2002 SUMMARY REPORT
of
REDHEAD LAKE

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Redhead Lake is a 51 acre glacial lake located in unincorporated Grant Township, northwest of the intersection of Route 12 and Big Hollow Road. Access to Redhead Lake from the shoreline is private. However, since Redhead Lake is part of the Chain O' Lakes (a public body of water), public access is available through Pistakee Lake. Development did not begin on Redhead Lake until 1957, which is later than other development on the Chain. Currently there are two subdivisions; on the southwest (Lakeview Hills) and northeast (Hilldale Manor) shores. These two subdivisions chemically treat a small area of the lake for Eurasian water milfoil once a year.

Overall, Redhead Lake has *poor* water quality as compared to other County lakes. In 2002, the average total phosphorus concentration in Redhead Lake was 0.141 mg/L, which is two and a half times higher than the Lake County median value of 0.056 mg/L. High phosphorus concentrations are due to elevated concentrations of organic and inorganic particles. The average total suspended solids concentration in Redhead Lake was 37.0 mg/L and was as high as 68.0 mg/L in September, which is over eleven times the Lake County median concentration of 6.0 mg/L. These high concentrations of suspended sediment and accompanying nutrients are contributing to algae blooms, which are greatly reducing clarity. Average Secchi disk depth, a measurement of water clarity, was 1.28 feet. This is much lower than the County median Secchi depth of 3.8 feet and is the lowest Secchi of any of the Chain lakes in 2002.

Aquatic plant assessments revealed slightly above average species diversity with a Floristic Quality Index (FQI) of 19.3, which is above the County mean FQI of 14.2. From May through September a total of twelve species of aquatic plants were found. However, the overall occurrence of these species is uneven with the population being dominated by the aquatic weeds Eurasian water milfoil and coontail. Eurasian water milfoil and coontail were found at 75% and 62% of sample sites, respectively. In contrast, flat stem pondweed, a more desirable aquatic plant species, was only found at 4% of the sample sites. This is typical of the lakes in the Chain O' Lakes system, with milfoil and coontail dominating the aquatic plant community and a low occurrence of desirable species.

A majority of Redhead Lake's shoreline is undeveloped (68%). The majority of this undeveloped shoreline is made up of wetland (91%) and wooded areas (9%). The high occurrence of these two shoreline types is encouraging as they provide good wildlife habitat. A majority of the developed shoreline consisted of rip rap (32%), lawn (20%), and seawall (11%). The high occurrence of these developed shoreline types is of some concern, as they do not provide the habitat of more heavily vegetated shorelines. Lawn is more susceptible to shoreline erosion than other shoreline types. However, the occurrence of shoreline erosion on Redhead Lake was low with only 6% of shoreline assessed with slight and 2% assessed as moderate. This can be attributed to the large expanse of undeveloped shoreline along with the high occurrence of seawalls and rip rap. However, the creek flowing into the lake on the east side was found to have a high occurrence of erosion, which may be contributing to the high turbidity levels in the lake.

LAKE IDENTIFICATION AND LOCATION

Redhead Lake is a 51-acre glacial lake located in unincorporated Grant Township just northwest of the intersection of Route 12 and Big Hollow Road (T45N, R9E, Sections 15, 16, 21, & 22). The current maximum water depth is 4.5 feet with an estimated average depth of 2.25 feet and lake volume has been calculated to be approximately 114.3 acre-feet (LMU morphometric data). Redhead Lake is part of the Lower Chain O' Lakes drainage basin of the Fox River Watershed. Redhead Lake receives water from the Chain (Fox River) as well as from Lake of the Hollow (a.k.a. Brandenburg Lake) to the south and a small creek on the east side of the lake. Redhead Lake is connected to the Chain O' Lakes through a channel on the southeast side (Myers Bay) of Pistakee Lake, which then flows into Fox River. Lake bottom ownership is held by a mix of eight private individuals, Lakeview Hills Improvement Association, and three government agencies (State, County, and Township).

