2000 SUMMARY REPORT
of
HARVEY LAKE

Lake County, Illinois

Prepared by the

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LAKE IDENTIFICATION AND LOCATION

Harvey Lake is a 12.5-acre man-made lake located within the Village of Vernon Hills (T44N, R11E, S33). It is north of Route 60 behind the Hawthorn Center shopping mall, with encroaching new development in the Gregg's Landing subdivision. The lake has an outlet at the southwest corner that drains to a small low area, which is an intermittently flooded wetland. Harvey Lake lies within the Indian Creek watershed, which drains to the Des Plaines River. The maximum depth of the lake is 15 feet, with an estimated average depth of 7.5 feet, or half the maximum depth. The estimated volume is 112.5 acre-feet[1], or 36.6 million gallons. The shoreline length is 1.1 miles.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

This lake was privately owned before being purchased by the Village of Vernon Hills as part of the Gregg's Landing subdivision. During 2000, a stormwater pipe to drain this subdivision was placed at the northeast shoreline. Grading was note completed at the time, so it was unclear as to how much of this area would eventually drain to Harvey Lake. The area to be drained was stripped of vegetation for the construction of new homes for the new subdivision. No public access is available at this time, although the Village plans to create a walkway around the lake in the future. Previously, access to the lake was for the owner of a now abandoned house on the north shore. A small pier still exists at the water's edge. There may have been a walking path along the shoreline several decades ago, as staff noted concrete structures on both sides of a constricted part of the lake that may have supported a small bridge. The immediate surroundings are heavily wooded except for the east shoreline, which was cleared of vegetation during 2000. However, the Harvey Lake area must have been disturbed many years ago since an invasive exotic shrub, buckthorn, was noted growing along virtually the entire shoreline. Several of these trees were very large for this species, indicating that they had been growing for many years.

LIMNOLOGICAL DATA WATER QUALITY

Water samples were collected once a month, from May through September 2000, at the deepest point in the lake (See Figure 1). Samples were collected at three feet and at 11 feet. The samples were analyzed for a variety of parameters. See Appendix A for water quality sampling and laboratory methods.

INSERT FIGURE 1.

[1] One acre-foot is once acre filled with one foot of water, or 325,900 gallons.

The water clarity in Harvey Lake is poor, averaging 2.03 feet for the 2000 season. The Lake County seasonal average clarity is 5.0 feet deep[2]. The reason for the poor water clarity is the high concentration of total suspended solids (TSS) in the water column. Total suspended solids, which include algal bodies and sediment particles, were nearly five times higher near the surface in Harvey Lake than the Lake County seasonal median. Few rooted plants were found in Harvey Lake, which help keep the sediment from being swept up into the water column by wind, wave and carp action. The water color indicated that both sediment and algae clouded the water. Because of the low numbers of plants in the lake, algae had no competition from large plant beds for sunlight or nutrients for growth. Total volatile solids (TVS), which include algal bodies, plant particles and other organic materials, was nearly twice as high near the surface of Harvey Lake than the Lake County seasonal average. The entire shoreline is eroding, which adds humic, peaty soil to the water. This soil type is highly organic which also adds to the TSS and TVS within the water column.

The trophic condition of a lake indicates its overall nutrient enrichment. The two key nutrients that fuel algae growth are phosphorus and nitrogen. Most lakes in Lake County are eutrophic, or nutrient rich, and are productive lakes in terms of plants and/or algae and fish. These lakes frequently have heavy algae blooms or dense plant beds. In terms of its phosphorus content, Harvey Lake is classified as a eutrophic lake. Total phosphorus and nitrogen were both in high concentrations in Harvey Lake. The seasonal median for total phosphorus (TP) near the surface was nearly twice as high as the Lake County median. Samples near the bottom had total phosphorus concentrations that were indicative of a nutrient rich system, but were slightly lower than the Lake County median. The thermal stratification that occurred in Harvey Lake did not allow the water layers to mix, and as the season progressed, the TP and ammonia concentrations increased at the bottom until fall turnover in September. This is because the bottom water layer lost oxygen over time from the process of decomposition of organic materials. The dissolved oxygen (D.O.) was measured from the surface to the bottom, taking readings at every foot. The lake held the least amount of D.O. in May and July, when sufficient concentrations for a bluegill/bass fishery (3.0 mg/L) were from the surface down to six feet deep. Harvey Lake was anoxic (less than 1.0 mg/L) at the bottom each month except September. However, the reading near the bottom in September was only 1.9 mg/L. Without volume data from a recent, accurate bathymetric map, the volume of oxygenated water in Harvey Lake cannot be calculated. The nitrate nitrogen concentrations throughout the water column were close to or higher than the Lake County median from May through August. The concentrations in September were below laboratory detection limits. Ammonia concentrations near the surface of Harvey Lake were high in May, but dropped to less than detectable concentrations by the month of July. Two reasons why this concentration dropped are ammonia conversion and algae use of ammonia. If the water is oxygenated, as it was during these months in Harvey Lake, the ammonia will convert to nitrate nitrogen. Algae strip the surface water of this nutrient for growth purposes during the remainder of the season. Ammonia was very high in the deep water layer, increasing to 7.14 mg/L in August. The strong thermal stratification in the lake trapped ammonia near the bottom as it was continually being released by the sediment.

