2004 SUMMARY REPORT
of
BITTERSWEET GOLF COURSE LAKE #13

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Bittersweet Golf Course Lake #13 is a private lake located within the Bittersweet Golf Course in Gurnee (Warren Township). It is part of the Mill Creek drainage of the Des Plaines River watershed. Bittersweet Lake's watershed is approximately 604 acres, and has a watershed to lake ratio of 96:1. Bittersweet Lake encompasses approximately 6.3 acres and has a shoreline length of 0.52 miles. The current maximum depth was determined to be 17.4 feet, as measured in May 2004.

Water clarity, as measured by Secchi disk transparency readings, averaged 1.98 feet for the season, which is 36% below the county median (where 50% of the lakes are above and below this value) of 3.08 feet. The deepest reading was recorded in June (4.27 feet) and the shallowest recorded in September (1.05 feet). The decline in clarity over the season can be attributed primarily to the reduction in water volume in the lake that occurred after June. On August 12 we mapped the boundary of the shoreline and determined the surface area decline by 70%, going from 6.3 acres (May) to 1.9 acres (August).

Bittersweet Lake had high concentrations of total suspended solids, total phosphorus, and total Kjeldahl nitrogen. All of these parameters were well above county medians. These parameters increased in concentration as the water levels declined. The problems were exacerbated by the presence of carp, which resuspended bottom sediments.

Aquatic plants were scarce in Bittersweet Lake. Only three aquatic plant species and several emergent shoreline plants were found. The lack of plant is due to the poor clarity caused by carp activity.

The entire shoreline of Bittersweet Lake was classified as developed. Wetland habitat was the dominant shoreline type consisting of 73% of the shoreline. Buffer habitat was the next most common type at 23%. The remaining 4% consisted of riprap. Due to the shoreline types around the lake, there was no erosion noted.

Several exotics were found growing along the shoreline, including purple loosestrife and reed canary grass. Removal or control of these exotic species is recommended.

LAKE IDENTIFICATION AND LOCATION

Bittersweet Golf Course Lake #13 (T45N, R11, Sections 17 and 18), hence referred to as Bittersweet Lake, is a private lake located within the Bittersweet Golf Course. The lake is located west of Almond Road and north of Dada Road in Gurnee (Warren Township). It is part of the Mill Creek drainage of the Des Plaines River watershed. Bittersweet Lake's watershed is approximately 604 acres, and has a watershed to lake ratio of 96:1 (Figure 1). There are nine stormwater culverts that drain into the lake or into the wetland complex adjacent to the lake. All of these culverts drain residential areas. The outlet is a single culvert on the northwestern end of the lake. Water leaves the lake and enters other stormwater pipes, eventually flowing north of Grand Avenue and into Mill Creek.

Bittersweet Lake encompasses approximately 6.3 acres and has a shoreline length of 0.52 miles. The current maximum depth was determined to be 17.4 feet, as measured in May 2004. Since no bathymetric (depth contour) map of Bittersweet Lake is known to exist, the volume of the lake was estimated based on data from lakes with known depths and volumes. Mean depth was obtained by multiplying the maximum depth by 0.5. Volume was obtained by multiplying the mean depth by the lake surface area. Based on these calculations, Bittersweet Lake has an estimated mean depth of 8.7 feet and an estimated volume of 55 acre-feet. This estimated volume is based on the water depth in May 2004. The lake volume significantly decreased as the season progress, primarily as a result of golf course irrigation. More information on this will be discussed in the **Water Quality Assessment** section. The lake elevation is approximately 756 feet above sea level.

BRIEF HISTORY OF BITTERSWEET LAKE

The exact date of lake creation is unknown, but it is believed that Bittersweet Lake was created by the excavation of a depression/wetland area. Figure 2 shows a 1939 aerial photograph of the area, prior to the lake's creation.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Bittersweet Lake is used primarily for water detention and irrigation for the Bittersweet Golf Course. The Village of Gurnee owns the lake and golf course. The lake has no public access and no watercraft are permitted on the lake. The lake lacks any formal management plan.

Figure 1. Watershed.

Figure 2. 1939 aerial

Figure 3. Land uses.

