# BOG MONITORING PROGRAM 2000
# SURVEY SUMMARY
# Bearpath Golf and Country Club, Eden Prairie, Minnesota


## ABSTRACT

The three bogs within the Bearpath Golf and Country Club are *Open Graminoid Bogs* with characteristics of fens, marshes, sedge meadows, and wet shrub communities. All displayed typical *Sphagnum* bog vegetation. The bogs also contained vegetation that indicated a transition away from a bog toward a more fertile, aerated, and alkaline fen. Vegetation indicating this transition included noxious weeds, aliens, xenophytes, marsh and fen species, and shrubs, as well as increased species diversity along the bog perimeter. Also indicative of the transition toward fen or marsh was the presence of dry laggs on the perimeter. It is a matter of debate whether or not this transition is a natural process. However, the presence of noxious weeds, aliens, and xenophytes as well as the drastic alteration of the surrounding environment gives strong support to the conclusion that the transitions evident in the bogs were largely the result of anthropogenic factors. To be specific, these would be elimination of the original flora and fauna from adjacent lands, farming, housing development, golf course development, an increase in sedimentation, an alteration of hydrology, nutrient loading from fertilizers, and the application of pesticides and herbicides. Suggested steps to preserve the integrity of the bogs included introduction of wider, native species buffer zones, controls on fertilizers, pesticides, and herbicides within the bog watersheds, and elimination of noxious weeds. In this survey 54 species were encountered that were not seen in 1998. Thirty-seven species seen in 1998 were not seen this season. This may be a result of the drought conditions that prevailed at the time of the survey.


## PROJECT INFORMATION

There are three sphagnum bogs located within the Bearpath Golf and Country Club properties in Eden Prairie, Minnesota. In 1992, the U. S. Army Corps of Engineers determined that the rarity and location of these bogs warranted efforts to preserve the quality of the bogs. To accomplish this, the Corps concluded that the vegetation of the bogs was to be assessed and monitored. A long-term vegetation assessment and monitoring program was established in 1994.

Summit Envirosolutions conducted the first surveys of this program in the summer of 1994. Follow-up surveys were conducted in 1998 and 1999. Continuing this bog monitoring program, David Schmoller of Yellowfield Biological Surveys conducted vegetation surveys on the three bogs on July and August 1998.

## METHODS

Methods used in this survey are the same as those outlined in the Summit Envirosolutions survey of this site dated January 6, 1995, Project Number 922760, pages 15 through 17 and as described in the STS Project Proposal 610754PP. These methods included a Plot Sampling and Meander Survey at each bog.

Plot Sampling was conducted in early July along transects established in the three bogs. A total of 12 permanently staked transects were established in the bogs in 1994. Three transects were established in Bog F, four in Bog O, and five in Bog Y. The plot sampling involved: 1) Line intercept method for trees and shrubs. In this method, individual tree and shrub species with crowns that intersect the transect line were counted and measured. The location of the species was indicated by recording the point along the metered transect line at which the trunk was located. And the length of its crown was indicated by recording the endpoints of its intersection with the transect line. 2) One square meter plot method for surface and herbaceous vegetation. This method involved placement of a square meter plot frame at five locations along each transect line. All plant species within the plot frame were separated into two strata, herbaceous and surface. They were then identified to the species if possible, and each species was assigned an estimated percent of total coverage. 3) Lagg vegetation documentation. The plants located within the bog were identified to the species if possible, and each species was assigned an estimated percent of total coverage. Photographs of the laggs were taken at transect endpoints that ended at a lagg.

The Meander survey was conducted within each bog in late August. This survey included visual observations along the transect lines and within the lagg areas of any plant species that were not readily identifiable during the Plot Sampling surveys. The objective here was to complete the list of species present in the bogs. Hence, no percent cover was assigned to any of these species.

In all surveys, observations as to bog ecology were made, including observations concerning matters such as threats, vegetation stress, noxious weeds, hydrology, values, and rare species.

