

**2001 SUMMARY REPORT  
of  
ANTIOCH 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  
Joseph Marencik  
Mark Pfister

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## **EXECUTIVE SUMMARY**

Antioch Lake is a 89 acre manmade lake, located in Antioch Township, which was created in the 1930's by damming the north end of a natural slough area. The northern portion of the lake lies within the municipal boundaries of the Village of Antioch and the remainder is in unincorporated Lake County. The lake has a maximum depth of 9 feet.

Water clarity in Antioch Lake was poor, particularly after herbicide treatments in May. After plants died back, water clarity decreased as a result of subsequent algae blooms and sediment resuspension in the water from wind, wave and carp action. The algae blooms are substantial because of the high phosphorus concentrations in Antioch Lake. Similar results were noted in water quality samples collected by the Lake County Health Department in 1992 and 1993. Sources of phosphorus include inputs from the watershed, local sources (i.e., lawn fertilizers and agricultural runoff) and internal loading from the sediment.

Because Antioch Lake is shallow, the water column can easily mix from wind and wave action, distributing dissolved oxygen from the surface to the bottom. During 2001, dissolved oxygen concentrations were > 1.0 mg/L from the surface to the bottom during the months of May, June, and September and from the surface to six feet in July and August. Antioch Lake does not have a history of summer fishkills due to dissolved oxygen losses. A winter fishkill did occur in 1958-59.

In 2001, approximately 96% of the lake bottom was covered with plants before being treated with aquatic herbicides. Because the lake is shallow, aquatic plants have the ability to grow on almost 100% of the lake bottom. The three most common species during 2001 were curlyleaf pondweed, Eurasian water milfoil and white water lily. Curlyleaf pondweed is by far the most dominant plant, followed closely by Eurasian water milfoil. Both plants are nonnative exotic plants, and are considered nuisance plants. Eurasian water milfoil was not noted in Antioch Lake until about 1994. White water lily was not noted during water quality sampling visits in 1992 or 1993.

The two most common types of shoreline around Antioch Lake are woodland and lawn. Approximately 73% of the shoreline surrounding the lake is developed. This includes mowed turfgrass, riprap, seawall, and unmowed buffer areas. Over half of the shoreline is eroding in some degree. Most of the erosion occurs along shorelines with manicured lawns or with shrubs. The severely eroded areas should be addressed immediately as they are contributing sediment to the lake.

## **LAKE IDENTIFICATION AND LOCATION**

Antioch Lake is a 89 acre manmade lake, located in Antioch Township (T44N, R10E, Sections 17 and 18). The northern portion of the lake lies within the municipal boundaries of the Village of Antioch and the remainder is in unincorporated Lake County. The lake has several inflow locations, including a small creek that drains the southern residential area, a large square culvert that drains the area by Illinois Highway 173 at the northeast side, and 8 culvert/swales that drain the residential areas surrounding the lake. Antioch Lake empties through a culvert at the north end of the lake. The water flows into Lake Tranquility, and eventually into Sequoit Creek, which flows to Lake Marie of the Fox River Chain O'Lakes. Antioch Lake has a maximum depth of 9 feet and an average depth of 4.5 feet, which is estimated at half of the maximum depth. The estimated volume of the lake is 400 acre-feet<sup>1</sup>, or 130.5 million gallons. The shoreline length is 2.5 miles. During 1992 and 1993, the Lake County Health Department (LCHD) collected water quality samples for the Sequoit Creek 319 Project, which included Antioch Lake. These data will also be discussed in the water quality section of this report.

## **BRIEF HISTORY OF ANTIOCH LAKE**

In the early 1930's, local farmers constructed a dam at the north end of what was then a natural slough. Over the next three years, water continued to fill in what is now the lake. The homeowner's associations annually use aquatic herbicides to control the aquatic plants in the lake.

## **SUMMARY OF CURRENT AND HISTORICAL LAKE USES**

The lake bottom of Antioch Lake has several ownership parcels, the majority of which have been deeded to the Friends of Lake Antioch, which is a not-for-profit organization that consists of members of five homeowner's associations. Other large parcels are owned by Autozone, Osmond Enterprises and a private individual. Several smaller parcels are privately owned. The homeowner's associations included within the Friends of Lake Antioch are Sabrina Manor, Landmark Pointe Subdivision Property Owner's Association, Mystic Cove, Sunset Ridge Subdivision Association, and Antioch Hills Property Owner's Association. Two associations, Sunset Ridge and Antioch Hills, have access locations to the lake for their members, with both areas offering a beach, some boats for members' use, and a small picnic area. The residents enjoy the lake by nonmotorized boating, fishing, swimming and aesthetics. Some of the associations use aquatic herbicides to treat extensive plant beds throughout the lake. There is no public access to Antioch Lake.

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<sup>1</sup> One acre-foot is one acre filled with one foot of water, or 325,900 gallons.

## LIMNOLOGICAL DATA - WATER QUALITY

Water samples were taken once a month, from May through September 2001, at the deepest location (See Figure 1). The document, "Interpreting Your Water Quality Data" explains these parameters in detail. See Appendix B for water quality sampling and laboratory methods.

The water clarity in Antioch Lake during 2001 averaged 2.48 feet deep (Table 1, Appendix A). Fifty percent of Lake County lakes had a water clarity reading of at least 4.18 feet<sup>2</sup>. The best clarity reading was in May (4.63 feet deep), before the aquatic plants were treated with herbicides. Clarity dropped dramatically after the plants died back and an algae bloom occurred, causing the water to become turbid. Total volatile solid (TVS) concentrations are an indicator of algal growth in the water, and increased near the surface after the aquatic plants died back. The 2001 decrease in water clarity following plant treatments in Antioch Lake followed the same pattern in 1992 and 1993. The seasonal average concentration of TVS, however, was lower in 2001 (130 mg/L) than in 1992 (165 mg/L) and 1993 (236 mg/L).

Algae in Antioch Lake is able to thrive on the large supply of phosphorus, an essential nutrient for growth. During 2001, total phosphorus (TP) concentrations in the near surface sample averaged 0.145 mg/L. The median TP concentration in near surface samples for Lake County lakes is 0.047 mg/L. The TP concentration increased in the water column after the plants died back and the algae bloom occurred. The 2001 seasonal average is higher than the 1992 and 1993 seasonal averages (0.107 mg/L and 0.084 mg/L, respectively). Each year, increases in TP were also noted as the algae blooms began. Another indication of large amounts of phosphorus present in the water is the amount of soluble reactive phosphorus (SRP), available for plant and algae use, found throughout the season. Frequently this phosphorus is non-detectable in water samples since it is in the chemical form most easily taken up by plants and algae. In 2001, both the near surface samples and the deep water samples, SRP was found at detectable levels in each month with the exception of May near the surface. Aquatic plants utilizing the available phosphorus (SRP) likely caused the non-detectable reading in May. Thus, phosphorus concentrations in Antioch Lake are very high and will likely continue in the future. Sources of phosphorus include inputs from the watershed and internal loading from the sediment.

The trophic condition of a lake indicates the overall level of nutrient enrichment. Most lakes in Lake County are eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae and fish. Hypereutrophic lakes are those that have excessive nutrients. Lakes with nuisance algae growth reminiscent of "pea soup" are often labeled hypereutrophic, and usually have poor water clarity. Higher TP concentrations are linked

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<sup>2</sup> This is the median value, or the point at which half of the lake samples have clarity readings less than this value, and the other half have greater values. Median and average values were calculated using results of lakes sampled by the LCHD from 1995 through 2001.