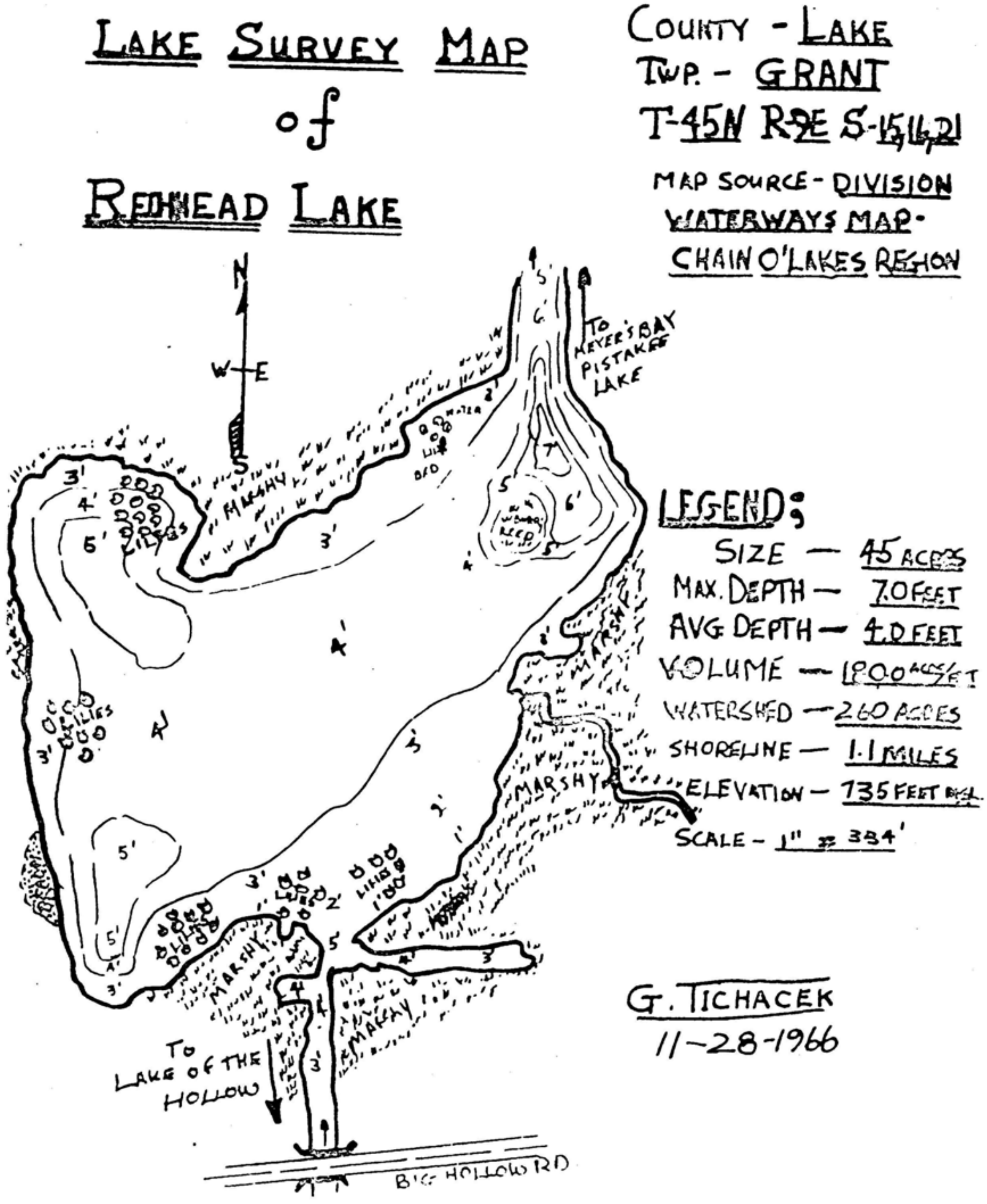
BRIEF HISTORY OF REDHEAD LAKE

Redhead Lake had been part of the Fox River Chain O' Lakes since early years of the Chain in the early 1900's. The Chain O' Lakes was shallower prior to 1907 and 1946 when dams were installed at McHenery and Algonquin, respectively. Prior to the installation of these dams, Redhead Lake was more than likely a shallow wetland with some open water. Historical accounts state that the channel between Pistakee and Redhead was widened and deepened around 1908 to allow access to Redhead from the main lakes. Development on the lake did not begin until after water elevations rose making Redhead Lake deeper. The first houses began appearing on the lake in 1957 when the first association, Hilldale Manor Home Owners Association, formed. A second subdivision and association, Lakeview Hills Improvement Association, was organized in 1970. However, active management of the lake did not begin until 1998. Over the years, parts of Redhead Lake have filled in due to deposition of organic mater (dying lily pads and other plants) and sedimentation. Overall, Redhead Lake is nearly the same depth now as it was half a century ago when bathymetric (contour) maps from 1966 shows that a majority of Redhead Lake was 4 feet deep(Figure 1).

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Direct shoreline access to Redhead Lake is limited to residents of the two subdivisions that border the lake. However, since Redhead Lake is part of the Fox Chain O' Lakes, and is a public body of water, it may also be accessed from the Pistakee Lake. There are two access points on the lake (one for each subdivision)(Figure 2). Lakeview Hills has a boat ramp as well as several slips for use by subdivision residents. Hilldale Manor also has a boat ramp but does not have slips. There are also swimming areas, fishing piers, and a small park at each location. Additionally, several homeowners on the lake also have private swimming areas and piers. Historically, the uses of Redhead Lake have gone unchanged since its development in the late 1950's with recreational boating,

Figure 1. 1966 Bathymetric map of Redhead.