All data was entered into spreadsheets. Meander survey data was entered into a plant database provided by the City of Eden Prairie. Finally, a summary report was created.

## RESULTS AND DISCUSSION

### BOG ECOLOGY

The three wetlands in the Bearpath Golf and Country Club are referred to as bogs, and rightly so, but they actually have the characteristics of bogs, fens, marshes, sedge meadows, and wet shrub communities.

**Bogs**, in the words of Howard Crum in his book A Focus on Peatlands and Peat Mosses, are “mineral-poor, acid peatlands raised above the groundwater by an accumulation of peat. They are dominated by a hummocky growth of *Sphagnum* covered by a shrub layer of heaths and later, in North America, by Black spruce”.

Many factors result in a bog. Generally, saturated, anaerobic, and cool conditions, as found in northern locales such as ours, favor the development of a bog. These conditions result in poor organic decomposition, wherein organic acids accumulate and mineral components of the organic matter are not liberated. Thus, plant growth outpaces decomposition and the excess of plant material accumulates as peat. That is why a close inspection of peat reveals an abundance of partially decomposed plant litter. It lies in a limbo between black dirt and rotten leaves. This fibrous nature of peat has made it attractive as horticultural peat moss, potting soil, lawn dressing, and fuel.

Bogs are extremely acidic and very deficient in nutrients. The water that finds its way into a bog originates almost entirely from precipitation. This results in a lack of the mineral input enjoyed by wetlands fed by groundwater, lakes, or streams. The cool, moist, anaerobic conditions found in bogs results in high acidity. The high acid and low nutrition result in the low species diversity common in bogs. That is why when looking across an average bog, one sees at best, *Sphagnum,* low shrubs and herbs, and perhaps a few stunted trees. Relatively few plant species are able to tolerate these conditions. (Crum 1992, Niering 1985).

Those plants that are able to tolerate the harsh conditions of bogs include some that circumvent poor nutrition of bogs by obtaining their nutrients from insects. All three bogs in the Bearpath Golf and Country Club have one such species, *Drosera rotundifolia*, or Round-leaved sundew. This plant secretes a sticky liquid from hairs on its leaves. A small insect that chances to land on the leaves, perhaps in search of nectar, is unable to extricate itself from the tacky substance. Despite its struggle to escape, enzymes secreted from the plant work their way onto the insect, attacking its exterior, and then breaking down the entire creature into its basic nutrients. In the austere surroundings of a bog, a plant kills an insect for food.

Orchids are often found in bogs. One species is found in all three bogs, *Pogonia ophioglossoides*. Its pink blossoms can be seen from late June into August. It is especially abundant in the interior of Bog Y. Cranberries, *Vaccinium macrocarpon,* are common throughout bogs of the eastern United States. They are found in all three bogs, especially in the interior of Bog Y. This variety is completely edible, and the slightly warmer climate afforded by such a southernmost location seems to favor the development of some rather large specimens. Many other classic bog plants exist in the bogs of Bearpath, especially in the interior of Bog Y. These include *Carex paupercula, Eriophorum gracile, Scirpus hudsonianus, Rhyncospora alba,* and *Meyanthes trifoliata*

As with most wetlands, bogs are frequented by mammals, birds, reptiles and amphibians. One excellent species of frog, Cope’s grey treefrog, *Hyla chrysoscelis*, was seen in Bog F in the survey of 1998. None were seen in this survey. An unidentified frog was seen on the loose in Bog F. A rodent the size of a mink or

muskrat may have been seen in Bog F as well. Some sort of animal trails were seen in all bogs, along with beds of a size normally associated with deer. However, no deer sign was seen.