Figure 1.

to more algae in the water and hence, lower water clarity. The condition of Antioch Lake in terms of its phosphorus concentrations during 2001 was hypereutrophic. The trophic status in Antioch Lake during 1992 was also hypereutrophic, and in 1993 was eutrophic, bordering on hypereutrophic. Antioch Lake ranked #84 out of 103 Lake County lakes based on average total phosphorus concentrations (See Table 2 in Appendix A).

Total Kjeldahl nitrogen (TKN) averages of water samples near the surface have also increased since 1992 (0.935 mg/L in 1992, 0.737<sup>k</sup> mg/L<sup>3</sup> in 1993 and 1.536 mg/L in 2001). The Lake County TKN average for near surface samples is 1.266 mg/L. The ratio of total nitrogen to total phosphorus (TN:TP) indicates if the amount of phosphorus or nitrogen would limit algae and/or plant growth in the lake. Lakes with TN:TP ratios of more than 15:1 are usually limited by phosphorus. Those with ratios less than 10:1 are usually limited by nitrogen. In Antioch Lake, the 2001 seasonal TN:TP ratio was 11:1, indicating a lake that is not limited by either nutrient. However, when analyzed on a month-by-month basis, the lake was nitrogen limited in May and August. The TN:TP ratios in 1992 and 1993 were slightly lower, at 10:1 during 1993 and 9:1 in 1992. On a month-by-month basis in 1992 and 1993, the lake was more often nitrogen limited. This explains why SRP concentrations were found at detectable levels in most of the months sampled in all three years, since plants and algae could not utilize the available phosphorus (SRP) without sufficient nitrogen. Most lakes throughout Lake County are phosphorus limited, which is not the case in Antioch Lake.

The dissolved oxygen (DO) concentrations and temperature throughout the water column of Antioch Lake were measured from the surface down to the bottom in one-foot increments. The lake weakly stratified during June (at approximately 7 feet) and July (at approximately 5 feet). The remainder of the season, the water column was able to mix, and did not maintain stratification. Dissolved oxygen concentrations were >1 mg/L from the surface to the bottom during the months of May, June, and September and to six feet deep in July and August. During 1993, the results were similar, with the lake having the least amount of DO in August. At that time, oxygen was > 1 mg/L from the surface down to five feet deep. During 1992, the lake held the least amount of DO in June, when oxygen was > 1 mg/L from the surface down to five feet deep. Without a bathymetric map, the volume of water sufficient to sustain aquatic life cannot be accurately calculated. However, Antioch Lake does not have a documented history of summer fish kills caused by insufficient dissolved oxygen. During May of 2001, staff did note a fish kill that affected only about 100-200 3"-5" sunfish. This was most likely a result of spawning stress or a disease that affected this species and not from a dissolved oxygen loss, which would have affected all fish species.

Another parameter, total suspended solids (TSS), was found in high concentrations in Antioch Lake in 2001. The near surface samples averaged 15.2 mg/L, which is significantly higher than the county median of 5.7 mg/L. Also noteworthy is the increase in TSS from the near surface samples in 1992 and 1993 (8.2 mg/L and 7.5 mg/L, respectively). Due to the lake's shallow nature, wind, wave, and carp action coupled with

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<sup>3</sup> "k" indicates that at least one reading is a value below detection limit, and the actual value is known to be less than the value presented.



the lack of aquatic plants, may resuspend sediment. Observations made by LCHD staff confirm that sedimentation or resuspension is a problem. More information on shoreline erosion can be found in the **Limnological Data – Shoreline Assessment** section and in **Objective V: Shoreline Erosion Control**.

The specific conductance (conductivity) varied little throughout the season, with the near surface average during 2001<sup>4</sup> of 0.7369 milliSiemens/cm, which is very close to the Lake County average of 0.7557 milliSiemens/cm. Total dissolved solids, which directly affect the conductivity readings, averaged 416 mg/L near the surface during 2001, compared to the Lake County average of 452 mg/L. Residents have expressed concern over the amount of road salt entering the lake from various locations around the lake. Road salts can increase total dissolved solids and conductivity readings. Since most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts, we can calculate the concentration of chlorides in each water sample based on conductivity readings. The 2001 calculated seasonal average for chloride in Antioch Lake is 97 mg/L in the epilimnion and 98 mg/L in the hypolimnion. The Illinois Environmental Protection Agency (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. The total road salt loading to this lake could not be determined, but the largest loading point is most likely from the culvert near Illinois Highway 173. At this time, it does not appear that road salt is affecting conditions in Antioch Lake. Concerned residents may still wish to contact state highway officials to discuss the amount of road salt being applied to areas that drain to the lake, such as the area near Illinois Highway 173.

The IEPA has assessment indices to classify Illinois lakes for their ability to support aquatic life, swimming, or recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations and aquatic plant coverage. Antioch Lake fully supports aquatic life according to these guidelines. Antioch Lake is impaired for swimming uses because of the high phosphorus concentrations and low water clarity. This, with its hypereutrophic condition, allows only partial support of swimming uses. The lake was placed in the nonsupport category for recreational uses because of the large plant beds, and high phosphorus concentrations. The overall use support category for Antioch Lake is that of partial support.

During 2001, LCHD staff measured water elevation of the lake each month at the inflow culvert below Illinois highway 173. The water elevation dropped nearly 8 inches from May to the August sampling date. Between the August and September sampling dates, the water elevation increased 3.25 inches. Rain was plentiful in the days before the May sampling date, but was lacking for several days before the June and July sampling dates.<sup>5</sup> Although 0.38 inches of rainfall fell two days prior to the August sampling date, the dry ground absorbed this so little of no runoff reached the lake. During the week before the September sampling date, a total of approximately 3 inches of rain fell. The water elevation increased by about three inches after these rains.

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<sup>4</sup> Conductivity and total dissolved solids were not analyzed in the water samples of 1992 or 1993.

<sup>5</sup> Rainfall data is from the nearest rain gage, which is located in Old Mill Creek, operated by the Lake County Stormwater Management Commission.

## LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Staff randomly sampled locations in Antioch Lake each month for aquatic plants, and identified eight species. Table 3 lists the plants that were identified by their common and scientific names. Table 4 in Appendix A lists the plant species and the frequency that they were found. Before the plants were treated with aquatic herbicides, the two plants found most often were curlyleaf pondweed (found at 93% of sample locations in May) and Eurasian water milfoil (found at 77% of sample locations in May). At this time, plants could be found in heavy beds or scattered across an estimated 96% of the lake bottom. To maintain a healthy fishery, the Illinois Department of Natural Resources (IDNR) suggests that aquatic plants cover approximately 20% to 40% of the lake bottom. On June 7, 2001, 26 gallons of Reward® and 5 gallons of Aquathol K® were used to treat the aquatic plants in both southern bay areas, about 200 feet along the northwest corner of the lake, and in front of 3 to 4 homes scattered along the eastern shoreline. The plants had died back by the June sampling date, except for scattered small beds. Spot treatments were done in these same areas on August 9, 2001, using 1 gallon of Reward® and 1 gallon of Aquathol K®. Plant coverage for the remainder of the season was approximately 12 acres, or 14% of the lake surface. From June through September, Eurasian water milfoil and white water lily were found most often. Some residents are concerned with the spread of white water lilies in the lake. However, the presence of some native beneficial plants, such as water lilies, is important to maintain in the lake since plants aid in sediment stabilization and nutrient utilization. If residents wish to remove some water lilies near piers or to create pathways through lily beds, the use of a 2,4-D product can offer some control over water lilies, and is more specific to these plants than Reward® or Aquathol K®.