fishing, swimming, and most importantly access to the rest of the Chain O' Lakes as its major uses. Despite the very shallow depth, Redhead Lake is open to power boating (the channel from Pistakee is 'No Wake'), which is undoubtedly adding to turbidity (clarity) problems in the lake.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples collected from Redhead Lake were analyzed for a variety of water quality parameters. Since Redhead Lake is so shallow, samples were collected near the surface instead of at multiple depths as in deeper Lakes (Figure 2). Redhead Lake does not thermally stratify, which means the lake does not divide into a warm upper water (epilimnion) and cool lower water (hypolimnion) but instead stays well mixed. This is due to the shallow lake morphology and long fetch (the longest distance which wind blows across a lake unobstructed by land). This mixing of water is reflected in the dissolved oxygen (DO) profiles as well as other water quality data such as temperature. The complete data set for Redhead Lake can be found in Table 1, Appendix A and the multiparameter data in Appendix C.

Dissolved oxygen (DO) concentrations in Redhead Lake were adequate (>5.0 mg/L) throughout the study. This is due to the lake's shallow morphometry, which helps to keep Redhead well mixed. Average DO concentrations ranged from 10.7 mg/L (July) to 5.70 mg/L (September). Furthermore, hypoxic conditions (DO < 1.0 mg/L) never formed. When DO concentrations drop below 1.0 mg/L, biological and chemical processes release nutrients into the water, which are sequestered in the hypolimnion due to stratification and can be released into the surface waters. However, since stratification and subsequent anoxic conditions do not form in Redhead Lake this type of nutrient release is not an issue.

Secchi disk depth is a direct indicator of water clarity as well as overall water quality. In general, the greater the Secchi disk depth, the clearer the water and better the water quality. Based on water clarity (Secchi depth), Redhead Lake has *below average* water quality compared to other lakes in Lake County. Average Secchi disk depth on Redhead Lake during the 2002 study was 1.27 feet, which was well below the Lake County median Secchi depth of 3.81 feet (1998-2002) and was the lowest of the Chain lakes in 2002. Monthly variations in Secchi depth were slight and ranged from a low of 0.67 feet in August to a high of 1.77 feet in September. Overall, many of the lakes in the Chain O' Lakes have poor water clarity with Channel and Catherine the exceptions (Figure 3). Poor clarity is due to a variety of factors including, high concentrations of suspended sediment, and elevated nutrient levels, which are causing algae blooms.

Total suspended solids (TSS) are a measurement of suspended solids such as algae and other organic matter as well inorganic matter such as silt and clay particles. In 2002, the average TSS in Redhead Lake was 36.8 mg/L, which is six times higher than the County

median value of 6.0 mg/L. The TSS ranged from 18.0 mg/L in September to as high as 68.0 mg/L in August, which is over eleven times higher than the County median value. These high concentrations of suspended solids in the water column directly impact Secchi depth (clarity) and have a negative impact on many other aspects of lake health (Figure 4). The calculated nonvolatile suspended solids (NVSS), which is the portion of the TSS that can be attributed to inorganic (soil particles) was 24.7 mg/L. This means that 67% of turbidity (TSS) was caused by suspended inorganic particles such as silts and clays. The other 33% can be attributed to suspended organic particles such as algae. Average total volatile solids (TVS) concentrations (141 mg/L), which are a measurement of suspended organic matter (such as algae and decomposing plant matter), were also above the County median concentrations (135 mg/L).

Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that nutrients (N&P) are usually the limiting factors in algal growth. To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios <10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. Most lakes in the County are phosphorus limited. In these phosphorus-limited lakes even a small addition of P can trigger algae blooms. In 2002, Redhead Lake had an average TN: TP ratio of 16:1, which means that Redhead Lake is slightly phosphorus limited but overall there are enough of both nutrients to support algae growth, which did occur throughout the season in Redhead Lake.

The phosphorus concentrations in Redhead Lake are *high*. Average TP was 0.141 mg/L in 2002. This is over double the median TP concentration for Lake County lakes (0.056 mg/L). These high TP concentrations cause nuisance algae blooms, which are reducing the water clarity (high TSS) and deteriorating other aspects of lake health (Figure 5). TP concentrations varied on a monthly basis and ranged from 0.077 mg/L (September) to 0.226 mg/L (August). Monthly variations in TSS, NVSS, and TVS correspond well to variations in TP, which supports that above average TP concentrations are originating from an internal loading (sediment and algae blooms). These internal sources may not be the only explanation of elevated TP concentrations in the lake. Another input of phosphorus may be from sources outside of the lake (external). They can include fertilizer runoff, failing septic systems, goose feces, and erosion carried by rainfall/runoff. TP concentrations did not correlate with rainfall data, which may indicate that a majority of Redhead Lake's TP may be from internal sources (Figure 6).

Nitrogen concentrations (NO_3-N and NH_3-N) were below detectable concentrations for the entire study. However, average total Kjeldahl nitrogen (TKN), an organically (algae) associated form of nitrogen, in Redhead Lake was 2.20 mg/L, which was higher than County median of 1.170 mg/L. These elevated concentrations can be attributed to algae blooms and decomposing plant matter. This is supported by monthly TSS and TVS concentrations, which matched variations in monthly TKN concentrations (Figure 7).