[2] Medians and averages were calculated with LCHD water quality data collected from 72 lakes from 1995 – 2000.

The ratio of total nitrogen (TN) to total phosphorus in the lake will signify whether the lake is in shorter supply of either nitrogen or phosphorus. 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. Harvey Lake has a TN:TP ratio of 19:1 indicating a lake limited by phosphorus, but with enough of both nutrients to support algal blooms.

Harvey Lake also had high total dissolved solids (TDS) and conductivity readings. Total dissolved solids concentrations directly affect conductivity readings. For example, the higher the TDS concentration the higher the conductivity. This holds true in Harvey Lake. The alkalinity readings near the surface were similar to the Lake County average. However, the alkalinity results in the deep water samples were high, and the result in August (309 mg/L) was the highest recorded in the 1995-2000 Lake County Health Department (LCHD) database. As previously mentioned, the deep water samples also yielded an extremely high ammonia concentration in August. Harvey Lake was strongly stratified, allowing no mixing of the surface and bottom water layers. It is possible that not only was ammonia being released from the sediment, but other ion producing substances, such as calcium carbonate, which would directly influence an increase in alkalinity. Calcium carbonate is often found in lakes with underlying limestone bedrock. Limestone features are commonly found throughout Lake County.

LIMNOLOGICAL DATA - PLANT ASSESSMENT

Only six plant species were found in Harvey Lake, which were scattered in very small numbers (See Table 1). Eurasian water milfoil was found most, occurring in 9% of the plant samples, or on six occasions throughout the season. The milfoil was found most often in the shallow channel between the main shore and the island. The other two plants found most often were northern water milfoil and sago pondweed, both occurring in 7% of the plant samples. Combined, the total amount of lake bottom with plants was approximately 1.0 acre, or 8% of the lake bottom. The planktonic algae clouds the water, competing with plants for available sunlight. 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. During 2000, the least amount of available light was in September, when 1% of the available light was extinguished below 3.23 feet. During the other months, the 1% light level could be found between 4 and 7 feet deep. The peaty sediment is not a preferred growth substrate for milfoil, so this coupled with the low water clarity is why the lake is not overgrown with milfoil.

Table 1. Aquatic Plant Species in Harvey Lake (May – September, 2000)

<u>*Aquatic Plants*</u>	
Coontail	*Ceratophyllum demersum*
Duckweed	*Lemna minor*
Eurasian Water Milfoil	*Myriophyllum spicatum*
Northern Water Milfoil	*Myriophyllum sibiricum*
Leafy Pondweed	*Potamogeton foliosus*
Sago Pondweed	*Stuckenia pectinatus*

LIMNOLOGICAL DATA - SHORELINE ASSESSMENT

During 2000, LCHD staff evaluated the shoreline around Harvey Lake. Methodology is detailed in Appendix A. Of the 5808 feet of shoreline that rings the lake, all is classified as undeveloped at this time. However, nearby construction may change this. Trees, shrubs and other "field" plants along the east shore were cut down during the 2000 assessment. Most of the tree species, though, were invasive buckthorn trees. Buckthorn surrounds nearly the entire shoreline. Although it does provide cover for wildlife, the removal of this species is always recommended. Buckthorn exudes a chemical that discourages other plant growth. Staff noted bare soil under these shrubs along the shoreline, which aggravates erosion. Most of the shoreline around Harvey Lake is severely eroding, except for approximately 150 feet of shoreline in the small bay in the southeast portion of the lake. The soils are loose, hydric, peaty soils that are highly erodable. Another reason for the eroding shoreline is the fluctuating water level in the lake. Although the nearest rain gauge recorded 7 inches of rain between the May and June sample dates, the water level in Harvey Lake dropped nearly 16 inches. Between July and August, the water level increased by nearly 9 inches. The fluctuating water level, the bare erodable soils under the buckthorn, and damage from ice formation are all reasons for the eroding shorelines. Because there is a large number of buckthorn trees, it may be difficult and/or cost prohibitive to remove all of them at one time, and replant the shoreline simultaneously. It may be easier to remove the buckthorn a portion at a time, with the intent to immediately plant native species that can help stabilize the shoreline and maintain habitat. However, because of the severity of the erosion, native plantings may need to be used in conjunction with riprap, A-Jacks ®, or willow posts to prevent further erosion until the new plants become established.

WILDLIFE ASSESSMENT

LCHD staff observed wildlife species during sampling visits to Harvey Lake. Methodology is discussed in Appendix A. A listing of the wildlife can be found in Table 2. Staff identified juvenile black-crowned night herons on two occasions, indicating that this Illinois State endangered species could be nesting at Harvey Lake. An osprey was also observed fishing in the lake. Although much the heavily wooded area consists of nuisance buckthorn trees, they provide some wildlife habitat. The small cove in the southeast part of the lake and the area between the island and the main shoreline had downed trees (deadfall), which provide good habitat for turtles, fish and water birds. Deadfall should be left in the water.