**Table 3. Aquatic and shoreline plant species in Antioch Lake, May–September, 2001.**

<u><i>Aquatic Plants</i></u>	
Coontail	<i>Ceratophyllum demersum</i>
Chara	<i>Chara</i>
Duckweed	<i>Lemna spp.</i>
Eurasian Water Milfoil	<i>Myriophyllum spicatum</i>
Curlyleaf Pondweed	<i>Potamogeton crispus</i>
Flatstem Pondweed	<i>Potamogeton zosteriformis</i>
Sago Pondweed	<i>Stuckinia pectinatus</i>
White Water Lily	<i>Nymphaea tuberosa</i>
 <u><i>Shoreline Plants</i></u>	
Teasel	<i>Dipsacus sylvestris</i>
Honeysuckle	<i>Lonicera ssp.</i>
Purple Loosestrife	<i>Lythrum salicaria</i>
Reed Canary Grass	<i>Phalaris arundinacea</i>
Buckthorn	<i>Rhamnus spp.</i>

Aquatic plants will not photosynthesize in water depths with less than 1% of the available sunlight. 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 the case of Antioch Lake, the 1% light level reached the bottom during May and July of 2001, hence the high percentage of plant growth to the surface before the aquatic herbicide treatment. Plants were found at the maximum lake depth (9.0 feet) in May. The 1% light level was down to six feet deep in June and August, but the June sampling date was after the initial aquatic herbicide treatment (hence fewer plants), and the August sampling date was after the normal life span of curlyleaf pondweed. Plants were found at a maximum depth of 5.2 feet in June and July, and 5.3 feet in August. The 1% light level was at four feet deep in September, with plants being found at a maximum depth of 5.0 feet.

Floristic quality index 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 floristic quality index (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 64 lakes measured in 2000 and 2001 ranges from 0 to 37.2, with an average of 14. Antioch Lake has a floristic quality of 11.3, indicating a lower than average aquatic plant diversity, based on the 64 lakes measured.

## **LIMNOLOGICAL DATA – SHORELINE ASSESSMENT**

In August 2001, LCHD staff assessed the shoreline of Antioch Lake. See Appendix B for a discussion of the methods used, and Figure 2 for a shoreline type map. The two most common types of shoreline are woodland (nearly 25% of the entire shoreline), and lawn (21%). Approximately 73% of the shoreline surrounding the lake is developed. This includes 2670 feet of mowed turfgrass (21%), 2169 feet of riprap (17%), 1007 feet of seawall (8%), and 1009 feet of unmowed buffer areas (8%). The 3523 feet (27%) of undeveloped shoreline offers good wildlife habitat such as fallen trees (deadfall) and shrubby areas.

Over half of the shoreline (53%; 6884 feet) is eroding in some degree (See Figure 3). Approximately 26% or 3433 feet of the shoreline is slightly eroding, 11% or 1440 feet is moderately eroding, and nearly 16% or 2011 feet is severely eroding. Most of the erosion occurs along shorelines with manicured lawns (28% of the eroding shoreline) or shrubs (14% of the eroding shoreline). However, these shorelines are either slightly or moderately eroding. The severely eroding shorelines are all classified as woodland or shrub. These shorelines will continue to erode as a result of wind induced wave action if

Figure 2

Figure 3

Figure 4

protective measures are not taken. This can add sediment to the water and result in a loss of shoreline property.

Throughout the 2001 season, staff noticed the southwestern bay was more turbid than the remainder of the lake. This area may be more turbid due to either carp activity, sediment coming in from the inlet, or a combination of the two. The inlet stream drains an area comprised primarily of residential homes. Upon field inspection some bank erosion along the stream was seen. Invasive exotic plant species such as buckthorn and honeysuckle also dominated this area. Rehabilitating the streambank may help alleviate sediment entering the lake. In September, staff noted silt-laden plumes in the water along the northeastern shoreline where severe erosion had been identified, indicating the input of silt from the eroding banks. Immediate action on the severely eroded areas is recommended. The issue of sediment flowing into Antioch Lake has been identified as a primary concern among the Friends of Antioch group.

In 1992, the Lake County Soil and Water Conservation District (LCSWCD) assessed the shoreline around Lake Antioch for the 319 Sequoit Creek Watershed Management Project. Similar to the LCHD shoreline assessment, eroding shorelines were classified as “slight”, “moderate” or “severe” along several locations. LCSWCD staff also made notations such as shoreline type. Comments were similar to the LCHD notations, but in addition, mentioned that erosion along the northern and western shorelines were not only a function of steep slopes and little vegetation, but also of soil type. LCSWCD also observed two eroding sites adjacent to the lake with severe downcutting of the channels. One is just beyond the outlet of the lake into the receiving channel, and the other is the inlet north of State Route 173 that discharges into the lake. Erosion control alternatives can be found in **Option V: Shoreline Erosion Control**.

Staff also noted the presence of invasive, aggressive plant species, the majority of which were located along the western and northeastern shorelines (Figure 4). Two were shrub species - buckthorn and honeysuckle, and two were herbaceous plants – purple loosestrife and teasel. In addition, reed canary grass was dominant along the inlet stream. These aggressive plants can crowd out native, beneficial plants. The removal of these species is recommended. Alternatives for their removal can be found within **Objective IV: Eliminate or Control Exotic Species**. Some of the shoreline on which the buckthorn and honeysuckle grow is steep and eroding. If these shrubs are removed, a plan needs to be in place to address shoreline protection. If possible, the shoreline should be planted as soon as the buckthorn and honeysuckle are removed.

## LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Good numbers of wildlife, particularly birds, were noted on and around Antioch Lake. 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.

One bird, the pied-billed grebe, is listed as a threatened species in the state of Illinois and was seen in April. It is likely this bird was migrating through the area and was not a summer resident.

Decent habitat exists along the western shoreline of the lake. This area is relatively undeveloped and consists of woodland and shrub habitat and includes numerous deadfalls. Many of the birds noted in Table 5 were heard or observed along this shoreline. Poor habitat exists along much of the remainder of Antioch Lake's shoreline. This is due mostly to the presence of manicured lawns, riprap and seawalls. This habitat is preferred by Canada Geese, which were found in large numbers throughout the 2001 season. The feces of these birds is very high in organic phosphorus and likely contributes large amounts of this nutrient into the lake. Options to control geese can be found in **Objective VII: Canada Geese Control**.

One near complete fishkill has been recorded in the winter 1958-59. The lake was restocked in 1960. LCHD did not conduct any fish inventories in 2001.