Another way to look at nutrient concentrations and how they affect the productivity of a lake is the use of a Trophic State Index (TSI) based on average phosphorus concentrations. The TSI can be based on phosphorus, chlorophyll *a*, and Secchi depth to classify and compare lake productivity levels (trophic state). The phosphorus TSI is setup so the higher the phosphorus concentration, the greater amount of algal biomass and as a result, a higher trophic state. Based on a TSI phosphorus value of 75.6, Redhead Lake is classified as *hypereutropic* ($\geq$70 TSI). This means that the lake is a highly productive system that has excessive nutrient levels and high algal biomass (growth). Field observations reinforce that Redhead Lake is *hypereutrophic* and is plagued by thick plant and algae growth (filamentous and planktonic). For comparison, most lakes in the County are eutrophic (TSI values $\geq$50 <70). Out of all of the lakes in Lake County studied by the LMU since 1998, Redhead Lake ranks 85 out of 103 lakes based on phosphorus (Table 2, Appendix A).

TSI values along with other water quality parameters can be used to calculate water quality and use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). These indices rate a given lake based on several water quality parameters. Based on above average phosphorus concentrations, Redhead Lake was listed as having a *Moderate* exceedance of Illinois water quality standards. Additionally, there were exceedances for low DO, noxious and exotic aquatic plant growth (Eurasian water milfoil and curly leaf pondweed), and high levels of suspended solids (NVSS). Based on IEPA Swimming Use Index, Redhead Lake is categorized as providing *Nonsupport*. This is due to poor Secchi disk readings and high phosphorus concentrations, which lead to high algal biomass (increased turbidity) and decreased visibility. Redhead Lake's average Secchi disk was only 15.2 inches, which is well below the IDPH's recommendation of 48 inches. Based on the Recreational Use Index, Redhead Lake was also categorized as *Nonsupport*. This is due to a high TSI value and high levels of suspended solids, which result in poor visibility and contribute to an overall reduction in use of the lake. Redhead Lake provides *Partial* support based on the Aquatic Life Use index. Finally, Overall Use, which is based on the average of all of the use impairment indices, Redhead Lake is listed as providing *Nonsupport*.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

A healthy aquatic plant population is critical to good lake health. Aquatic vegetation provides important wildlife habitat and food sources. Additionally, aquatic plants provide many water quality benefits such as sediment stabilization. Aquatic plant diversity on Redhead Lake is slightly *above average* (Table 3). Floristic quality index (FQI) (Swink and Wilhelm 1994) is a rapid assessment metric designed to evaluate the closeness that the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each submersed and floating aquatic plant species (emergent shoreline species were not counted) in the lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). Nonnative species were also counted in the FQI calculations for Lake County lakes. We then averaged these numbers and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. In 2002, Redhead Lake has a FQI of 19.3. The average FQI of lakes studied by the LMU in 2000-2002 was 14.2. Redhead Lake has slightly *above average* aquatic plant diversity compared to other lakes in Lake County.

While the overall diversity of the aquatic plant community at Redhead Lake is healthy, the occurrence of these species is unbalanced, with Eurasian water milfoil (EWM) and coontail (both undesirable species) dominating the lake. Aquatic plant surveys were conducted every month for the duration of the study (*Appendix A* for methodology). During the 2002 study of Redhead Lake, twelve species of aquatic plants were found (Table 3). The month with the highest plant diversity was June, in which ten species were sampled (Table 4, *Appendix A*). The most frequent species during the study was EWM, which occurred at 75% of all sample sites from May-September. Other plants that were commonly present included coontail (62% of sites) and white water lily (51% of sites). These three species made up the overwhelming majority of plants found at Redhead Lake. Spot treatments with aquatic herbicides have been used since 1998 to reduce Eurasian water milfoil and coontail densities (and curlyleaf pondweed to an extent). The main purpose of these treatments has been to maintain boat navigation on the lake. These spot treatments seem to be alleviating some of the problems and could continue on an as needed basis.

The extent to which aquatic plants grow is largely dictated by light availability. Aquatic plants need at least 1% of surface light levels in order to survive. Based on light penetration, the extent of aquatic growth in Redhead Lake could have been as high as 100% of the surface area (bottom coverage). Aquatic vegetation in Redhead Lake occupied approximately 50-60% of the surface area, which is a bit excessive (30-40% is ideal). This is due more to the overall shallow depth of Redhead Lake than to water clarity. Normally, high densities of aquatic plants assure better water clarity. However, due to the shallow depth, boat traffic, wind and wave action, and high nutrient concentrations, the clarity of Redhead Lake is poor.