The composition of land uses within a lake's watershed often influences its water quality. The major land use in Bittersweet Lake watershed (based on 2000 land use maps) is Public and Private Open Space (38.4%), followed by single family (29.5%) and transportation (11.7%). All of the other land uses in the watershed individually comprise less than 10% (Table 2). Based on the land uses in the watershed and the estimated volume of Bittersweet Lake, the approximate retention time of the lake is 51 days. Implications of the land uses and retention time will be addressed in the **Water Quality Assessment** section below.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were collected monthly from May - September 2004 at the deep-hole location in the lake (Figure 4). See Appendix B for water sampling methods.

Bittersweet Lake's water quality was poor compared to many lakes in Lake County (Table 1 in Appendix A). Most of the water quality parameters measured were below the averages of other lakes that we have monitored. Several important findings were noted.

Water clarity, as measured by Secchi disk transparency readings, averaged 1.98 feet for the season, which is 36% below the county median (where 50% of the lakes are above and below this value) of 3.08 feet. The deepest reading was recorded in June (4.27 feet) and the shallowest recorded in September (1.05 feet). The decline in clarity over the season can be attributed primarily to the reduction in water volume in the lake that occurred after June. On August 12 we mapped the boundary of the shoreline to determine the decline in surface area. The surface area decline by 70% going from 6.3 acres (May) to 1.9 acres (August). The water level dropped by 3.27 inches from May to June, 28.9 inches from June to July, and by 6.25 inched from August to September (no measurement taken in August since the stake we were measuring from was above the surface of the water). The reduction in water volume can not be calculated since no bathymetric map of the lake exists. It is likely that the volume of water lost was less than 70% since the area lost consisted of very shallow water (<3 feet deep). However, the reduction in surface area did restrict the lake's large population of common carp (*Cyprinus carpio*) to a smaller area, which had negative impacts on water quality, particularly in July, August, and September. To track future water quality trends, it is recommended that the lake become enrolled in the Volunteer Lake Monitoring Program (VMLP), which trains a volunteer to measure the Secchi disk readings on a bimonthly basis from April to October. For more information see **Objective II: Illinois Volunteer Lake Monitoring Program.**

Correlated with the poor clarity readings in July, August, and September were high concentrations of total suspended solids (TSS; Figure 5). The seasonal average in the epilimnion was 17.0 mg/L, which is 115% higher than the county median of 7.9 mg/L. In order to determine if the TSS was primarily organic or inorganic, we calculated the non-volatile suspended solids (NVSS) concentration, which indicates the inorganic portion in

Figure 4.

Figure 5.

TSS. The average NVSS in the lake was 80% of the average TSS for the season indicating the TSS is primarily of inorganic substances, such as sediment. This supports the theory that carp activity is largely responsible for the high concentrations. Carp activity resuspends bottom sediment into the water column causing these high concentrations and also increasing the turbidity in the water, which reduces water clarity.

The total phosphorus (TP) concentrations in the lake were very high. The 2004 average TP concentrations in Bittersweet Lake were 0.110 mg/L in the epilimnion and 0.214 mg/L in the hypolimnion, compared to the county medians of 0.063 mg/L and 0.178 mg/L, respectively. Again, these concentrations were highest in the months when the water level was reduced. The July hypolimnetic concentration of 0.321 mg/L was the seasonal high. The July hypolimnetic sample was the only near-bottom sample taken during the low water level months (July, August, and September) when the lake was stratified, thus concentrating the TP under the thermocline. The source of the TP may be either external of internal. Since the lake is surrounded by residential homes and the golf course itself, runoff from these sites may be contributing to the high concentrations. One of the largest threats to the lake is probably fertilizer (which is often high in phosphorus) applied to the lawns near the lake as well as the golf course. It is recommended that homeowners and the golf course use a no-phosphorus fertilizer on their lawns. Once the TP enters the lake, internal processes (i.e., algae blooms, thermal stratification and carp activity) recycle this nutrient.

Bittersweet Lake did thermally stratify during part of the season. On the May sampling date, a weak thermocline was established at eight feet. A stronger thermocline was at eight feet in June and July, but by the August and September dates had dissipated. The impacts on the stratification on the water quality parameters collected have been mentioned previously; with TP and TSS concentrations being impacted the most.