**Table 5. Wildlife species observed on Antioch Lake, May – September, 2001.**

Birds

Pied-billed Grebe+	<i>Podilymbus podiceps</i>
Mute Swan	<i>Cygnus olor</i>
Canada Goose	<i>Branta canadensis</i>
Mallard	<i>Anas platyrhynchos</i>
Ring-billed Gull	<i>Larus delawarensis</i>
Great Blue Heron	<i>Ardea herodias</i>
Green Heron	<i>Butorides striatus</i>
Spotted Sandpiper	<i>Actitis macularia</i>
Broad-winged Hawk	<i>Buteo platypterus</i>
Mourning Dove	<i>Zenaida macroura</i>
Belted Kingfisher	<i>Megaceryle alcyon</i>
Great Crested Flycatcher	<i>Myiarchus crinitus</i>
Barn Swallow	<i>Hirundo rustica</i>
Tree Swallow	<i>Iridoprocne bicolor</i>
Chimney Swift	<i>Chaetura pelagica</i>
American Crow	<i>Corvus brachyrhynchos</i>
Blue Jay	<i>Cyanocitta cristata</i>
Black-capped Chickadee	<i>Poecile atricapillus</i>
House Wren	<i>Troglodytes aedon</i>
Catbird	<i>Dumetella carolinensis</i>
American Robin	<i>Turdus migratorius</i>
Cedar Waxwing	<i>Bombcilla cedrorum</i>
Red-eyed Vireo	<i>Vireo olivaceus</i>



**Table 5. Wildlife species observed on Antioch Lake, May – September 2001 (cont'd).**

Warbling Vireo	<i>Vireo gilvus</i>
Yellow Warbler	<i>Dendroica petechia</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Common Grackle	<i>Quiscalus quiscula</i>
Starling	<i>Sturnus vulgaris</i>
House Sparrow	<i>Passer domesticus</i>
Northern Cardinal	<i>Cardinalis cardinalis</i>
House Finch	<i>Carpodacus mexicanus</i>
American Goldfinch	<i>Carduelis tristis</i>
Indigo Bunting	<i>Passerina cyanea</i>
Song Sparrow	<i>Melospiza melodia</i>

Mammals

Muskrat	<i>Ondatra zibethicus</i>
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Amphibians

None noted.

Reptiles

Painted Turtle	<i>Chrysemys picta</i>
Snapping Turtle	<i>Chelydra serpentina</i>

Insects

Cicadas  
Dragonfly  
Damselfly

\* **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 in effective lake management since it provides information on the morphometric features of the lake, such as depth, surface area, volume, etc. The knowledge of this morphometric information would be necessary if lake management practices such as aquatic herbicide use, fish stocking, dredging, an alum treatment or aeration were part of the overall lake management plan. Antioch Lake does not have a recent bathymetric map. The one created in 1974 is outdated. Maps can be created by the Lake County Health Department – Lakes Management Unit or other agencies for costs that vary from \$3,000-\$10,000, depending on lake size.

- *Lack of Historical Data*

Limited historical water quality data for Antioch Lake exists. Participation in the Illinois Volunteer Lake Monitoring Program is recommended. This program will train and assist volunteers in collecting important information on the lake which will benefit the management of the lake by providing long-term trend analysis as well as educating the volunteers and residents around the lake.

- *Excessive Aquatic Vegetation*

The most prolific plants found in Antioch Lake are curlyleaf pondweed, Eurasian water milfoil and white water lily. Before the use of aquatic herbicides, plants could be found in heavy beds or scattered across an estimated 96% of the lake surface. The shallow nature of this lake allows aquatic plants to grow across much of the surface. After the use of aquatic herbicides, the plant coverage was estimated at 14% of the lake surface. To maintain a healthy fishery, the Illinois Department of Natural Resources suggests that aquatic plants cover approximately 20% to 40% of the lake's surface area.

- *High Nutrient and Total Suspended Solid Concentrations*

Antioch Lake has total phosphorus and total suspended solid concentrations nearly three times higher than the Lake County medians. High concentrations of total Kjeldahl nitrogen were also found. Sources of these nutrients include inputs from the watershed and internal loading from the sediment. High nutrient levels caused large algae blooms in the lake during 2001.

- *Excessive Algae Blooms*

After the aquatic plants die back from the yearly herbicide treatment, the lake experiences a severe algae bloom, causing poor water clarity. The excessive concentration of phosphorus in this lake system supports the large algal growth and the lack of competition from plants.

- *Poor Water Clarity*

Antioch Lake has poor water clarity due to algal growth and sediment suspended in the water. The water clarity decreased after the herbicide treatments. The shallow nature and fetch of this lake lends itself to sediment resuspension from the bottom by wind, wave and carp action.

- *Shoreline Erosion*

Over half of the shoreline is eroding in some degree. Most of the erosion occurs along shorelines with manicured lawns or shrubs. However, these shorelines are either slightly or moderately eroding. The severely eroding shorelines are all classified as woodland and shrub. These shorelines will continue to erode as a result of wind induced wave action and fluctuating water levels if protective measures are not taken. This can add sediment to the water and result in a loss of shoreline property. Immediate action is recommended on the severe eroded areas.

The inlet stream, which enters at the southwestern corner of the lake, may be contributing sediment to the bay. The streambank is eroding in several locations and the plants along the bank are mostly invasive exotic species. Rehabilitating the streambank may help alleviate sediment entering the lake.

- *Invasive Shoreline Plant Species*

LCHD staff noted the presence of aggressive exotic plant species along the western and northeastern shorelines. Two were shrub species - buckthorn and honeysuckle, and two were herbaceous plants – purple loosestrife and teasel. These aggressive plants can crowd out native, beneficial plants. They should be removed and replanted with native species.

- *Canada Geese*

Canada geese were noted in significant numbers throughout the season. Their favorite type of habitat is one with short plants such as the manicured lawns along 21% of the lakeshore. Their abundant feces add more phosphorus to the lake, and create nuisance situations on lawns.

- *Carp*

Excessive numbers of carp are present in Antioch Lake. Carp activity likely contributes to many of the water quality problems in the lake, particularly by resuspending bottom sediment. Total elimination of carp may help improve water quality.

## **POTENTIAL OBJECTIVES FOR ANTIOCH LAKE MANAGEMENT PLAN**

- I. Bathymetric Map
- II. Illinois Volunteer Lake Monitoring Program
- III. Aquatic Plant Management Options
- IV. Nuisance Algae Management Options
- V. Shoreline Erosion Control
- VI. Eliminate or Control Exotic Species
- VII. Canada Geese Control
- VIII. Controlling Excessive Number of Carp
- IX. Enhance Wildlife Habitat Conditions

## **OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES**

### **Objective I: 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., 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. Currently, only an old bathymetric map of Antioch Lake exists.

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: Illinois 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, 150-200 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 250 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 the 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, two 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.

For more information about the VLMP contact the VLMP Regional Coordinator:

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

### **Objective III: Aquatic Plant Management Options**

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

#### **Option 1: No Action**

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

#### ***Pros***

There are positive aspects associated with the no action option for plant management. The first, and most obvious, is that there is no cost. However, if an active management plan for vegetation control were eventually needed, the cost would be substantially higher than if the no action plan had not been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, no chemicals, mechanical alteration, or introduction of any organisms would take place. This is important since studies have shown that nuisance plants are more likely to invade disrupted areas. If the



lake contains native, non-invasive plant species, expansion of the native plant population would increase the overall biodiversity and health of the lake. Habitat, breeding areas, and food source availability would greatly improve. Use of the lake would continue as normal and in some cases might improve (fishing) if native plants keep “weedy” plants under control.