Shoreline plants of interest were also observed (Table 3). However, no surveys were made of these shoreline species and all data is purely observational. Cattails and a few other wetland plants dominate a majority of the shoreline of Redhead Lake, which is to be expected based on the wetland areas surrounding the lake. Other parts of Redhead's shoreline supported several tree and brush species. Additionally, there were a few invasive species, such as purple loosestrife, observed along the shores of Redhead Lake that are of some concern (see *Limnological Data-Wildlife Assessment*).

Table 3. Aquatic and shoreline plants on Redhead Lake, May-September 2002.

Aquatic Plants	
Coontail	*Ceratophyllum demersum*
Common Duckweed	*Lemna minor*
Eurasian Water Milfoil	*Myriophyllum spicatum*
Slender Naiad	*Najas flexilis*
Spatterdock	*Nuphar variegata*
White Water Lily	*Nymphaea tuberosa*
Curlyleaf Pondweed	*Potamogeton crispus*
Leafy Pondweed	*Potamogeton foliosus*
American Pondweed	*Potamogeton nodosus*
Sago Pondweed	*Potamogeton pectinatus*
Flatstem Pondweed	*Potamogeton zosteriformis*
Common Bladderwort	*Utricularia vulgaris*
Shoreline Plants	
Reed Canary Grass	*Phalaris arundinacea*
Purple Loosestrife	*Lythrum salicaria*
Swamp Loosestrife	*Decodon verticillatus*
Common Cattail	*Typha latifolia*
Common Buckthorn	*Rhamnus cathartica*
Multiflora Rose	*Rosa multiflora*
Red-osier Dogwood	*Cornus stolonifera*
Beggars Tick	*Bidnes frondosa*
Cottonwood	*Populus deltoides*
Giant Reed	*Phragmites australis*
Common Cocklebur	*Xanthium strumarium*

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

Shoreline assessment was conducted at Redhead Lake on July 12, 2002. Shorelines were assessed for a variety of criteria (*Appendix B* for methodology). A large majority (68%) of Redhead Lake's shoreline is undeveloped. This undeveloped shoreline was made up of two types; wetland (91%) and woodland (9%). A majority of the developed shoreline consisted of rip rap (32%), lawn (20%), and seawall (11%)(Figure 8). The dominance of undeveloped shoreline is encouraging, as they (wetlands and woodlands) contain plants with deep root systems that are less prone to erosion and provide good wildlife habitat. Overall, the undeveloped wetlands made up 68% of total shoreline. However, other types of shoreline found on developed portions of the lake are not as encouraging. Seawalls (and rip rap to an extent) are undesirable because of their tendency to reflect wave action back into the lake. This can cause resuspension of near shore sediment, which can lead to a variety of water quality problems. These types (seawall and rip rap) of shoreline, along with manicured lawn, are area considered undesirable as they do not provide good habitat. Additionally, manicured lawn, which accounted for 20% of the developed shoreline, is a poor shoreline/water interface. This is due to the poor root structure of turf grasses, which provide poor soil stabilization.

The occurrence of erosion on Redhead Lake is *low*. Overall, only 8% of the shoreline on Redhead Lake had some type of erosion (Figure 9). The majority of the shoreline (92%) was uneroded. The eroded shoreline was made up of *Slight* (6%) and *Moderate* (2%) with all of the eroded shoreline occurring on developed shorelines. The most affected shoreline type was developed woodland, which accounted for 50% of total erosion. This can be attributed to the lack of management of these woodlands that have become over grown with dense invasive tree growth (common buckthorn). This dense growth shades out deep-rooted, beneficial under story vegetation, which helps to stabilize the shoreline. Other types of developed shoreline that have experienced erosion are manicured lawn and shrub areas. The lawn areas that have experienced erosion were found to be poorly maintained and as stated previously, are predisposed to erosion due to the lack of a quality root structure. While the occurrence of erosion in the main part of the lake is low, the creek leading into Redhead on the east side is experiencing a high degree of erosion. This eroding stream is probably exacerbating the already turbid waters of Redhead Lake. Assessments of the creek revealed that 100% of the banks were eroding (Slight – 76%, Moderate – 18%, Severe 6%) (Figure 9). Furthermore, the banks of this creek are overgrown with invasive and low value species suck as buckthorn, purple loosestrife, giant reed, and multifora rose.

