Buteo jamaicensis*
Mourning Dove	*Zenaida macroura*
Eastern Kingbird	*Tyrannus tyrannus*
Purple Martin	*Progne subis*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
Chimney Swift	*Chaetura pelagica*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
House Wren	*Troglodytes aedon*
Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo	*Vireo olivaceus*
Warbling Vireo	*Vireo gilvus*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow Warbler	*Dendroica petechia*
Red-winged Blackbird	*Agelaius phoeniceus*
Brown-headed Cowbird	*Molothrus ater*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*

Table 6. Wildlife Species observed on Dogbone Lake May – September, 2004, cont'd.

Mammals	
Beaver	*Castor canadensis*
Eastern Chipmunk	*Tamias striatus*
Muskrat	*Ondatra zibethicu*s
Bat	Unknown species
Reptiles	
Painted Turtle	*Chrysemys picta*
Eastern Spiny Softshell Turtle	*Apalone spinifera*
Fish	
Common Carp	*Cyprinus carpio*

* Endangered in Illinois

EXISTING LAKE QUALITY PROBLEMS

- *Lack of a Quality Bathymetric Map*

A bathymetric (depth contour) map is an essential tool in effective lake management, especially if the long term lake management plan includes intensive treatments, such as fish stocking, dredging, chemical application or alum application. No bathymetric map currently exists for Dogbone Lake. Morphometric data obtained in the creation of a bathymetric map is necessary for calculation of equations for correct application of many types of treatments. It is also necessary to determine the volume of water affected by low DO levels.

- *Poor Water Clarity*

Dogbone Lake had an average Secchi disk transparency reading of 0.94 feet, which is well below the county median of 3.08 feet. The poor water clarity was attributed to the high concentration of total suspended solids in the water, which was mostly sediment. A large carp population is a major part of this problem as their activities resuspend sediment into the water column in this shallow lake. Wind and wave action can also resuspend sediment in shallow lakes.

- *High Concentrations of Total Suspended Solids*

Dogbone Lake had high total suspended solid concentrations that decreased the water clarity. The concentrations were about five times higher than the Lake County median. The high concentrations were mostly due to wind, wave and carp activity in this shallow lake that resuspended sediment into the water column.

- *High Nutrient Concentrations*

The lake had high concentrations of total phosphorus (TP) and total Kjeldahl nitrogen (TKN). TP and TKN in Dogbone Lake averaged about three times and two times higher, respectively, than the Lake County medians. Sources of these nutrients are from internal loading such as the resuspension of sediment particles with attached nutrients and from the watershed that flows to the lake. Nutrients are likely coming via run-off from residential areas and the golf course. Establishment of a wider buffer strip (> 20 feet) along the shoreline adjacent to the golf course would help filter some of the nutrients coming in from runoff. Residents can also do this and use low or no phosphorus fertilizers on their lawns. They can also help by not fertilizing near the water's edge.

- *Carp*

Dogbone Lake is infested with common carp. These fish have been known to be the cause of many detrimental aspects of a lake. These include poor water clarity from resuspended sediment due to their activities, loss of aquatic vegetation and subsequent reduction of habitat.

- *Limited Aquatic Vegetation*

Aquatic plants were very scarce in Dogbone Lake, probably due to the low water clarity and by carp activity in the lake. Of 92 samples taken over the season, only 15 had aquatic plants. Duckweed, a small floating plant, was found most often, in six samples. Only five species were found over the season.

- *Shoreline Erosion*

Approximately 35% (5,623 feet) of the shoreline is eroding. Continued neglect of these shorelines could lead to further erosion, resulting not only in a loss of property, but additional soil inputs into the water that negatively affects water clarity.

- *Invasive Shoreline Plant Species*

Numerous exotic plant species (i.e., purple loosestrife, buckthorn, and reed canary grass) were found along the shoreline. These plants are problematic as they out compete native plants and offer little value in terms of shoreline stabilization or wildlife habitat. These invasive plants should be removed and replaced with native shoreline plants.