The lake also had high concentrations of total Kjeldahl nitrogen (TKN), which is a form of organic nitrogen. The epilimnetic average was 2.18 mg/L, 79% higher than the county median of 1.220 mg/L. Similarly, the hypolimnetic TKN average for Bittersweet Lake was 3.15 mg/L, 40% higher than the county median of 2.250 mg/L. Similar to TP and TSS, the highest TKN concentrations in the epilimnion were found in the months of low water levels. In the hypolimnion, however, the TKN concentration remained high throughout the season. This may have been due to thermal stratification discussed earlier.

High nutrient concentrations are usually indicative of water quality problems. 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 usually the limiting factors in algal growth. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.) that are more difficult to control than sources of phosphorus. 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. The average ratio between total nitrogen and total phosphorus for

Bittersweet Lake in 2004 was 20:1, indicating a phosphorus-limited system. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

Alkalinity concentrations in Bittersweet Lake were also extremely high, with the seasonal averages in the epilimnion (226 mg/L $CaCO_3$) and hypolimnion (269 mg/L $CaCO_3$) were well above the county medians (162 mg/L $CaCO_3$ and 194 mg/L $CaCO_3$, respectively). The highest epilimnetic concentrations were during July, August, and September. The source of the high concentrations in Bittersweet Lake may be coming from sources in the watershed or possibly from groundwater sources.

Bittersweet Lake's average concentrations of total dissolved solids (TDS) and conductivity readings were higher than the county medians. These two parameters are correlated since the higher the concentrations of TDS in the water the higher the conductivity readings. The 2004 average for TDS was 654 mg/L in the epilimnion, which is 44% higher as the county median of 454 mg/L. Similarly, the 2004 average conductivity readings were 1.153 milliSiemens/cm in the epilimnion and 1.632 milliSiemens/cm in the hypolimnion, which are 34% and 101% higher the county medians of 0.7652 milliSiemens/cm and 0.8105 milliSiemens/cm, respectively. The possible cause for these high TDS concentrations and conductivity readings in Bittersweet Lake is input from solids washed into the lake from storm events in the watershed. One of the most common dissolved solids is road salt used in winter road deicing. Because of the high conductivity readings, one additional parameter, chlorides, was analyzed in June, July, and August. Chloride concentrations help determine if this was the case since most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. The three-month average for chlorides in Bittersweet Lake in 2004 was 184 mg/L in the epilimnion and 300 mg/L in the hypolimnion. The IEPA standard for chloride is 500 mg/L. Once values exceed this standard the water body is deemed to be impaired, thus impacting aquatic life. It appears that the road salt is compounding in many lakes in the county. Some lakes in the county have seen a doubling of conductivity readings in the past 5-10 years. In a study by Environment Canada (equivalent to our USEPA), it was estimated that 5% of aquatic species such as fish, zooplankton and benthic invertebrates would be affected at chloride concentrations of about 210 mg/l. Additionally, shifts in algae populations in lakes were associated with chloride concentrations as low as 12 mg/l. Thus, it appears that the chloride concentrations in Bittersweet Lake are negatively impacting the aquatic life to some degree. This parameter should be monitored closely in the future.

Dissolved oxygen (DO) concentrations in Bittersweet Lake fluctuated during the season. In June, concentrations at the surface were below 5 mg/L (4.44 mg/L and 54% saturation), while in August concentrations were supersaturated (11.84 mg/L and 138% saturation), due to an algae bloom that was occurring. Some fish species may become stressed when DO concentrations fall below 5 mg/L. However, since the lake is used not as a fishery this may not be a concern.

Rain events probably contribute additional sediment or nutrients (like phosphorus) to a lake, which may have influenced the water sample results. However, rain occurred within 48 hours prior to water sampling in May (1.27 inches), June (0.01 inches), and August (0.21 inches) as recorded at the Lake County Stormwater Management Commission rain gage in Old Mill Creek. The water quality parameters did not appear to be impacted by either of the rainfall events, however, the lake may be receiving nutrient inputs from stormwater from the adjacent landscape including the golf course, residential lawns and roads.