The encroaching development will eventually disturb some of this habitat. To preserve the integrity of a wooded area, the buckthorn trees should be removed and replaced with native shrub and/or tree species. Removal should be done after the nesting season, particularly if the black-crowned night herons are using the area for nesting purposes.

Table 2. Wildlife Species Present, May – September, 2000.

Birds	
Double Crested Cormorant	*Phalacrocorax auritus*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
Ring-billed Gull	*Larus delawarensis*
Common Tern*	*Sterna hirundo*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Black-crowned Night Heron*	*Nycticorax nycticorax*
Killdeer	*Charadrius vociferus*
Unknown accipiter hawk	*Accipiter spp.*
Red-tailed Hawk	*Buteo jamaicensis*
Osprey*	*Pandion haliaetus*
Mourning Dove	*Zenaida macroura*
Belted Kingfisher	*Megaceryle alcyon*
Hairy woodpecker	*Picoides villocus*
Eastern Kingbird	*Tyrannus tyrannus*
Eastern Pewee	*Contopus virens*
Rough-wing Swallow	*Stelgidopteryx ruficollis*
Bank Swallow	*Riparia riparia*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
House Wren	*Troglodytes aedon*
Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Rock Dove	*Columba livia*
Cedar Waxwing	*Bombycilla cedrorum*
Warbling Vireo	*Vireo gilvus*
Yellow-rumped Warbler	*Dendroica coronata*
Northern Waterthrush	*Seiurus noveboracensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Song Sparrow	*Melospiza melodia*
Arachnids	
Aquatic Wolf Spider	unknown species

* Endangered in Illinois
+Threatened in Illinois

EXISTING LAKE PROBLEMS

X *Harvey Lake has poor water clarity, with a seasonal average of only 2.03 feet.*

This is a result of high total suspended solids, which are algal bodies and sediment disturbed from the bottom, and soil sloughing from the eroding shorelines.

X *100% of the shoreline around Harvey Lake is severely eroding.*

Although the shoreline around the lake is undeveloped and wooded, the dominant plant is buckthorn, an invasive shrub. Because no plants grow underneath these shrubs, bare soil near the water's edge is easily eroded. The shoreline consists of soils that are loose and peaty, which are highly erodable. Shifting ice causes further damage along the shoreline.

- *Much of the shoreline vegetation consists of nuisance buckthorn trees.*

Although the buckthorn trees offer some habitat for wildlife, removal of these trees is always recommended. Buckthorn exudes a chemical that prohibits the growth of understory plants, leaving the soil bare. This promotes shoreline erosion.

X *Harvey Lake is rich in nutrients.*

The nutrient concentrations in Harvey Lake support an abundance of algae, which clouds the water.

- *A recent accurate bathymetric map of Harvey Lake does not exist.*

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, or aeration were part of a future overall lake management plan.

POTENTIAL OBJECTIVES FOR A LAKE MANAGEMENT PLAN FOR HARVEY LAKE

I. Create a Bathymetric Map.
II. Mitigate Shoreline Erosion
III. Remove Invasive Plant Species
IV. Re-Introduce Beneficial Native Plants, Including Shoreline Species
V. Create an Algae Control Plan
VI. Maintain and Improve Habitat for Wildlife

ALTERNATIVES FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES FOR HARVEY LAKE

Objective I: Create a 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, especially volume, would be important if lake management practices such as aquatic herbicide use, fish stocking, dredging, an alum treatment or aeration were part of a future overall lake management plan. Harvey Lake does not have a recent accurate bathymetric map. 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.

Objective II: Mitigate Shoreline Erosion.

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 worsen the problem. Erosion not only results in loss of shoreline property, but negatively influences the lake's overall water quality by contributing nutrients and sediment 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.

Because Harvey Lake has a naturalized shoreline, erosion control methods employing the use of plantings would maintain wildlife habitat. However, because of the highly erodable soil, and the fluctuating water level, plantings may be difficult to maintain. If this type of erosion control were used, the plants or willow posts may need to be augmented with riprap or even A-Jacks® to support the shore . The buckthorn trees would also need to be removed before installing new plants. Riprap would be better at controlling this eroding shoreline, but would disturb the integrity of the present wildlife habitat if plantings were not included. Biologs may not work well with this highly erodable shoreline. Replacing the shoreline plants with turfgrass is not recommended, as turfgrass will not be able to stabilize this shoreline with its short root structure. The Village may want to mitigate small shoreline sections at a time, rather than trying to improve the entire shoreline at once. Small sections of different erosion control methodology can also provide different types of wildlife habitat.

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 worsen the poor water clarity in Harvey Lake due to high levels of sediment. More nutrients can also enter the lake. This will provide additional nutrients for increased 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: 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 riprap.

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 3 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 highly erodible, willow posts may have to be used in conjunction with another erosion control technique such as biologs, A-Jacks ®, or riprap.

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or riprap. 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 3 should be considered for native plantings.

All eroding areas could benefit from vegetative plantings, but depending on the severity of erosion, another technique in conjunction with plants may be necessary. One method would be to use willow posts in conjunction with a biolog, which would protect the shoreline until the willows become established. The plantings on the biolog would add further protection.