The Association's as well as individual homeowners around the lake could easily address these *Slightly* eroded areas by establishing well-maintained buffer strips consisting of prairie grasses and wildflowers. Additionally, it would be beneficial to extend these buffers into the lake by planting native emergent vegetation such arrowhead and pickerel weed. Improving the *Moderately* eroded areas would involve more labor-intensive measures such as regrading. Due to the overgrown nature of the land surrounding the creek, improvement projects may prove to be difficult without clearing large areas of vegetation to provide access.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Wildlife observations were made on a monthly basis during water quality and plant sampling activities. All observations were visual. Several types of waterfowl were observed during the course of the study including the common tern, which is a State of Illinois endangered species (Table 5). There are healthy populations of mature trees that provide good habitat for a variety of bird species. There are also a few large dead trees that provide excellent habitat for Double Crested Cormorants. Additionally, there are several shrub and woodland areas that provide habitat for smaller bird and mammal species. The majority (68%) of Redhead's shoreline is undeveloped, which is encouraging especially for a residential lake in Lake County, and provides good habitat. There are three invasive plant species (purple loosestrife, reed canary grass and buckthorn) found along Redhead Lake's shoreline habitat around the lake and should be controlled/eliminated. At least 41% of the shoreline parcels had some invasive species growth. This means that some portion of roughly 8,937 lineal feet (81% of total shoreline) of Redhead Lake's shoreline is infested with one (or more) of these three species (Figure 10). Additionally, 100% of the banks of the creek leading into Redhead are infested with all of these invasives as well as several other low value plant species. These plants are seldom used by wildlife for food or shelter. They should be controlled/eliminated before they spread and displace other native and more desirable plant species. Additionally, shoreline habitat should be further improved upon and should include buffer strips and more naturalized shoreline areas in place of manicured lawns.

The Redhead Lake Associations do not currently have fish stocking programs. However, the IDNR annually stocks fish such as largemouth bass and northern pike into the Chain O' Lakes. These fish may make their way into Redhead Lake thus improving the fishery of the lake. Past IDNR fishery reports of Redhead Lake indicated various states of condition with the fishery made-up of bluegill, largemouth bass, sunfish, yellow perch, black crappie, white crappie, bullhead, carp, and northern pike. Additionally, the Fox Waterway Agency has started to install fish cribs (artificial structure) throughout the Chain. Currently there are no plans to sink any of these artificial structures into Redhead Lake due to the shallow depths.

Table 5. Wildlife species observed on Redhead Lake, May – September 2002.

<u>Birds</u>	
Double-crested Cormorant	*Phalacrocorax auritus*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Blue-winged Teal	*Anas discors*
Ring-Billed Gull	*Larus delawarensis*
Common Tern*	*Sterna hirundo*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularia*
Common Flicker	*Colaptes auratus*
Mourning Dove	*Zenaida macroura*
Belted Kingfisher	*Megaceryle alcyon*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
Marsh Wren	*Cistothorus palustris*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo	*Vireo olivaceus*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Red-wing Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Song Sparrow	*Melospiza melodia*

*Endangered in Illinois

EXISTING WATER QUALITY PROBLEMS

Redhead Lake has *below average* water quality due to high nutrient and suspended sediment concentrations. This is a common problem throughout Lake County and especially in most of the Chain O' Lakes. Listed, below are the main problems Redhead Lake is currently facing.

- *Invasive Species Management*

  Three exotic, invasive species found along Redhead Lake's shoreline that are of concern are buckthorn, reed canary grass, and purple loosestrife. All of these species provide minimal food or habitat benefit to wildlife. Furthermore, all three species are extremely aggressive and will displace desirable, native vegetation, which will lead to further loss of food and habitat. The spread of these three aggressive species must be stopped before they become further established. These noxious weeds can be controlled using several different management techniques. The cattail fringe is also of some concern. Yearly or alternate year burnings of the cattails would be beneficial in slowing its encroachment and further filling in of the lake. Additionally, these burnings would help control the spread of invasive species such purple loosestrife. Burning should be conducted as early in the year as possible to avoid any conflicts with migrating and/or nesting birds.

- *Shallow Depth*

  Sedimentation can bring about negative impacts on the lake's fishery and aquatic plant community. Sedimentation can also bring about an increase in algae blooms and turbidity and an overall decrease in lake health. Dredging may reduce impacts from this ongoing problem. For overall lake health, it is advisable to increase the depth so that 25% of the lake is greater than 10 feet deep (12.5 acres). In order to accomplish this goal an estimated 3,267,000 cubic yards would have to be removed. This would be extremely expensive. Typically, at a minimum hydraulic dredging costs \$3-10/yd^3 and removal of 3,267,000 cubic yards would cost \$9,801,000 – \$32,670,000. These costs include plan design and execution. Additionally, a bathymetry study, sediment thickness survey and dewatering site construction and leasing, would inflate costs further (possibly double). The main question the Associations of Redhead Lake must ask themselves is *what do they want to achieve with dredging*? If it is fishery health, then increasing the lake depth so that 25% is deeper than 10 feet is an appropriate plan. On the other hand, if the goal of the Associations were to deepen the lake for navigational purposes, then dredging specific locations would be more appropriate and possibly reduce costs. Additionally, there are other ways to reduce costs such as alternative disposal sites (i.e., Geo tubes) and utilizing the Fox Waterway Agency to do the dredging.