Based on data collected in 2004, standard classification indices compiled by the Illinois Environmental Protection Agency (IEPA) were used to determine the current condition of Bittersweet Lake. A general overall index that is commonly used is called a trophic state index or TSI. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich productive). This index can be calculated using total phosphorus values obtained at or near the surface. The TSIp for Bittersweet Lake in 2004 classified it as a hypereutrophic lake (TSIp = 71.9). Eutrophic lakes are the most common type of lake throughout the lower Midwest, and they are particularly common among manmade lakes. See Table 2 in Appendix A for a ranking of average TSIp values for Lake County lakes (Bittersweet Lake is currently #115 of 161). This ranking is only a relative assessment of the lakes in the county. The current rank of a lake is dependent upon many factors including lake origin, water source, nutrient loads, and morphometric features (volume, depth, substrate, etc.). Thus, a small shallow manmade lake with high nutrient loads could not expect to achieve a high ranking even with intensive management.

In Bittersweet Lake, all of the IEPA impairment indices were classified as having a partial degree of support, due to the high trophic state of the lake, lack of aquatic plants, poor water clarity, and the high NVSS concentrations. The overall use index for the lake was partial support. Bittersweet Lake should not be used for public recreation, given its current trophic state.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Bittersweet Lake were assessed monthly from May through September 2004 (see Appendix B for methods). Only three aquatic plant species and several emergent shoreline plants were found (see Table 3, below). Terrestrial shoreline plants were also noted, but not quantified.

Aquatic plants were scarce in Bittersweet Lake. In May, August and September, no plants were found. In June, small duckweed, sago pondweed, and water smartweed were found, but in small numbers. The poor water clarity, exacerbated by the presence of carp, is the probable cause of the lack of plants in the lake.

The 1% light levels (the point where plant photosynthesis ceases) dropped as the water level dropped during the season with the 1% level penetrating down to seven feet in May and June, but declined to 3-4 feet from July to September. This data corresponds to the drop in water clarity and the increase in TSS as the water levels dropped. Although no bathymetric map of Bittersweet Lake exists, depth soundings throughout the season indicate that most of the lake is less than eight feet deep. The Illinois Department of Natural Resources recommends 25-40% aquatic plant coverage to maintain ideal gamefish habitat conditions. Although an ideal fishery is not one currently one of the main lake uses, this information may be useful in the future if fishing becomes a higher priority. Beneficial native plants (both submersed and emergent) are present in the lake and should be encouraged to expand to enhance habitats for fish and other wildlife and well as improve water quality. However, this will not be achievable given the current carp population in the lake. Total elimination of the carp population would be needed in order to begin in-lake improvements. For more information on this see **Objective III: Controlling Excessive Numbers of Carp.**

Floristic quality index (FQI; Swink and Wilhelm 1994) is an assessment tool designed to evaluate the closeness that the flora of an area is to that of 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 aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were counted in the FQI calculations for Lake County lakes. In 2004, Bittersweet Lake had a FQI of 8.1. The median FQI of lakes that we have studied from 2000-2004 is 12.1.

Table 3. Aquatic and shoreline plants on Bittersweet Lake, May - September 2004.

<u>*Aquatic Plants*</u>	
Small Duckweed	*Lemna minor*
Water Smartweed	*Polygonum amphibium*
Sago Pondweed	*Potamogeton pectinatus*
<u>*Shoreline Plants*</u>	
Velvet Leaf#	*Abutilon theophrasti*
Water Plantain	*Alisma plantago-aquatica*
Burdock#	*Arctium minus*
Swamp Milkweed	*Asclepias incarnata*
Common Milkweed	*Asclepias syriaca*
Oxeye Daisy	*Chrysanthemum leucanthemum*
Canada Thistle#	*Cirsium arvense*
Queen Anne's Lace#	*Daucus carota*
Purple Loosestrife#	*Lythrum salicaria*
White Sweet Clover#	*Melilotus alba*
Yellow Sweet Clover#	*Melilotus officinalis*
Common Evening Primrose	*Oenothera biennis*
Reed Canary Grass#	*Phalaris arundinacea*
Cottonwood	*Populus deltoides*
Sow Thistle#	*Sonchus* sp.
Cattail	*Typha* sp.
Wild Grape	*Vitis* sp.

 # Exotic species

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted in July 2004 to determine the condition of the lake shoreline (see Appendix B for methods). Of particular interest was the condition of the shoreline at the water/land interface.