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. The wet soils around the Harvey Lake shoreline and the fluctuating water level will not will not allow turfgrass to survive along the shoreline. Also, the short root structure of turfgrass will not provide protection against shoreline erosion. 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. 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. Because the shoreline is severely eroding, native plants alone may not be sufficient without the further protection of willow posts, biologs, or A-Jacks ®. The cost of installing willow posts alone around the shoreline of Harvey Lake (except for the shoreline along the small southeast bay) would range from approximately $77,000 - $103,000. The labor that is needed may be completed by the shoreline owner (in this case, the Village of Vernon Hills), 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. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

Table 3. Costs for Native Plants

Terrestrial-Dry soil	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Big Bluestem Grass (*Andropogon gerardii*)	10-25b lbs/acre	$20/lb	NA	$4-5
Bluejoint Grass (*Calamagrostis canadensis*)	2 lbs/acre	$2-4/oz	NA	$4-5
Little Bluestem Grass (*Andropogon scoparius*)	10-25 lbs/acre	$20/lb	NA	$4-5
Prairie Cord Grass (*Spartina pectinata*)	0.25-1.0 lbs/acre	$2-3/oz	250-500/acre	$2-4
Switch Grass (*Panicum virgatum*)	0.5-2.0 lbs./acre	$6-7/oz	NA	$1-5
Terrestrial-Wet Soil	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Blue Flag (*Iris versicolor*)	NA	$10/oz	1000/acre	$0.60-1.50
Blue Vervain (*Verbena hastata*)	NA	$6/oz	500-1000/acre	$0.80-1.00
Blunt Spike Rush (*Eleocharis obtusa*)	NA	$30/oz	500-1000/acre	$0.50-1.00
Boneset (*Eupatorium perfoliatum*)	0.006-0.25 lbs./acre	$6-7/oz	500-700/acre	$1.00
Water Horsetail (*Equisetum fluviatile*)	NA	NA	1000/acre	$0.50
Joe-Pye-Weed (*Eupatorium maculatum*)	NA	$8/oz	500-700/acre	$0.50-1.00
Sweet Flag (*Acorus calamus*)	NA	$10/oz	250/acre	$0.50-1.00
Wild Rice (*Zizania aquatica*)	NA	$5.00/lb	1000/acre	$0.50-0.20
Trees and Shrubs	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Bur Oak (*Quercus acrocarpa*)	NA	NA	NA	$5-6
Buttonbush (*Cephalanthus occidentalis*)	NA	NA	NA	$6-7
Red Osier Dogwood (*Cornus stolonifera*)	NA	$9/oz	NA	$2-5
White Oak (*Quercus alba*)	NA	$5-8/oz	NA	$6-7
Seed Mixes	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Forb and Grass Seed Mix	500 square ft	$20-60	NA	NA
Forb and Grass Seed Mix	1000 square ft	$66-108	NA	NA

Option 3: Install Biolog, Fiber Roll, or Straw Blanket with Plantings

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Once established, a buffer strip of native plants can be planted along side or on top of the roll (depending if rolls are made of synthetic or natural fibers). They are most effective in areas where plantings alone are not effective due to already severe erosion. In areas of severe erosion, other techniques may need to be employed or incorporated with these products. This may be the case with Harvey Lake, since the shoreline is highly erodable. The Village may want to try using this method on a small portion of the shoreline as a pilot project, with the use of additional erosion techniques such as willow posts.

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. If a 100-foot section of shoreline were mitigated with biologs and willow posts, this would cost from $4,000 - $5,500. This does not include the necessary permits and surveys, which may cost $1,000 – 2,000 depending on the type of earthmoving that would be needed. Additional costs may be incurred if compensatory storage is needed.

Option 4. Install Rock Riprap

Riprap 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. Riprap can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the riprap, 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). Although the use of riprap would disturb the natural setting of the present lake shoreline around Harvey Lake, this method may be a viable solution to curtail the severe erosion. Fill can be added to provide a growth medium for native plants in voids of the riprap after it has been installed.

Pros

Riprap 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, riprap will last for many years. Maintenance is relatively low, however, undercutting of the bank can cause sloughing of the riprap and subsequent shoreline. Areas with severe erosion problems may benefit from using riprap. 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 riprap 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. This would not be an option for the shorelines that could not be accessible by heavy equipment, such as the island. Permits are required if replacing existing or installing new riprap 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 riprap 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 riprap 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 riprap 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.

Riprap 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 riprap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $30-45 per linear foot. 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. If this method were used around the shoreline of Harvey Lake (except for the shoreline along the small southeast bay), the cost would range from approximately $154,000 to $231,000. Costs for permits and surveys can be $1,000-2,000 for installation of riprap, 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 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® cannot 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 runoff nutrients, sediment, and pollutants. Less runoff 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.

Costs for the installation of A-Jacks® along the shoreline of Harvey Lake (except for the shoreline along the small southeast bay) would range approximately $205200 - $385,000. This does not include replacing the soil and planting native vegetation, which is recommended.