- *Historical Lake Data*

The lack of quality lake data is a common problem for many of the lakes in Lake County. This is either due to poor record keeping or lack of involvement on the part of the management entity or lake residents. There has been development on the lake for almost 50 years and active management of the lake for the last 4 years, but accurate records may not have always been kept. Additionally, data such as Secchi depth, water fluctuations, DO profiles, and nutrient concentrations are not collected/monitored on a regular basis. Collection of this type of lake data can be very important in making decisions on the management of the lake. This data can be used to track changes (or lack of) in lake quality over many years. This data is very important to agencies, such as the LMU, when conducting studies of the lake and allows for a more complete analysis. It is the recommendation of the LMU that Redhead Lake becomes involved in the IEPA's Volunteer Lake Monitoring Program (VLMP). This program has volunteer lake residents to collect bimonthly lake data for the IEPA. This program is worth the time and effort and provides valuable information about the lake. Furthermore, there is no current or accurate bathymetric map for Redhead Lake. This type of map would be essential in lake management projects such as dredging and the Association's should get one made.

- Creek Erosion

The LMU found the creek leading into Redhead Lake to be highly eroded. There are many causes for this erosion including increased flow from nearby development, poor stabilization by shoreline vegetation, and water level fluctuations. This erosion may be exacerbating the already turbid conditions in Redhead Lake. LMU shoreline assessments found 100% of the creek to be experiencing some form of erosion (slight, moderate, and severe). Some of this erosion could easily be rectified by removal of undesirable species such as buckthorn and purple loosestrife and replanting with more desirable, deep-rooted native vegetation. Other portions of the creek will require more intensive methods such as regrading and use of bioengineering techniques.

POTENTIAL OBJECTIVES FOR REDHEAD LAKE MANAGEMENT PLAN

I. Shoreline Improvement and Erosion Control
II. Eliminate or Control Invasive Species
III. Volunteer Lake Monitoring Program
IV. Create a Bathymetric Map with Morphometric Data
V. Dredging Feasibility Study

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Shoreline Improvement and Erosion Control

Erosion to shorelines on Redhead Lake is a potential problem. Shoreline erosion occurs as a result of wind, wave, ice action, water fluctuations 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. During the 2002 survey of Redhead Lake a large majority of shoreline was found to be uneroded. Approximately 8.5% (947 feet) of the developed shoreline on Redhead Lake has some form of erosion. However, the creek leading into Redhead on the east side of the lake is experiencing moderate erosion (100% of the 3187 feet). These areas should be addressed as soon as possible in order to avoid further shoreline deterioration.

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

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 Rock Rip Rap

Rip rap is the term for using rocks to stabilize shorelines. Size of the rock depends on the severity of the erosion, distance to rock source, and aesthetic preferences. Generally, four to eight inch diameter rocks are used. *The use of rip rap should be viewed as a last resort* after other alternatives such as biologs have been tried or are inappropriate. Rip rap can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the rip rap fill will probably be needed to cover the rocks and provide an acceptable medium for plants to grow on. *It is imperative that filter fabric be used under the rip rap to provide quality, long lasting results.* Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained (see costs below). Rip rap is best used for areas of **moderate erosion** and gentle to moderately sloped shores (<2:1). If rip rap is to be used on shorelines steeper than 2:1, then grading must be done in order to reduce grade to ≤ 2:1, preferably 3:1. *Every effort should be made to use more natural, less intrusive methods of shoreline stabilization (buffer strips and biologs).* However, the site must be prepared (grading, etc.) accordingly.

Pros

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

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

Cons

A major disadvantage of rip rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip rap and must be acquired prior to work beginning. If any fill material is placed in the floodplain along the shoreline; compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain. While rip rap absorb wave energy more effectively than seawalls, there is still some wave deflection that may cause resuspension of sediment and nutrients into the water column.

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

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

Costs
Cost and type of rip rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $30-45 per linear foot. Based on assessed *moderately* eroded shoreline, Redhead Lake would need approximately 234 linear feet of rip rap. This would come to a cost of approximately $7,020 – 10,530. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be $1,000-2,000 for installation of rip rap, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

Option 3: Buffer Strips

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

Stabilizing the shoreline with vegetation is most effective on shorelines with **slight erosion** and slopes no less than 2:1 to 3:1, horizontal to vertical or flatter. Usually a buffer strip of at least 25 feet is recommended, however, wider strips (50 or even 100 feet) are recommended on steeper slopes or areas with more severe erosion problems. Areas where erosion is severe or where slopes are greater than 3:1, additional erosion control techniques may have to be incorporated such as Biologs or rip rap. Furthermore, it is the recommendation of the LMU that buffer strips be established along all applicable shorelines of Redhead Lake regardless of shoreline type (including beach and seawalls).

Buffer strips can be constructed in a variety of ways with various plant species. Generally, buffer strip vegetation consists of native terrestrial (land) species and emergent (at the land and water interface) species. Terrestrial vegetation such as native grasses and wildflowers can be used to create a buffer strip along lake shorelines. Table 6 gives some examples, seeding rates and costs of grasses and seed mixes that can be used to create buffer strips. Native plants and seeds can be purchased at regional nurseries or from catalogs. When purchasing seed mixes, care should be taken that native plant seeds are used. Some commercial seed mixes contain non-native or weedy species or may contain annual wildflowers that will have to be reseeded every year. If purchasing plants from a nursery or if a licensed contractor is installing plants, inquire about any guarantees they may have on plant survival. Finally, new plants should be protected from herbivory (e.g., muskrats) by placing a wire cage over the plants for at least one year.