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

### ***Cons***

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

Water quality could also be negatively impacted with the implementation of the no action option. Deposition of large amounts of organic matter and release of nutrients upon the death of the massive stands of vegetation is a probable outcome of the no action option. These dead plants will contribute to the sediment load of the lake and could accelerate its filling in. The large nutrient release when the plants die back in the fall could lead to lake-wide algae blooms and an overall increase of the internal nutrient load. In addition, the decomposition of the massive amounts of vegetation will lead to a depletion of the lakes dissolved oxygen. This can cause fish stress, and eventually, if the stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake’s ecosystem.

In addition to the ecological impacts, many physical uses of the lake will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick stands of plants. Swimming could also become increasingly difficult due to thick vegetation that would develop at beaches. Fishing could

become more and more exasperating due in part to the thick vegetation and also because of stunted fish population. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by tangled mats of vegetation and the odors that will develop when they decay. The combination of the above events could cause property values on the lake to suffer. Property values on lakes with weedy plant/algae problems have been shown to decrease by as much as 15-20%.

### **Costs**

No cost will be incurred by implementing the no action management option. However, if in the future a management plan was initiated, costs might be significantly higher since a no action plan was originally followed.

### **Option 2: Aquatic Herbicides**

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

There are two groups of herbicides: contact and systemic. Contact herbicides, like their name indicates, kill on contact. These herbicides affect only the above ground portion of the plant that they come into contact with and therefore do not kill the root system. An example of a contact herbicide is diquat. Systemic herbicides are taken up by the plant and disrupt cellular processes, which in turn cause plant death. These herbicides kill both the above ground portions of the plant as well as the root system. An example of a systemic herbicide is fluridone. Both types of herbicides are available in liquid or granular forms. Liquid forms are concentrated and need to be mixed into water to obtain the desired concentration. The solution is then sprayed on the water's surface or injected into the water in the treatment areas. Granular herbicides are broadcast in a known rate over the treatment area where they sink to the bottom. Some granular products slowly release the herbicide, which is then taken up by the plant. These are referred to as SRP formulations (Slow Release Pellet). Other granular herbicides come in crystal form and dissolve as they come in contact with water. This is typical of herbicides such as copper sulfate. Many herbicides come in both liquid and granular forms to fit the management needs of the lake. Herbicide applications can either be done as whole lake treatments or as more selective spot treatments. Multiple herbicides are often mixed and applied together. This is called a tank mix. This is done to save time, energy, and cost.

Aquatic herbicides are best used on actively growing plants to ensure optimal herbicide uptake. For this reason, herbicides are normally applied mid to late spring when water temperatures are above 60°F. This is the time of year when the plants are most actively

growing and before seed/vegetative propagule formation. Follow up applications should be done as needed. When choosing an aquatic herbicide it is important to know what plants are present, which ones are problematic, which plants are beneficial, and how a particular herbicide will act upon these plants. The herbicide label is very important and should always be read before use. There may be more than one herbicide for a given plant. As with other management options, proper usage is the key to their effectiveness, benefits, and disadvantages.

In Antioch Lake, an aquatic plant management plan is needed since the aquatic plant communities have the potential to cover 100% of the lake bottom. Treatments should occur early in the spring (April or May). If herbicides are used in Antioch Lake, systemic herbicides like 2,4-D granular (Aquacide®, Aqua-Kleen®, Navigate®, or Weedar 64®) or fluridone (Sonar™ or Avast™) could be used. The herbicide 2,4-D may be more selective than fluridone and is effective on dicots such as EWM and white water lily, which are common in Antioch Lake, but will not normally affect the curlyleaf pondweed.

### ***Pros***

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

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

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

### *Cons*

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

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

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

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

### ***Costs***

Granular 2,4-D spot treatment cost approximately \$350-425/surface acre. Fluridone is applied based on the volume of the lake (acre-feet [AF]). A current bathymetric map should be used to accurately calculate this value. The cost for fluridone is approximately \$9.75/AF at a concentration of 8 part per billion (ppb) and \$11.75/AF at 10 ppb.

### **Option 3: Hand Removal**

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

This technique could be used in Antioch Lake to eliminate small patches of nuisance vegetation, such as around piers or beaches.

### ***Pros***

Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. Hand removal is an activity in which all lake residents could participate. The work involved in removing plants can provide a rewarding sense of accomplishment. By removing excess vegetation, use of beaches and piers would be improved. Many of the improved water quality benefits of a well-executed herbicide program or harvesting program are also shared by hand removal. Wildlife habitat, such as fish spawning beds, could be greatly improved. This in turn would benefit other portions of the lake's ecosystem.

### ***Cons***

There are few negative attributes to hand removal. One negative implication is labor. Depending on the extent of infestation, removal of large amount, of vegetation can be quite tiresome. Another drawback can be disposal. Finding a site for numerous residents to dispose of large quantities of harvested vegetation can sometimes be problematic. However, individual homeowners would be removing limited quantities of plant material so there would not be much to dispose of. Another drawback is possible nonselective removal by hand harvesting. By throwing a rake blindly into the depths, it is impossible to determine what plants are removed and which ones are not until the rake is pulled up. Even in shallow depths, untrained persons might mistakenly remove desirable

vegetation and/or disrupt valuable habitat (fish spawning beds). Over removal could also be a problem but is not normally a concern with hand removal.

### ***Costs***

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

## **Option 4: Reestablishing Native Aquatic Vegetation**

This option is strongly recommended for Antioch Lake.

Revegetation should only be done when existing nuisance vegetation, such as Eurasian water milfoil, are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. Without adequate light penetration, revegetation will not work. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake are allowed to naturally expand into adjacent areas thereby filling the niche left by the nuisance plants. Another technique utilizing existing plants is to transplant vegetation from one area to another. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 6 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

In Antioch Lake, native emergent plants could be planted along the shoreline, particularly along the areas where erosion is occurring. Submersed aquatic plants could be planted as well, however, success will be somewhat dependent on water clarity. If water clarity can be improved, submersed plants will have a higher chance of success.

### ***Pros***

By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. Once established, expanded native plant populations will help to control growth of nuisance vegetation. This

provides a more natural approach as compared to other management options. In addition, using established native plants to control excessive invasive plant growth can be less expensive in the long run than other options. Expanded native plant populations will also help with sediment stabilization. This in turn will have a positive effect on water clarity by reducing suspended solids and nutrients that decrease clarity and cause excessive algal growth. Properly revegetating shallow water areas with plants such as cattails, bulrushes, and water lilies can help reduce wave action that can lead to shoreline erosion. Increases in desirable vegetation will increase the plant biodiversity and also provide better quality habitat and food sources for fish and other wildlife. Recreational uses of the lake such as fishing and boating will also increase due to the improvement in water quality and the suppression of weedy species.

### ***Cons***

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

### ***Costs***

See Table 6 for plant pricing. Additional costs will be incurred if a consultant/nursery is contracted for design and labor.