Objective III: Remove Invasive Shoreline Plant 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. Buckthorn trees were found most often around the entire shoreline of Harvey Lake. Buckthorn trees exude a chemical that discourages plant growth beneath. This may have aggravated the shoreline erosion, since the trees are close to the shoreline and few understory plants are present to stabilize the soil. The removal of buckthorn trees is always recommended. Removal of a few buckthorn trees at a time could be done instead of attempting to remove all of them at once. This section will address terrestrial shoreline exotic species.

Although purple loosestrife and reed canary grass were not noted during the LCHD survey of Harvey Lake, these plants are adept at colonizing disturbed areas, such as the eastern shoreline where the buckthorn trees were removed in the spring of 2000. Village staff will want to watch for these species and remove them if they start to invade the area. 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. 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 3 in Objective III: "Mitigate Shoreline Erosion" 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: 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 excavated. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. The numbers of purple loosestrife found along the east side of the channel are small enough that this option is feasible. 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. Girdling could control large buckthorn trees, which is done by removing a ring of bark around the trunk. However, the tree could resprout from the base of the trunk. It may be best to remove small sections of these trees at a time rather than trying to eradicate them all at once. Replanting the areas with native beneficial plants would be important soon after the buckthorn trees are removed.

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

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.

Because the buckthorn trees by Harvey Lake are near water, only the use of the herbicide Rodeo® (active ingredient, glyphosphate) can be used if the Village wishes to use herbicides. The trees would need to be girdled, and injected with the herbicide, or cut down, and their exposed stumps would need to be wicked with Rodeo®. Again, it may be easiest to treat small areas of buckthorn (rather than the entire shoreline) and then replant the area with beneficial native plants soon after treatment.

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:

The cost for one gallon of Rodeo® is $65. Wicking devices are $30-40. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively.

Objective IV: Re-Introduce Beneficial Native Plants, Including Shoreline Species

The reintroduction of beneficial, native aquatic plants would benefit Harvey Lake. However, since the lake has poor clarity due to excessive algal growth, the algae must be controlled at the same time that a revegetation plan is in process. Without adequate light penetration, revegetation will not work. At minimum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

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 grass carp, 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 4 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are aquatic shoreline vegetation (rushes, cattails, etc) and deeper water plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

Pros

By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. Once established, expanded native plant populations will help to control growth of nuisance 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 is less expensive than other options. Expanded native plant populations will also help with sediment stabilization. This in turn will have a positive effect on water clarity by reducing suspended solids and nutrients that decrease clarity and cause excessive algal growth. Properly revegetating shallow water areas with plants such as cattails, bulrushes, and water lilies can help reduce wave action that can lead to shoreline erosion. Increases in desirable vegetation will increase the plant biodiversity and also provide better quality habitat and food sources for fish and other wildlife. Recreational uses of the lake such as fishing and boating will also increase due to the improvement in water quality and the suppression of weedy species.

Cons

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

Costs

Costs are listed in Table 4 on the following page. They include plants that grow in both near-shore and deepwater environments.

Table 4. Costs for Native Aquatic Plants

1"-1.5' Deep	Seeding Rate	Seed Price	Planting Rate	Price/Plant
Arrow Arum (*Peltandra virginica*)	NA	$4-5/oz	1000/acre	$0.40-1.00
Bottle Brush Sedge (*Carex comosa*)	0.12-0.19 lbs./acre	$6-8/oz	NA	NA
Chairmakers Rush (Scirpus americanus)	0.06-0.25 lbs/acre	$8-15/oz	1000/acre	$0.25-0.85
Common Arrowhead (*Sagittaria latifolia*)	0.06-0.125 lbs/acre	$15-16/oz	1000/acre	$0.60-1.25
Common Burreed (*Sparganium euycapum*)	0.06-0.25 lbs/acre	$10-15/oz	1000/acre	$0.22-0.50
Common Cattail (*Typha latifolia*)	0.06-0.5 lbs/acre	$3-15/oz	1000/acre	$0.40-1.00
Hardstem Bulrush (*Scirpus acutus*)	0.06-0.25 lbs/acre	$8-15/oz	1000/acre	$0.25-0.50
Pensylvania Smartweed (*Polygonum pensylvanicum*)	0.06-0.25 lbs/acre	$5/oz	NA	NA
River Bulrush (*Scirpus fluviatilis*)	0.06-0.25 lbs/acre	$5/oz	NA	NA
Soft Rush (*Juncus effusus*)	0.06-0.125 lbs/acre	$15-16/oz	$4-5	$0.25-0.90
Softstem Bulrush (*Scirpus validus*)	NA	$20/oz	1000/acre	$0.25-0.90
Water Plantain (*Alisma subcordatum*)	0.06-0.25 lbs/acre	$10-15/oz	1000/acre	$0.25-0.85
Water Smartweed (*Polygonum fluitans*)	0.06-0.5 lbs/acre	$3-25/oz	1000/acre	$0.35-0.50
White Water Buttercup (*Ranunculus longirostris*)	NA	NA	500/acre	$0.40-0.50
Yellow Water Buttercup (*Ranunculus flabellaris*)	NA	NA	500/acre	$0.70-1.51
1.5'-3' Deep	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Watersheild (*Brasenia schreberi*)	NA	NA	1000/acre	$0.65-1.49
White Water Lily (*Nymphaea tuberosa*)	NA	NA	200/acre	$0.30-0.40
Yellow Water Lily (*Nuphar advena*)	NA	NA	200/acre	$3.75
3'-8' Deep	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Elodea (*Elodea canadensis*)	NA	NA	1000/acre	$0.25-0.51
Large-leaved Pondweed (*Potamogeton amplifolius*)	NA	NA	1000/acre	$0.25-0.51
Richardson's Pondweed (*Potamogeton richardsonii*)	NA	NA	250lbs/acre	$2/lb
Sago Pondweed (*Potamogeton pectinatus*)	NA	NA	1000/acre	$0.35-0.50
Vallisineria, Eel Grass (*Vallisineria americana*)	NA	NA	1000/acre	$0.40-0.75
Water Stargrass (*Zosterella dubia*)	NA	$4.00/lb	1000/acre	$0.25-0.50