POTENTIAL OBJECTIVES FOR THE
DOGBONE LAKE MANAGEMENT PLAN

I. Create a Bathymetric Map Including a Morphometric Table
II. Illinois Volunteer Lake Monitoring Program
III. Controlling Excessive Number of Carp
IV. Shoreline Erosion Control
V. Eliminate or Control Exotic Plant Species

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Create a Bathymetric Map Including a Morphometric Table

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Dogbone Lake does not have a bathymetric map. Maps can be created by agencies like the Lake County Health Department - Lakes Management Unit or other companies. Costs vary, but can range from $3,000-10,000 depending on lake size.

Objective II: Participate in the Volunteer Lake Monitoring Program

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection agency (Illinois EPA) to gather fundamental information on Illinois inland lakes, and to provide an educational program for citizens. Annually, about 300 citizen volunteers sample approximately 165 lakes (out of 3,041 lakes in Illinois). The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake.

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

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

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

Objective III: Controlling Excessive Number of Carp

A frequent problem that plagues many of the lakes in the County is the presence of common carp (*Cyprinus carpio*). Common carp were first introduced into the United States from Europe in the early 1870's, and were first introduced into Illinois river systems in 1885 to improve commercial fishing. The carp eventually made their way into many inland lakes and are now so widespread that many people do not realize that they are not native to the U.S.

Carp prefer warm waters in lakes, streams, ponds, and sloughs that contain high levels of organic matter. This is indicative of many lakes in Lake County. Carp feed on insect larvae, crustaceans, mollusks, and even small fish by rooting through the sediment. Immature carp feed mainly on small crustaceans. Because their feeding habits cause a variety of water quality problems, carp are very undesirable in lakes. Rooting around for food causes resuspension of sediment and nutrients, which can both lead to increased turbidity. Additionally, spawning, which occurs near shore in shallow water, can occur from late April until June. The spawning activities of carp can be violent, further contributing to turbidity problems. Adult carp can lay between 100,000 –500,000 eggs, which hatch in 5-8 days. Initial growth is rapid with young growing 4 ¾" to 5" in the first year. Adults normally range in size from 1-10 lbs., with some as large as 60 lbs. Average carp lifespan is 7-10 years, but they may live up to 15 years.

There are several techniques to remove carp from a lake. However, rarely does any technique completely eradicate carp from a lake. Commonly, once a lake has carp, it has carp forever. However, it is up to the management entity to dictate how big the problem is allowed to become. Rotenone is the only reliable piscicide (fish poison) on the market at this time, but it kills all fish that is comes into contact with. Currently, there is a rotenone laced baiting system that can selectively remove carp. While the process is a step in the right direction, several factors still need to be worked out in order for it to be a viable alternative to the whole lake treatment. Until this baiting technique is further developed and produces consistent results, it is not being recommended by the LMU at this time.

The carp that infest Dogbone Lake cause many problems within. Because the lake flows to a tributary that feeds to a tributary of Flint Creek, a rotenone treatment could harm fish downstream. Only a district fisheries biologist from the Illinois Department of Natural Resources can apply the rotenone, and in cases like this, the biologist may not deem this practice possible or appropriate.

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

By following a no action management approach, nothing would be done to control the carp population of the lake. Populations will continue to expand and reach epidemic proportions if they do not already exist.

Pros
There are very few positive aspects to following a no action plan for excessive carp populations. The only real advantage would be the money saved by taking no action.

Cons
There are many negative aspects to a no action management plan for carp management. The feeding habits of carp cause most of the associated problems. As carp feed they root around in the lake sediment. This causes resuspension of sediment and nutrients.   Increased nutrient levels can lead to increased algal blooms, which, combined with resuspended sediment, lead to increased turbidity (reduced clarity). As a result there is a decrease in light penetration, negatively impacting aquatic plants. Additionally, the rooting action of the carp causes the direct disruption of aquatic plants. Loss of aquatic plants can further aggravate sediment and nutrient loads in the water column due to loss of sediment stabilization provided by the plants. Additionally, the fishery of the lake may decline and/or become stunted due to predation issues related to decreased water clarity and loss of habitat. Other wildlife, such as waterfowl, which commonly forage on aquatic plants and fish, would also be negatively impacted by the decrease in vegetation.