## **Option IV: Nuisance Algae Management Options**

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

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

### **Option 1: No Action**

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



blooms can spread to cover 100% of the surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

### ***Pros***

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

### ***Cons***

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

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

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

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

### *Costs*

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

### **Option 2: Algicides**

Algicides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate (CuSO<sub>4</sub>) and chelated copper products are the two main algicides in use. These two compounds are sold by a variety of brand names by a number of different companies. They all work the same and act as contact killers. This means that the product has to come into contact with the algae to be effective. Algicides come in two forms, granular and liquid. Granular herbicides are spread by hand or machine over an effected area. They can also be placed in a porous bag (such as a burlap sack) and dragged though the water in order to dissolve and disperse the product. Granular algicides are mainly used on filamentous algae where they are spread over the mats. As the granules dissolve, they kill the algae. Liquid algicides, which are much more widely used, are mixed with a known amount of water to achieve a known concentration. The mixture is then sprayed onto/into the water. Liquid algicides are used on both filamentous and planktonic algae. Liquid algaecides are often mixed with herbicides and applied together to save on time and money. The effectiveness of some herbicides are enhanced when mixed with an algicide. When applying an algicide it is imperative that the label is completely read and followed. If too much of the lake is treated at any one time an oxygen crash may occur. This may cause fish kills due to decomposition of treated algae. Additionally, treatments should never be made when blooms/mats are at their fullest extent. It is best to divide the lake into at least two sections depending on the size of the lake. Larger lakes will need to be divided into more sections. Then treat the lake one section at a time allowing at least two weeks between treatments. Furthermore, application of algicides should never be done in extremely hot weather (>90°F) or when D.O. concentrations are low. This will help lessen the likelihood of an oxygen crash and resulting fish kills. When possible, treatments should be made as early in the season as possible when temperature and D.O. concentrations are adequate. It is best to treat in spring or when the blooms/mats starts to appear there by killing the algae before they become a problem.

### *Pros*

When used properly, algicides can be a powerful tool in management of nuisance algae growth. A properly implemented plan can often provide season long control with minimal applications. Another benefit of using algicides are their low costs. The fisheries and waterfowl populations of the lake would greatly benefit due to a decrease in nuisance algal blooms. By reducing the algae, clarity would increase. This in turn would allow the native aquatic plants to return to the

lake. Newly established stands of plants would improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed (*Potamogeton amplifolius*) and sago pondweed (*Potamogeton pectinatus*). Additionally, copper products, at proper dosages, are selective in the sense that they do not affect aquatic vascular plants and wildlife.

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

### ***Cons***

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

### ***Costs***

To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's aquatic plant management plan. Chelated copper products costs about \$35-45 per gallon. Treatment applications vary but generally are recommended at 1-5 gallons per acre foot, depending on the product.

### **Option 3: Alum Treatment**

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum does not directly kill algae as copper sulfate does. Instead, alum binds phosphorus making it unavailable, thus reducing algal growth. Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom. This floc layer can then prevent sediment bound phosphorus from entering the water column. Phosphorus inactivation using alum

has been in use for 25 years. However, cost and sometimes unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds and small lakes, and its use in larger lakes is increasing. Alum treatment typically lasts 1 to 20 years depending on various parameters. Lakes with low mean depth to surface area ratio are good candidates. This encompasses many lakes within Lake County. Lakes that are thermally stratified experience longer inactivation than non-stratified lakes due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited. Alum treatments must be carefully planned and carried out by an experienced professional. If not properly done, there may be many detrimental side effects.

### ***Pros***

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

### ***Cons***

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

*Costs*

Morphometric data is required to make proper calculations. However, based on the estimated volume of Antioch Lake (400 acre-feet) an alum treatment would cost approximately \$62,300 – 106,800.

**Option 4: Revegetation With Native Aquatic Plants**

This option is identical to Option 4 in **Objective III: Aquatic Plant Management Options**.

## **Objective V: 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 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 Steel or Vinyl Seawall**

Seawalls are designed to prevent shoreline erosion on lakes in a similar manner they are used along coastlines to prevent beach erosion or harbor siltation. Today, seawalls are generally constructed of steel, although in the past seawalls were made of concrete or wood (frequently old railroad ties). Concrete seawalls cracked or were undercut by wave

action requiring routine maintenance. Wooden seawalls made of old railroad ties are not used anymore since the chemicals that made the ties rot-resistant could be harmful to aquatic organisms. A new type of construction material being used is vinyl or PVC. Vinyl seawalls are constructed of a lighter, more flexible material as compared to steel. Also, vinyl seawalls will not rust over time as steel will.

### ***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 \$65-80 per linear foot for steel and \$70-100 per linear foot for vinyl. A licensed contractor installs both types of seawall. On Antioch Lake to install a seawall along the moderately eroded shorelines (1440 feet) would cost \$93,600 – 115,200 for steel and approximately \$100,800 – 144,000 for vinyl. For the severely eroded areas (2011 feet), a steel seawall would cost approximately \$130,715 – 160,880 and a vinyl seawall would cost approximately \$140,770 – 201,100. Additional costs may occur if the shoreline needs to be graded and backfilled, has a steep slope, or poor accessibility. Price does not include the necessary permits required. Additional costs will be incurred if compensatory storage is needed. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained. For seawalls, a site development permit and a building permit are needed. Costs for permits and surveys can be \$1,000-2,000 for installation of a seawall. Contact the Army Corps of Engineers, local municipality, or the Lake County Planning and Development Department.

### **Option 3: Install Rock Rip-Rap or Gabions**

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

### ***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 \$30-45 per linear foot. Costs for gabions are approximately \$20-30 per linear foot, and approximately \$60-100 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. On Antioch Lake, the approximate costs to install rip-rap along the moderately eroded shorelines (1440 feet) would be \$43,200 – 64,800, and for the severely eroded shoreline (2011 feet) approximately \$60,330 – 90,495. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be \$1,000-2,000 for installation of rip-rap or gabions, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

### **Option 4: Create a Buffer Strip**

Another effective method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat. Cost of creating a buffer strip is quite variable, depending on the current

state of the vegetation and shoreline and whether vegetation is allowed to become established naturally or if the area needs to be graded and replanted. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Non-native plants or noxious weedy species may be present and should be controlled or eliminated.

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

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

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

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

On Antioch Lake, the installation of buffer strips is strongly recommended. The areas that are currently lawn, rip-rap and even seawall would benefit from a buffer strip. When possible emergent plants could be incorporated at the land/water interface.

### ***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 overwintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Many species of amphibians, birds, fish, mammals, reptiles, and invertebrates have

suffered precipitous declines in recent years primarily due to habitat loss. Buffer strips may help many of these species and preserve the important diversity of life in and around lakes.

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

### ***Cons***

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

### ***Costs***

If minimal amount of site preparation is needed, costs can be approximately \$10 per linear foot, plus labor. Cost of installing willow posts is approximately \$15-20 per linear foot. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as \$1,000-2,000 depending on the types of permits needed.

## **Option 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 \$40-75 per linear foot, but does not include permits and surveys, which can cost \$1,000-2,000 and must be obtained prior to any work implementation. Additional costs will be incurred if compensatory storage is needed. For Antioch Lake, the estimated costs for installation would be \$57,600 – 108,000 for the moderately eroded shoreline (1440 feet) and \$80,440 – 150,825 for the severely eroded shoreline (2011 feet).

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

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

### ***Pros***

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

### ***Cons***

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

### ***Costs***

Costs range from \$25 to \$35 per linear foot of shoreline, including plantings. This does not include the necessary permits and surveys, which may cost \$1,000 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.