Objective V: Create an Algae Control Plan

Control of the algae may be needed to encourage plant growth in Harvey Lake.

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

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

Cons

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

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

In addition to ecological impacts, many physical lake uses will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick mats of filamentous algae. Swimming could also become increasingly difficult and unsafe due to thick mats and reduction in visibility by planktonic blooms. Fishing could become more and more exasperating due in part to the thick mats and stunted fish populations. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by large green mats and/or blooms of algae and the odors that may develop, such as with large blue-green blooms. The combination of above events could cause property values on the lake to suffer. Property values on lakes with algae problems have been shown to decrease by as much as 15-20%.

Costs

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

<u>Option 2: Algicides</u>

Algicides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate ($CuSO_4$) and chelated copper products are the two main algicides in use. These two compounds are sold by a variety of brand names by a number of different companies. They all work the same and act as contact killers. This means that the product has to come into contact with the algae to be 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^oF). This will help lessen the likelihood of an oxygen crash and resulting fish kills. When possible, treatments should be made as early in the season as possible. It is best to treat in spring or when the blooms/mats starts to appear there by killing the algae before they become a problem.

Pros

When used properly, algicides can be a powerful tool in management of nuisance algae growth. A properly implemented plan can often provide season long control with minimal applications. Another benefit of using algicides are their low costs. The fisheries and waterfowl populations of the lake would greatly benefit due to a decrease in nuisance algal blooms. By reducing the algae, clarity would increase. This in turn would allow the native aquatic plants to return to the lake. Newly established stands of plants would improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed (*Potamogeton amplifolius*) and sago pondweed (*Potamogeton pectinatus*). Additionally, copper products, at proper dosages, are selective in the sense that they do not affect aquatic vascular plants and wildlife.

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

Cons

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

Costs

In liquid form, copper sulfate is applied at a rate of 2.7 gallons per acre-foot with a cost of about $7.50 per gallon. 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. Because a recent accurate bathymetric map of Harvey Lake is unavailable, the costs and amounts are only estimates. An estimate for Harvey Lake is 112.5 acre-feet x 2.7 gallons, or 304 gallons, with a cost of $2280. A chelated copper product, such as Cutrine plus, is applied at a rate of 0.5 –1.5 gallons per acre-foot with a cost of about $35 per gallon. An estimate for Harvey Lake ranges from 56 to 170 gallons, with a cost estimate of $1960- $5950.

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, which can then prevent sediment bound phosphorus from entering the water column. Phosphorus inactivation using alum has been in use for 25 years. However, cost and unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds, and its use in larger lakes is increasing. Alum treatment typically lasts 1 to 20 years depending on various parameters. Lakes with low average depth to surface area are good candidates. This encompasses many lakes within Lake County. Lakes that are thermally stratified experience longer inactivation than non-stratified lakes due to isolation of the flocculent layer. 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.

Without a recent, accurate bathymetric map of Harvey Lake, calculations to determine the amount of alum necessary for phosphorus inactivation will be a rough estimate. An accurate calculation to determine the necessary alum amount is vital for the success. Unless a recent, accurate bathymetric map is available or will be created just prior to alum use, this option should not be attempted. Harvey Lake may not be a perfect candidate for an alum treatment since the amount of phosphorus loading from the watershed is not known. If the watershed does deliver heavy amount of phosphorus yearly, the alum treatment would be short-lived.

Pros

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

Cons

There are several drawbacks to alum. External nutrient inputs must also be reduced or eliminated for alum to provide long-term effectiveness. With larger watersheds this could prove to be physically and financially impossible. Phosphorus inactivation may be shortened by excessive plant growth or motorboat traffic, which can disturb the flocculent layer and allow phosphorus to be released. Also, lakes that are shallow, non-stratified, and wind blown typically do not achieve long term control due to disruption of the flocculent layer. If alum is not properly applied toxicity problems may occur. Typically aluminum toxicity occurs if pH is below 6 or above 9. Most of Lake County's lakes, including Valley Lake, 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.