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

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or rip rap. Native emergent vegetation can be either hand planted or allowed to become established on its own over time. Some plants, such as native cattails (*Typha* sp.), quickly spread and help stabilize shorelines, however they can be aggressive and may pose a problem later. Other species, such as those listed in Table 6 should be considered for native plantings.

Pros

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

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

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

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

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

Cons

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

Costs

If minimal amount of site preparation is needed, costs can be approximately $10 per linear foot, plus labor. Cost of installing willow posts is approximately $15-20 per linear foot. Based on assessment *slightly* eroded shoreline, Redhead Lake would need approximately 713 linear feet of buffer strip. This would come to a cost of approximately $7,130. It is advisable that buffer strips be planted on all appropriate shoreline areas on Redhead Lake. However, some of this shoreline would be better suited for use of biologs incorporated with buffer vegetation (see *Option 4* below), which includes the use of buffer strips. 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.

<u>Option 4: Install Biolog, Fiber Roll, or Straw Blanket with Plantings</u>

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

Pros

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

Cons

These products may not be as effective on highly erodible shorelines or in areas with steep slopes, as wave action may be severe enough to displace or undercut these products. On steep shorelines grading may be necessary to obtain a 2:1 or

3:1 slope or additional erosion control products may be needed. If grading or filling is needed, the appropriate permits and surveys will have to be obtained.

Costs

Costs range from $25 to $35 per linear foot of shoreline, including plantings. Based on *moderately* eroded shorelines, Redhead Lake would need 234 linear feet of one of the above products on the moderate eroded areas of shoreline. This would cost approximately $5,850 – 8,190. This does not include the necessary permits and surveys, which may cost $1,000 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.

Objective II: Eliminate or Control Invasive Species

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. Plants such as purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus cathartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. These exotic and invasive plants have made their way onto the shores of Redhead Lake. 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 per plant), and high seed germination rate, purple loosestrife spreads quickly. Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants and is quick to become established on disturbed soils. Reed canary grass is an aggressive plant that if left unchecked will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

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

Option 1: No Action

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

Pros

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics when possible. Table 6 (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 monoculture. 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.

<u>Option 2: Hand Removal</u>

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

Pros

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

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

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

Option 3: Herbicide Treatment

Treatment with herbicides is one of the best options for controlling **mature stands** of invasive species, such as buckthorn and purple loosestrife, on Redhead Lake. 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. The label is the law. Table 7 (Appendix A) contains herbicides that are approved for use near water for control of nuisance vegetation. Included in this table are rates, costs, and restrictions on use.

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

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

Costs
See Table 7 (Appendix A) for herbicide rates and prices. Total cost to treat the limited amount of purple loosestrife and other invasive species on Redhead Lake would be minimal and could be done by individual homeowners or the TLIA. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. For other species, such as buckthorn, a device such as a Hydrohatchet®, a hatchet that injects herbicide through the bark (about $300) may be needed. Another injecting devise, E-Z Ject® is $450. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. A low cost alternative to specialized spray equipment is the use of household spray bottles (commonly used for window and bathroom cleaners). These bottles can be purchased at department stores for minimal costs. However, after there use for herbicide application they should not be used for anything else. Similarly, spray canisters like those used to apply lawn chemicals also provide lower costs alternatives to commercial spray equipment.

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

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

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Objective IV: Create a Bathymetric Map and Morphometric Data

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some lakes in Lake County do have a bathymetric map, but they are frequently old, outdated and do not accurately represent the current features of the lake. Redhead Lake does not have a bathymetric map. If management activities intensify, Redhead Lake should consider having a detailed bathymetric map made. 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 V: Dredging Feasibility Study

The main question the Associations' of Redhead Lake must ask themselves is "*What do they want to achieve with dredging?*" If it is fishery health, then increasing the lake depth so that 25% is deeper than 10 feet is an appropriate plan. On the other hand, if the Associations' goal were to deepen the lake for navigational purposes, then dredging specific locations would be more appropriate. If there is to be a successful dredging project on Redhead Lake the first step would be a feasibility study. This study should examine such issues as the costs/benefits of mechanical versus hydraulic dredging and the availability of disposal/dewatering sites. Additionally, a bathymetric map and sediment thickness survey will need to be performed in order to determine the quantity of sediment to be removed. Finally, and maybe most importantly, the Associations need to explore possible funding sources to finance the above-motioned services, disposal site construction, and eventually the dredging itself. This will not be a quick nor inexpensive process and the Associations need to work together to develop a realistic set of goals.