## **Objective VI: 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 and is quick to become established on disturbed soils. Reed canary grass is an aggressive plant that if left unchecked will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Alliaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

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

### **Option 1: No Action**

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

#### ***Pros***

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary

grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics when possible. 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 effected.

### ***Costs***

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

## **Option 2: 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 beetles (*Galerucella pusilla* and *G. californiensis*) and two weevils (*Hylobius transversovittatus* and *Nanophyes marmoratus*) have offered some hope to control purple loosestrife by natural means. These insects feed on either the leaves or juices of purple loosestrife, eventually weakening or killing the plant. In large stands of loosestrife, the beetles and weevils naturally reproduce and in many locations, significantly retard 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 (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 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 (607-255-2821) sells overwintering adult beetles (which will lay eggs the year of release) for \$2 per beetle and new generation beetles (which will lay eggs beginning the following year) at \$0.25 per beetle. Some beetles may be available for free by contacting the Illinois Natural History Survey (217-333-6846).

### **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. Many exotic species, such as purple loosestrife, buckthorn, and garlic mustard are proficient at colonizing disturbed sites.

Around Antioch Lake, this option may only be practical for small areas of infestation such as small patches of purple loosestrife, honeysuckle, or buckthorn. Most of the western and northeastern shorelines consist of extensive stands of exotic plants and may be best removed by another technique.



### ***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 unpractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option due to the fact that in order to chemically treat the area a broadcast application would be needed. Since many of the herbicides that are used are not selective, meaning they kill all plants they contact; this may be unacceptable if native plants are found in the proposed treatment area.

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

### ***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™), cost approximately \$100 and \$65 per gallon, 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.

## **Objective VII: Canada Geese (*Branta canadensis*) Control**

Canada geese are migratory waterfowl common throughout North America. Geese in urban areas can be undesirable primarily due to the large amount of feces they leave behind. Recreational activities on lawns and parks are impeded due to goose feces. Large amounts of feces may end up in the water, either directly from geese on the water or rainwater runoff from lawns where feces have accumulated. Goose feces is high in organic phosphorus. High nutrient levels, particularly phosphorus, can contribute to excessive algae growth in lakes. This may inhibit other recreational activities such as boating or swimming, as well as create poor habitat for fish and wildlife, and possibly bad odors when the algae decays.

Geese become problematic for many reasons. They seek locations that have open water, adequate food supplies, and safety from predators. If these factors are present, geese may not migrate. Since geese exhibit a high level of site fidelity, they return to (or stay at) the same area each year. Thus, adults will likely come back to the same area year after year to nest. If conditions remain optimal, one pair of geese can quickly multiply causing additional problems. Increased development in Lake County has inadvertently created ideal habitat for goose populations. Manicured lawns mowed to the edge of lakes and detention ponds provide geese with open areas with ample food and security. Other conditions that encourage goose residency include open water during winter (primarily the result of aerators in lakes and ponds), mild winters, and people feeding birds with bread or similar human food.

Large populations of geese pose a potential disease threat both to resident and wild populations of waterfowl. This problem may be more serious in residential populations since these birds stay in one area for long periods of time are more likely to transmit any disease to neighboring groups of geese. There is no threat of disease transmission to humans or domestic dogs and cats since most of the diseases are specific to birds.

### **Option 1: No Action**

#### ***Pros***

This option has no costs, however, increasing numbers of geese will most likely exacerbate existing problems and probably create new ones, which in the future may cost more than if the problems are addressed immediately.

#### ***Cons***

If current conditions continue and no action is taken, numbers of Canada Geese and problems associated with them will likely increase. An increase of goose feces washed into a lake will increase the lake's nutrient load and eventually may have a detrimental impact on water quality through excessive algae growth. One study (Manny et al. 1975) documented that each goose excretes 0.072 lbs of feces per day. This may not seem like a significant amount, but if 100 geese are present (many lakes in the county can experience 1,000 or more at a time) that equates to over 7 lbs of feces per day! Algae blooms may negatively impact recreational

uses such as swimming, boating, and fishing. In addition, when algae dies, odor problems and depleted oxygen levels in the water occur. Increased numbers of geese may also result in overgrazed areas of grass.

### ***Costs***

There are a few short-term financial costs with this option. Costs of cleaning feces off lawns or piers are probably more psychological or physical than financial. Long-term costs may be more indirect, including increased nutrient deposition into lakes which may promote excessive algae and plants. Costs incurred may include money needed to control algae with algaecides.

### **Option 2: Removal**

Since Canada Geese are considered migratory waterfowl, both state and federal laws restrict taking or harassing geese. Under the federal Migratory Bird Treaty Act, it is illegal to kill or capture geese outside a legal hunting season or to harass their nests without a permit. If removal of problematic geese is warranted or if nest and egg destruction is an option, permits need to be obtained from the Illinois Department of Natural Resources (217- 782-6384) and the U.S. Fish and Wildlife Service (217-241-6700).

Hunting is one of the most effective techniques used in goose management. However, since many municipalities have ordinances prohibiting the discharge of firearms, reduction of goose numbers by hunting in urban areas (i.e., lakes, ponds, and parks) may not be an option. Hunting does occur on many lakes in the county, but certain regulations apply (e.g., 100 yard minimum distance from any residential property). Contact the Illinois Department of Natural Resources for dates and regulations regarding the waterfowl hunting seasons. Also, contact local and county law enforcement agencies regarding any ordinances concerning hunting within municipal boundaries.

Egg addling, or destroying the egg by shaking, piercing, or freezing, can be used to reduce or eliminate a successful clutch. Eggs should be returned to the nest so the hen goose does not re-lay another clutch. However, if no eggs hatch, she may still lay another clutch. Leaving one or two eggs unaltered and allowing them to hatch may prevent another clutch from being laid and reduces the total year's reproduction. Egg addling requires a state and federal permit.

The capture and relocation of geese is no longer a desirable option. First, relocated geese may return to the same location where they were captured. Second, there is a concern over potential disease transmission from relocated geese to other goose populations. Finally, since goose numbers in Illinois are already high there is no need to supplement other populations in the area.

### ***Pros***

Removing a significant portion of a problem goose population can have a positive effect on the overall health of a lake. Reduction of feces on lawns and parks is beneficial to recreation users of all types. Less feces in the water means less

phosphorus available for nuisance plant and algae growth. Thus, the overall water quality of the lake may be improved by this reduction in phosphorus.

### ***Cons***

If the habitat conditions still exist, more geese will likely replace any that were removed. Thus, money and time used removing geese may not be well spent unless there is a change in habitat conditions.

### ***Costs***

A Illinois residential waterfowl hunting license (including state and federal waterfowl stamps) is \$39.00 for the 2001-2002 hunting season. For depredation permits, there is a \$25 fee for the federal permit. Once the federal permit is issued the state permit can be obtained at no charge.

## **Option 3: Dispersal/Repellent Techniques**

Several techniques and products are on the market that claim to disperse or deter geese from using an area. These techniques can be divided into two categories: harassment and chemical. With both types of techniques it is important to implement any action early in the season, before geese establish territories and begin nesting. Once established, the dispersal/repellent techniques may be less effective and geese more difficult to coerce into leaving.