Cost

Aluminum sulfate is applied at a rate of 40-80lbs/acre-foot at 35-60 cents/lb. A very rough estimate for Harvey Lake using the estimated volume of 112.5 acre-feet gives a cost range of $1575-$5400.

Objective VI: Maintain or Enhance Areas for Wildlife.

Although it is recommended that they be removed, the buckthorn trees around Harvey Lake offer some good habitat in the form of cover for birds and small animals. As the buckthorn trees are removed, native plantings can help maintain habitat for wildlife. Other good habitat can be found in the secluded bay, where different wetland plants are growing along the shore. These plants can offer different food sources for a variety of species. However, with encroaching development, the variety of wildlife that was noted during 2000 will most likely diminish. Options below can help maintain and/or enhance habitat areas.

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

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

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

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

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

Pros

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

Cons

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

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

Costs:

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

<u>Option 2: Increase Habitat Cover</u>

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 Table 4 for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species outcompete native plants and provide little value for wildlife.

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

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

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

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

Pros

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

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

Cons

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

Costs:

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

Option 3: Increase Natural Food Supply

This can be accomplished in conjunction with Option 2. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Plants found in Table 4 should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily, sago pondweed, largeleaf pondweed, and wild celery to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

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

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

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

Pros

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

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

Cons

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

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

Costs:

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

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

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

Pros

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

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

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

Cons

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

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

Costs:

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

Table 4. 2000 Harvey Lake Water Quality Data

Epilimnion

DATE	DEPTH	ALK	TKN	NH3	NO3	TP	SRP	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
5/11/00	3	196	1.4	0.39	0.223	0.08	0.018	636	14	610	141	2.56	0.9495	7.8	4.85
6/15/00	3	176	1.22	0.13	0.105	0.07	<0.005	600	14	694	258	2.69	0.8537	8.1	6.81
7/13/00	3	163	1.48	<0.1	0.071	0.08	<0.005	590	23	615	246	1.74	0.7350	8.7	10.52
8/17/00	3	165	1	<0.1	0.06	0.07	<0.005	538	20	641	258	1.67	0.7773	8.4	6.06
9/14/00	3	148	1.74	<0.1	<0.1	0.09	0.032	NA	28	540	191	1.51	0.7315	8.4	7.22
Median		165	1.4	0.26[k]	0.09[k]	0.08	0.025[k]	595	20	615	246	1.74	0.7773	8.4	6.81
Average		170	1.37	0.261[k]	0.115[k]	0.077	0.03[k]	590	20	620	219	2.03	0.8094	8.28	7.09

Hypolimnion

DATE	DEPTH	ALK	TKN	NH3	NO3	TP	SRP	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
5/11/00	11	206	2.1	1.25	0.052	0.15	0.09	626	12	638	173	NA	0.9433	7.2	0
6/15/00	11	177	1.48	0.16	0.107	0.06	<0.005	650	14	718	286	NA	0.9171	7.2	0.01
7/13/00	11	206	2.88	1.71	0.073	0.14	0.081	642	12	671	233	NA	0.8866	7	0.04
8/17/00	11	309	8.4	7.14	0.064	0.19	0.027	560	16	630	212	NA	0.8944	6.9	0.13
9/14/00	10	155	1.62	0.18	<0.1	0.07	0.006	NA	19	537	181	NA	0.7731	7.5	0.56
Median		206	2.1	1.25	0.069[k]	0.14	0.054[k]	634	14	638	212	NA	0.8944	7.2	0.04[k]
Average		211	3.30	2.09	0.074[k]	0.121	0.051[k]	620	15	639	217	NA	0.8829	7.15	0.15[k]

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
TDS = Total dissolved solids, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi Disk Depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

Note: "k" denotes that the actual value is known to be less than the value presented.
NA = Not Applicable

Appendix C. Plants Species and Occurrences in Harvey Lake

5/12/00 - 9/14/00	Coontail	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Northern Watermilfoil	Sago Pondweed
Num. of Sites	1	2	6	1	5	5
% Occurance	1%	3%	9%	1%	7%	7%

5/12/00	Coontail	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Northern Watermilfoil	Sago Pondweed
Num. of Sites	0	0	0	0	0	0
% Occurance	0%	0%	0%	0%	0%	0%

6/13/00	Coontail	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Northern Watermilfoil	Sago Pondweed
Num. of Sites	0	0	0	0	4	1
% Occurance	0%	0%	0%	0%	27%	7%

7/13/00	Coontail	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Northern Watermilfoil	Sago Pondweed
Num. of Sites	1	1	1	0	0	1
% Occurance	6%	6%	6%	0%	0%	6%

8/17/00	Coontail	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Northern Watermilfoil	Sago Pondweed
Num. of Sites	0	0	2	0	0	1
% Occurance	0%	0%	20%	0%	0%	10%

9/14/00	Coontail	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Northern Watermilfoil	Sago Pondweed
Num. of Sites	0	1	4	0	0	1
% Occurance	0%	10%	40%	0%	0%	10%