The loss of aquatic plants and an increase in algae will drastically impair recreational use of the lake. Swimming could be adversely affected due to the increased likelihood of algal blooms. Swimmers may become entangled in large mats of filamentous algae, and blooms of planktonic species, such as blue-green algae, can produce harmful toxins and noxious odors. Fishing would also be negatively affected due to the decreased health of the lake's fishery. The overall appearance of the lake would also suffer from an increase in unsightly algal blooms, having an unwanted effect on property values.

Costs
There is no cost associated with the no action option.

Option 2: Rotenone

Rotenone is a piscicide that is naturally derived from the stems and roots of several tropical plants. Rotenone is approved for use as a piscicide by the USEPA and has been used in the U.S. since the 1930's. It is biodegradable (breaks down into CO_2 and H_2O) and there is no bioaccumulation. Because rotenone kills fish by chemically inhibiting the use of oxygen in biochemical pathways, adult fish are much more susceptible than fish eggs (carp eggs are 50 times more resistant). Other aquatic organisms are less sensitive to rotenone. However, some organisms are effected enough to reduce populations for several months. In the aquatic environment, fish come into contact with the rotenone by a different method than other organisms. With fish, the rotenone comes into direct contact with the exposed respiratory surfaces (gills), which is the route of entry. In other organisms this type of contact is minimal. Other species include frogs and mollusks but these organisms typically recover to pretreatment levels within a few months. Rotenone has low mammalian and avian toxicity. For example, if a human consumed fish treated with normal concentrations of rotenone, approximately 8,816 lbs. of fish would need to be eaten at one sitting in order to produce toxic effects. Furthermore, due to its unstable nature, it is unlikely that the rotenone would still be active at the time of consumption. Additionally, warm-blooded mammals have natural enzymes that would break down the toxin before it had any effects.

Rotenone is available in 5% and 2.5% concentrations. Both concentrations are available as synergized formulations. The synergist (piperonal butoxide) is an additive that inhibits fish detoxification of rotenone, making the rotenone more effective. Rotenone has varying levels of toxicity on different fish species. Some species of fish can detoxify rotenone quicker than it can build up in their systems. Unfortunately, concentrations to remove undesirable fish, such as carp, bullhead and green sunfish, are high enough to kill more desirable species such as bass, bluegill, crappie, walleye, and northern pike. Therefore, it is difficult to selectively remove undesirable fish while leaving desirable ones. Typically, rotenone is used at concentrations from 2 ppm (parts per million) – 12 ppm. For removal of undesirable fish (carp, bullhead and green sunfish) in lakes with alkalinities in the range found in Lake County, the target concentration should be 6 ppm. Sometimes concentrations will need to be increased based on high alkalinity and/or high turbidity. Rotenone is most effectively used when waters are cooling down (fall) not warming up (spring) and is most effective when water temperatures are $<50^{o}$F. Under these conditions, rotenone is not as toxic as in warmer waters but it breaks down slower and provides a longer exposure time. If treatments are done in warmer weather they should be done before spawn or after hatch as fish eggs are highly tolerant to rotenone.