The goal with harassment techniques is to frighten geese from an area using sounds or objects. Various products are available that simulate natural predators (i.e., plastic hawks and owls) or otherwise make geese nervous (i.e., balloons, shiny tape, and flags). Other products emit noises, such as propane cannons, which can be set on a timer to go off at programmed intervals (e.g., every 20-30 seconds), or recorded goose distress calls which can be played back over a loudspeaker or tape player. Over time these techniques may be ineffective, since geese become acclimated to these devices. Most of these products are more effective when used in combination with other techniques.

Another technique that has become popular is using dogs or swans to harass geese. Dogs can be used primarily in the spring and fall to keep birds from using an area by herding or chasing geese away from a particular area. Any dogs used for this purpose should be well trained and under the owners control at all times. Professional trainers can be contracted to use their dogs for this purpose. Dogs should not be used during the summer when geese are unable to fly due to molting. Swans are used because they are naturally aggressive in defending their territory, including chasing other waterfowl away from their nesting area. Since wild swans cannot be used for this technique, non-native mute swans are used. However, mute swans are not as aggressive and in some case are permissive of geese. Again, using a combination of techniques would be most effective.

Chemical repellents can be used with some effectiveness. New products are continually coming out that claim to rid an area of nuisance geese. Several products (ReJeX-iT® and GooseChase™) are made from methyl-anthranilate, a natural occurring compound, and can be sprayed on areas where geese are feeding. The spray makes the grass distasteful

and forces geese to move elsewhere to feed. Another product, Flight Control™, works similarly, but has the additional benefit of absorbing ultra violet light making the grass appear as if it was not a food source. The sprays need to be reapplied every 14-30 days, depending upon weather conditions and mowing frequency.

### ***Pros***

With persistence, harassment and/or use of repellants can result in reduced or minimal usage of an area by geese. Fewer geese may mean less feces and cleaner yards and parks, which may increase recreational uses along shorelines. If large numbers of geese were once present, the reduction of fecal deposits into the lake may help minimize the amount of phosphorus entering the water. Less phosphorus in the water means less “food” available for plant and algae growth, which may have a positive effect of water quality. Finally, any areas overgrazed by geese may have a chance to recover.

### ***Cons***

The effectiveness of harassment techniques is reduced over time since geese will adapt to the devices. However, their effectiveness can be extended if the devices are moved to different locations periodically, or used in conjunction with other techniques.

Use of dogs can be time consuming, since the dog must be trained and taken care of. Dogs must also be used frequently in the beginning of the season to be effective at deterring geese. This requires time of the dog owner as well. Dogs (frequently herding dogs, like border collies) that are effective at harassing or herding geese are typically may not be the best pests for the average homeowner. They are bred as working dogs and consequently have high levels of energy that requires the owner’s attention.

Repelling or chasing away geese from an area only solves the goose problem for that area and most likely moves the geese (and the problem) to another area. As long as there is suitable habitat nearby, the geese will not wander very far.

### ***Costs***

Costs for the propane cannons are approximately \$660 (\$360 for the cannon, \$300 for a timer), not including the propane tank. The cost of ReJeX-iT® is \$70/gallon, GooseChase™ is \$92/gallon, and Flight Control™ costs \$200/gallon. One gallon covers one acre of turf using ReJeX-iT® and, GooseChase™, and two acres using Flight Control™.

## **Option 4: Exclusion**

Erecting a barrier to exclude geese is another option. In addition to a traditional wood or wire fence, an effective exclusion control is to suspend netting over the area where geese are unwanted. Geese are reluctant to fly or walk into the area. A similar deterrent that is often used is a single string or wire suspended a foot or so above the ground along the length of the shoreline.

### ***Pros***

Depending on the type of barrier used, areas of exclusion will have less fecal mess and may have higher recreational uses. Vegetation that was overgrazed by geese may also be able to recover.

### ***Cons***

This technique will not be effective if the geese are using a large area. Also, use of the area by people is severely limited if netting is installed. Fences can also limit recreational uses. The single string or wire method may be effective at first, but geese often learn to go around, over, or under the string after a short period of time. Finally, excluding geese from one area will force them to another area on a different part of the same lake or another nearby lake. While this solves one property owners problem, it creates one (or makes one worse) for another. Also, problems associated with excess feces entering the lake (i.e., increased phosphorus levels) will continue.

### ***Costs***

The costs of these techniques are minimal, unless a wood or wire fence is constructed. String, wire, or netting can be purchased or made from materials at local stores.

## **Option 5: Habitat Alteration**

One of the best methods to deter geese from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for geese. Low vegetation near the water allows geese to feed and provides a wide view with which to see potential predators. In general, geese do not favor habitats with tall vegetation. To achieve this, create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn. Planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally can create buffer strips. A table in Appendix A has a list of native plants, seeding rates, and approximate costs that can be used when creating buffer strips.

Geese prefer ponds and lakes that have shorelines with gentle slopes to ones with steep slopes. While this alone will not prevent geese from using an area, steeper slopes used along with other techniques will be more effective. This option may not be practical for existing lake shorelines since any grading and/or filling would require permits and surveys, which would drive up the costs of redoing the shoreline considerably.

Aeration systems that run into the fall and winter prevent the lake from freezing, thus not forcing geese to migrate elsewhere. To alleviate this problem, turn aerators off during fall and early winter. Once the lake freezes over and the geese have left, wait a few weeks before turning the aerators on again if needed.

### ***Pros***

Altering the habitat in an area can not only make the habitat less desirable for geese, but may be more desirable for many other species of wildlife. A buffer strip has additional benefits by filtering run-off of nutrients, sediments, and pollutants and protecting the shoreline from erosion from wind, wave, or ice action. Finally, the more of the area that is in natural vegetation, the less turfgrass that needs to be constantly manicured and maintained.

### ***Cons***

Converting a portion or all of an area to tall grass or shrub habitat may reduce the lake access or visibility. However, if this occurs, a small path can be made to the lake or shorter plants may be used at the access location in the buffer strip.

### ***Costs***

If minimal amount of site preparation is needed to create a buffer strip, costs can be approximately \$10 per linear foot, plus labor. 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. 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. The permitting process is costly, running as high as \$1,000-2,000 depending on the types of permits needed.

Once established, a buffer strip of native plants needs little maintenance. If aerators are not run for several months, there will be a reduction in electrical costs.

### **Option 6: Do Not Feed Waterfowl!**

There are few “good things”, if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the “foods” (i.e., white bread) given to geese and other waterfowl are quite low. Since geese are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese that are accustomed to hand feeding may become aggressive toward other geese or even the people feeding the geese.

### ***Costs***

There are no costs to this option, except the public education that is needed to encourage people not to feed waterfowl. In some cases, signs could be posted to discourage waterfowl feeding.



**Reference:**

Manny, B. A., R. G. Wetzel, and W. C. Johnson. 1975. Annual contribution of carbon, nitrogen, and phosphorus by migrant Canada geese to a hardwater lake. *Verh. Internat. Verein. Limnol.* 19:949-951.

## **Objective VIII: 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 wide spread 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 it 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.

### **Option 1: No Action**

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<sub>2</sub> and H<sub>2</sub>O) 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°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 retreatment needs 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*

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.

### *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. Based on the estimated volume of 400 acre-feet for Antioch Lake, a rotenone treatment would cost approximately \$40,450 – 60,675.

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 IX: 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 effects 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 placed 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 where 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.