Appendix A. Methods for Field Data Collection and Laboratory Analyses

Water Sampling and Laboratory Analyses

Two water samples were collected once a month from May through September. Sample locations were generally at the deepest point in the lake (see sample site map), three feet below the surface, and approximately two feet off the bottom. Samples were collected with a horizontal or vertical Van Dorn water sampler. Approximately three liters of water were collected for each sample for all lab analyses. After collection, all samples were placed in a cooler with ice until delivered to the Lake County Health Department lab, where they were refrigerated. TestAmerica Incorporated, an environmental services lab, analyzed samples collected for total Kjeldahl nitrogen (TKN). The Health Department lab analyzed all other samples. Analytical methods for the parameters are listed in Table 1. Except nitrate nitrogen, all methods are from the Eighteenth Edition of Standard Methods, (eds. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1992). Methodology for nitrate nitrogen was taken from the 14th edition of Standard Methods. Total Kjeldahl nitrogen was analyzed by method 351.2 from the Methods for Chemical Analyses of Water and Wastes (EPA 600 Series). Dissolved oxygen, temperature, conductivity and pH were measured at the deep hole with a Hydrolab DataSonde® 4a. Photosynthetic Active Radiation (PAR) was recorded using a LI-COR® 192 Spherical Sensor attached to the Hydrolab DataSonde® 4a. Readings were taken at the surface and then every foot until reaching the bottom in lakes $\leq$ 15 feet deep, and every two feet in lakes >15 feet.

Plant Sampling

Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At random locations in the littoral zone, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, any plants on the rake were identified and recorded. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling, were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation. Approximate locations of each point were drawn on an aerial photo of the lake. Locations of the plant edge were also identified and marked on the aerial photo. The plant edge was defined as the area where aquatic plants presence dissipated, typically toward the deeper portions of the lake. The number of sample locations was contingent upon lake surface area, area of littoral zone, and presence and distribution of plants.

Shoreline Assessment

To assess the current condition of each lake's shoreline, a shoreline assessment was completed in 2000. This survey was conducted with the use of a boat, aerial photos, and county parcel maps. The shoreline along the land/water interface on each parcel was observed from a boat and various parameters were assessed (Table 2). Shorelines were first identified as developed or undeveloped. The type of shoreline was then determined and length of each type was recorded based on the parcel map or was estimated. In addition, several other parameters were measured including: the extent of shoreline vegetation, the degree of slope and erosion, and the presence of inlets, recreational structures (including boats, canoes, jetskis, boat ramps, piers, boat lifts, swimming platforms, etc.), aerators, irrigation pumps, water control structures, invasive vegetation, beaver activity, and deadfall (trees or shrubs lying in the water).

Frequently a parcel consisted of several shoreline types. For example, a parcel may have a beach, a steel seawall, and riprap along the its shore. In this case, the parcel was subdivided into three separate sections.

Data was entered and analyzed in ArcView 3.2 © Geographic Information System (GIS) software. Total shoreline lengths and percentages for each category were determined using Excel software.

Wildlife Assessment

Species of wildlife were noted during visits to each lake. When possible, wildlife was identified to species by sight or sound. However, due to time constraints, collection of quantitative information was not possible. Thus, all data should be considered anecdotal. Some of the species on the list may have only been seen once, or were spotted during their migration through the area.

Table A1. Analytical Methods Used for Water Quality Parameters.

Parameter	***Method***
Temperature	Hydrolab DataSonde® 4a
Dissolved oxygen	Hydrolab DataSonde ®4a
Nitrate nitrogen	Brucine method
Ammonia nitrogen	Electrode method, #4500F
Total Kjeldahl nitrogen	EPA 600 Series, Method 351.2
pH	Hydrolab DataSonde® 4a, Electrometric method
Total solids	Method #2540B
Total suspended solids	Method #2540D
Total dissolved solids	Method #2540C
Total volatile solids	Method #2540E, from total solids
Alkalinity	Method #2320B, titration method
Conductivity	Hydrolab DataSonde® 4a
Total phosphorus	Methods #4500-P B 5 and #4500-P E
Soluble reactive phosphorus	Methods #4500- P E and #4500-P B1
Clarity	Secchi disk
Color	Illinois EPA Volunteer Lake Monitoring Color Chart
Photosynthetic Active Radiation (PAR)	Hydrolab DataSonde® 4a, LI-COR® 192 Spherical Sensor

Table A2. Shoreline Type Categories and Assessment.

Category	***Assessment***
Developed	Yes, No
Inlets	None, Culvert, Creek, Farm Tiles, Storm Water Outlet, Swale, Sump
Shoreline Vegetation	None, Light, Moderate, Heavy
Type	Prairie, Shrub, Wetland, Woodland, Beach, Buffer, Canopy, Lawn, Riprap, Seawall, Vacant
Slope	Flat, Gentle, Steep
Erosion	None, Slight, Moderate, Severe
Water Control Structures	None, Culvert, Dam, Spillway
Recreational Structures	Yes, No
Irrigation Present	Yes, No
Aerator Present	Yes, No
Invasive Vegetation	Yes, No
Beaver Activity	Yes, No
Deadfall	Yes, No