Rotenone rarely kills every fish (normally 99-100% effective). Some fish can escape removal and rotenone treatment needs to be repeated about every 10 years. At this point in time, carp populations will have become reestablished due to reintroduction and reproduction by fish that were not removed during previous treatment. To ensure the best results, precautions can be taken to assure a higher longevity. These precautions include banning live bait fishing (minnows bought from bait stores can contain carp) and making sure every part of the lake is treated (i.e., cattails, inlets, and harbored shallow areas). Restocking of desirable fish species may occur about 30-50 days after treatment when the rotenone concentrations have dropped to sub-lethal levels. Since it is best to treat in the fall, restocking may not be possible until the following spring. To use rotenone in a body of water over 6 acres a *Permit to Remove Undesirable Fish* must be obtained from the Illinois Department of Natural Resources (IDNR), Natural Heritage Division, Endangered and Threatened Species Program. Furthermore, only an IDNR fisheries biologist licensed to apply aquatic pesticides can apply rotenone in the state of Illinois, as it is a restricted use pesticide.

Dogbone Lake flows into a small tributary of Flint Creek. If the treatment were done as flow exits the pond, fish downstream in the tributary could be harmed, and Dogbone Lake would not be effectively treated as the rotenone leaves the system. Only a district fisheries biologist from the Illinois Department of Natural Resources can apply the rotenone, and in cases like this, the biologist may not deem this practice possible or appropriate.

Pros

Rotenone is one of the only ways to effectively remove undesirable fish species. This allows for rehabilitation of the lake's fishery, which will allow for improvement of the aquatic plant community, and overall water quality. By removing carp, sediment will be left largely undisturbed. This will allow aquatic plants to grow and help further stabilize the sediment. As a result of decreased carp activity and increased aquatic plant coverage, fewer nutrients will be resuspended, greatly reducing the likelihood of nuisance algae blooms and associated dissolved oxygen problems. Additionally, reestablishment of aquatic plants will have other positive effects on lake health and water quality, increases in fish habitat and food source availability for wildlife such as waterfowl.

Cons

There are no negative impacts associated with removing excessive numbers of carp from a lake. However, in the process of removing carp with rotenone, other desirable fish species will also be removed. The fishery can be replenished with restocking and quality sport fishing normally returns within 2-3 years. Other aquatic organisms, such as mollusks, frogs, and invertebrates (insects, zooplankton, etc.), are also negatively impacted. However, this disruption is temporary and studies show that recovery occurs within a few months. Furthermore, the IDNR will not approve application of rotenone to waters known to contain threatened and endangered fish species. Another drawback to rotenone is the cost. Since the whole lake is treated and costs per gallon range from $50.00 - $75.00, total costs can quickly add up. This can be off-set with lake draw down to reduce treatment volume. Unfortunately, draw down is not an option on all lakes.

<u>Costs</u>

As with most intensive lake management techniques, a good bathymetric map is needed so that an accurate lake volume can be determined. To achieve a concentration of 6 ppm, which is the rate needed for most total rehabilitation projects (remove carp, bullhead and green sunfish), 2.022 gal/AF is required.

(Lake volume in Acre Feet)(2.022 gallons) = Gallons needed to treat lake

(Gallons needed)(Cost/gallon*) = Total cost

*Cost/gallon = $50-75 range

For Dogbone Lake this would have an approximate price range of $7,250 - $10,875. In waters with high turbidity such as Dogbone Lake, the ppm may have to be higher. A IDNR fisheries biologist will be able to determine if higher concentrations will be needed.

Objective IV: Shoreline Erosion Control

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

Option 1: No Action

Pros

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

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

Cons

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

Costs

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

Option 2: Install a Seawall

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

Pros

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

Cons

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

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

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

Costs

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

Around Dogbone Lake, the costs to install a seawall along the severely eroded shoreline (244 feet) would cost approximately $20,740-24,400 for steel and $23,180- 26,840 for vinyl, excluding permits. The moderately eroding shorelines (2053 feet) would cost about $174,505-205,300 for steel and $195,035-225830 for vinyl, excluding permits.

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

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

Pros

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

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

Cons

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

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

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

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

Costs

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

Around Dogbone Lake, the costs to install riprap along the moderately eroded shoreline (2053 feet) would cost approximately $71,855 – 102,650, excluding permits. Riprap along the severely eroded shoreline (244 feet) would cost about $8,540-12,200 excluding permits.