The entire shoreline of Bittersweet Lake was classified as developed. Wetland habitat was the dominant shoreline type consisting of 73% of the shoreline (Figure 6). Buffer habitat, which is a strip of unmowed vegetation preferably consisting of native plants located at the water's edge, was the next most common type at 23%. The remaining 4% consisted of riprap. The shoreline was assessed for the degrees and types of shoreline erosion. Due to the shoreline types around the lake, there was no erosion noted (Figure 7).

Figure 6.

Figure 7

Several exotics were found growing along the shoreline, including purple loosestrife and reed canary grass. Similar to aquatic exotics, these terrestrial exotics are detrimental to the native plant ecosystems around the lake. Removal or control of exotic species is recommended. More information can be found in **Objective IV: Eliminate or Control Exotic Species**.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Wildlife species were noted on and around Bittersweet Lake during the season. See Appendix B for methods. Several of the species listed in Table 5 (below) were seen during spring or fall migration and were assumed not to be nesting around the lake.

The number of species was limited due to the relatively poor habitat around the lake. The watershed is highly developed, consisting of many residential homes with limited vegetation. The wetland that surrounds the lake is dominated by cattails and offers minimal habitat. Additional habitat can be created around the lake, such as erecting birdhouses or allowing brush and trees that have falling into the water remain. More information can be found in **Objective V: Enhance Wildlife Habitat Conditions**.

We did not conduct any fish surveys of Bittersweet Lake in 2004. However, numerous carp were seen throughout the season. As mentioned previously, the carp reduce the water quality of the lake significantly by stirring up the lake bottom sediment, which is also detrimental to fish and wildlife habitat in the lake.

Table 5. Wildlife species observed on Bittersweet Lake, April – September 2004.

Birds	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Killdeer	*Charadrius vociferus*
Mourning Dove	*Zenaida macroura*
Willow Flycatcher	*Empidonax traillii*
Cliff Swallow	*Petrochelidon pyrrhonota*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
Black-capped Chickadee	*Poecile atricapillus*
Marsh Wren	*Cistothorus palustris*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*

House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
House Finch	*Carpodacus mexicanus*
American Goldfinch	*Carduelis tristis*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*

Amphibians, Mammals, and Reptiles
None noted

***Endangered in Illinois**
+Threatened in Illinois

EXISTING LAKE QUALITY PROBLEMS

- *Lack of a Quality Bathymetric Map*

  A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., aeration, chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Currently, no bathymetric map of Bittersweet Lake exists.

- *Poor Water Clarity*

  Bittersweet Lake had a Secchi disk transparency reading of 1.98 feet, which is slightly 36% below the county median. The decline in clarity over the season can be attributed primarily to the reduction in water volume in the lake that occurred after June as well as the presence of carp in the lake, which resuspend bottom sediments into the water column.

- *High Concentrations of Total Suspended Solids, Total Phosphorus, and Total Kjeldahl Nitrogen*

  Bittersweet Lake had high concentrations of total suspended solids, total phosphorus, and total Kjeldahl nitrogen. These parameters increased in concentration as the water levels declined. The problems were exacerbated by the presence of carp. Sources of these high nutrient concentrations could be from internal (i.e., carp activity) and external (i.e., stormwater runoff).

- *High Concentrations of Total Dissolved Solids and High Conductivity Readings*

  Bittersweet Lake's average concentrations of total dissolved solids (TDS) and conductivity readings were higher than the county medians. The possible cause for these high TDS concentrations and conductivity readings in Bittersweet Lake is input from solids washed into the lake from storm events in the watershed. One of the most common dissolved solids is road salt used in winter road deicing.

- *Limited Aquatic Vegetation*

  Aquatic plants were scarce in Bittersweet Lake. Only three aquatic plant species and several emergent shoreline plants were found. In May, August and September, no plants were found. In June, small duckweed, sago pondweed, and water smartweed were found, but in small numbers. The poor water clarity, exacerbated by the presence of carp, is the probable cause of the lack of plants in the lake.

- *Invasive Shoreline Plant Species*

  Numerous exotic plant species (i.e., purple loosestrife, buckthorn, and reed canary grass) were found on the shores of Bittersweet Lake. Loosestrife and buckthorn are particularly problematic as they outcompete native plants and offer little value in terms of shoreline stabilization or wildlife habitat. These exotic plants should be removed and replaced with native shoreline plants.