Option 4: Create a Buffer Strip

Another effective method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat. Cost of creating a buffer strip is quite variable, depending on the current state of the vegetation and shoreline and whether vegetation is allowed to become established naturally or if the area needs to be graded and replanted. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Non-native plants or noxious weedy species may be present and should be controlled or eliminated.

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

Buffer strips can be constructed in a variety of ways with various plant species. Generally, buffer strip vegetation consists of native terrestrial (land) species and emergent (at the land and water interface) species. Terrestrial vegetation such as native grasses and wildflowers can be used to create a buffer strip along lake shorelines. Table 7 in Appendix A gives some examples, seeding rates and costs of grasses and seed mixes that can be used to create buffer strips. Native plants and seeds can be purchased at regional nurseries or from catalogs. When purchasing seed mixes, care should be taken that native plant seeds are used. Some commercial seed mixes contain non-native or weedy species or may contain annual wildflowers that will have to be reseeded every year. If purchasing plants from a nursery or if a licensed contractor is installing plants, inquire about any guarantees they may have on plant survival. Finally, new plants should be protected from herbivory (e.g., geese and muskrats) by placing a wire cage over the plants for at least one year.

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

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or rip-rap. Native emergent vegetation can be either hand planted or allowed to become established on its own over time. Some plants, such as native cattails (*Typha* sp.), quickly spread and help stabilize shorelines, however they can be aggressive and may pose a problem later. Other species, such as those listed in Table 7 in Appendix A should be considered for native plantings.

Pros

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

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

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

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

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

Cons

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

Costs

If minimal amount of site preparation is needed, costs can be approximately $15 per linear foot, plus labor. Cost of installing willow posts is approximately $20-25 per linear foot. The approximate cost to repair all the eroding areas (5623 feet) on Dogbone Lake using buffer strips is $84,345. Using willow posts would be about $112,460 – 140,575. The severely eroding area may need extra stabilization of the shoreline, such as biologs or A-Jacks ®. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as $1,500-2,000 depending on the types of permits needed.

Option 5: Install A-Jacks®

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

Pros

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

Cons

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

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

To repair the moderately and severely eroding areas (about 2300 feet) on Dogbone Lake with A-Jacks® would cost approximately $115,000 – 172,500.

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

This is the preferred option to repair the eroded area around Dogbone Lake. Since the slope grade is relatively flat along the slightly eroding areas, this technique may be effective at controlling future erosion as well as providing needed habitat.

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 biodegradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from terrestrial sources. These factors help improve water quality in the lake by reducing the amount of nutrients available for algae growth and by reducing the sediment that flows into a lake.

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

Costs
Costs range from $40 to $45 per linear foot of shoreline, including plantings. This does not include the necessary permits and surveys, which may cost $1,500 –

2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.

To repair the moderately and severely eroding areas (2,300 feet) on Dogbone Lake with this option would cost approximately $92,000 – 103,500. To repair the slightly eroding shoreline (3325 feet), the cost range would be $133,000 - $149,625.

Objective V: Eliminate or Control Exotic Species

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

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

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

Option 1: No Action

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

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

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

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

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

<u>Option 2: Biological Control</u>

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

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

We noticed evidence of the beetles on the purple loosestrife plants on Dogbone Lake. Many plants had sustained substantial damage, and were unhealthy. Purple loosestrife was not found in high densities at this time, and the beetles could control them. The area should be monitored to see if they begin to spread, and if so, remove them. The other invasive plants, such as the buckthorn and reed canary grass were also in scattered locations. These too, should be removed before they spread.

Pros

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

Cons

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

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

Costs

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

Option 3: Control by Hand

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

Control by hand could be an option for the invasive plants around Dogbone Lake since they are not in high densities.

Pros

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

Cons

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

Costs

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

Option 4: Herbicide Treatment

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

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

Pros

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

Cons

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

Costs

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