POTENTIAL OBJECTIVES FOR THE BITTERSWEET LAKE MANAGEMENT PLAN

I. Create a Bathymetric Map Including a Morphometric Table
II. Illinois Volunteer Lake Monitoring Program
III. Controlling Excessive Numbers of Carp
IV. Eliminate or Control Exotic Plant Species
V. Enhance Wildlife Habitat Conditions

Objective I: Create a Bathymetric Map Including a Morphometric Table

A bathymetric map (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Maps can be created by agencies like the Lake County Health Department - Lakes Management Unit or other companies. 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, approximately 165 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 300 citizen volunteers. 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.

Currently the number of volunteers in the six county northeast Illinois region has reached its limit with regard to how many volunteers NIPC can handle. New lakes wishing to be part of the VLMP will be taken on and trained by the Lake County Health Department Lakes Management Unit (LMU). If you would like to be placed on this training list or would simply like more information, contact the Lakes Management Unit Local Coordinator:

LMU Local Coordinator:
Mary Colwell
Lake County Health Department
3010 Grand Ave.
Waukegan, IL 60085
(847) 377-8009

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 Numbers 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, we do not recommended it at this time.

<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. More sensitive nonfish 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 additional rotenone treatments need to occur 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.

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

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 offset with lake draw down to reduce treatment volume. Unfortunately, draw down is not an option on all lakes.

Costs

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

In waters with high turbidity and/or planktonic algae blooms, the ppm may have to be higher. A IDNR fisheries biologist will be able to determine if higher concentrations will be needed.

Objective IV: Eliminate or Control Exotic Species

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

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

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

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

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

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

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

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

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

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

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

Pros

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

Cons

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

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

Costs

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

Option 3: Control by Hand

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

Pros

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

Cons

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

Costs

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

<u>Option 4: Herbicide Treatment</u>

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

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

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

Pros

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

Cons

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

Costs

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

Objective V: Enhance Wildlife Habitat Conditions

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

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

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

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

Option 2: Increase Habitat Cover

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

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

Brush piles make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be place at least 10 feet away from the shoreline to prevent any debris from washing into the lake.

Trees that have fallen on the ground or into the water are beneficial by harboring food and providing cover for many wildlife species. In a lake, fallen trees provide excellent cover for fish, basking sites for turtles, and perches for herons and egrets.

Increasing habitat cover should not be limited to the terrestrial environment. Native aquatic vegetation, particularly along the shoreline, can provide cover for fish and other wildlife.

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

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

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

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

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

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

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

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

Pros

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

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

Cons

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

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

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

Costs

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

Option 4: Increase Nest Availability

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

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

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

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

Pros

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

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

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

Cons

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

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

Costs

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

Option 5: Limit Disturbance

Since most species of wildlife are susceptible to human disturbance, any action to curtail disturbances will be beneficial. Limiting disturbance can include posting signs in areas of the lake where wildlife may live (e.g., nesting waterfowl), establish a “no wake” area, boat horsepower or speed limits, or establish restricted boating hours. These are examples of time and space zoning for lake usage. Enforcement and public education are needed if this option is to be successful. In some areas, off-duty law enforcement officers can be hired to patrol the lake.

Pros

Limiting disturbance will increase the chance that wildlife will use the lake, particularly for raising their young. Many wildlife species have suffered population declines due to loss of habitat and poor breeding success. This is due in part to their sensitivity to disturbance.

This option also can benefit the lake in other ways. Limited boat traffic may lead to less wave action to batter shorelines and cause erosion, which results in suspension of nutrients and sediment in the water column. Less nutrients and sediment in the water column may improve water quality by increasing water clarity and limiting nutrient availability for excessive plant or algae growth.

Recreation activities such as canoeing and paddleboating may be enhanced by the limited disturbance.

Cons

One of the strongest oppositions to this option would probably be from the powerboat users and water skiers. However, this problem may be solved if a significant portion of the daylight hours and the use of the middle part of the lake (assuming the lake is deep enough) are allowed for powerboating. For example, powerboating could be allowed between 9 AM and 6 PM within the boundaries established by “no wake” restricted area buoys.

Costs

The costs of this option include the purchase and placement of signs and public educational materials as well as enforcement. Off-duty law enforcement officers usually charge $25/hour to enforce boating laws or local ordinances.