As for the development of bogs, it is widely believed that bogs are a stage in a process know as Lake-Fill. It is theorized that the process begins with a lowlands, such as a lake, with a constant water supply. The water is commonly aerated ground or surface water that is high in minerals, oxygen, and calcium carbonates. These waters are invaded by grassy, sedge-dominated plant community, called a *fen.* Under these oxygen and mineral rich conditions, plant productivity and diversity is high. Under the proper climatic conditions, plant matter accumulates more rapidly than it decomposes. Waterlogged peat accumulates and eventually impedes the movement of dissolved oxygen, minerals, and further retards the rate of decomposition. The wetland becomes acidic and anaerobic. This creates conditions favorable for the invasion of *Sphaghum* species. *Sphagnum* begins to dominate in what is called a *poor fen* stage. The *Sphagnum* becomes so dominant it is referred to as a *Sphagnum* lawn. When the accumulation of *Sphagnum* is so great that the water table is actually raised above an influx from lake, stream or ground water, the wetland has become an *acid bog* complex. As *Sphagnum* accumulates and the acidic and anaerobic conditions prevail, low shrubs enter the wetland. These are followed by bog tolerant trees. On land-locked lakes the development of bogs is concentric, following the margins of the lake.

**Fens**, as noted above, occur where there is continued access to a water supply, with its oxygen, minerals, and higher pH. Peat accumulates beneath a fen as it does in a bog. A fen will contain species not commonly seen in a bog, species such as *Alnus incana* and *Typha latifolia*. In a land-locked fen there may be the formation of a *lagg*, a ring of open water around the outer edge of the fen. This forms as a result of increased decomposition in the outer rim of the wetland due to the inflow of oxygenated, mineral rich water into the wetland.

**Marshes** are open, grassy or sedgy wetlands developed on mineral soil, as opposed to peat. There is shallow water at least part of the year and they are subject to drawdown and reflooding, resulting in an alternation between annual emergent species and submergent species. The mineral content, oxygen saturation, productivity, and pH are relatively high.

**Sedge meadows** are less wet than marshes and are dominated by plants such as *Carex*, and *Calamagrostis*. Water supply is seasonal and peat accumulation is low and usually well decomposed.

**Wet shrub communities** succeed marshes and sedge meadows and are dominated by *Salix, Cornus*, and *Alnus*. Water supply is seasonal and peat accumulation is low and usually well decomposed.

**What are they?** So which of these wetlands are the ones found in Bearpath Golf and Country Club? The presence of a lagg and the *Typha latifolia* throughout the wetland indicate a fen. The *Sphagnum* lawn found in the center of Bog Y might indicate a poor fen. The alternating submergent and annual emergent species in the lagg indicates a marsh. The *Calamagrostis* and *Carex* tussocks in the lagg area indicate a sedge meadow. The abundance of willows and scattered dogwoods around the perimeter indicates a wet-shrub community. But all in all, these wetlands have much in the way of bog characteristics, from the widespread bog plant species, the solid peat underpinnings in the center of the wetlands, the relative lack of plant diversity in the center of the wetlands, and the saturated peat and *Sphagnum* and standing water in the bog center at the same time that the laggs were dry. So it is fair to refer to these three wetlands as bogs. To be specific, these are *Open Graminoid Bogs*. (Crum, 1992; Harris and others, 1996; Niering, 1985)

## THE BEARPATH BOGS

### Vegetation Data

*General:* All field data collected on all three bogs is contained in the attached spreadsheets and maps. Two spreadsheets were created for each bog. One spreadsheet contains data collected in the Plot Sampling of June 30 and July 1, 2000. This includes data from the lagg boundary, surface layer, herbaceous layer, and tree and shrub layer of the bog. The other spreadsheet contains data collected in the vegetation meander survey of August 31, 2000. This includes vegetation identification, abundance, and novelty. A site map was created for each bog from aerial photographs. Each map presented transect line, baseline, and lagg photo locations.

All three bogs were in the midst of a serious drought at the time of the Plot Sampling survey. The laggs were completely dry, flowers were aborted, fruit was depauperate, *Sphagnum* was browning, upland annuals such as *Lactua serriola* and *Sonchus arvensis* had invaded the lagg and the bog mat, and low-lying herbs such as *Campanula aparanoides, Galium palustre, Scuttelaria galericulata, Triadenum virginicum, Lysimachia thrysiflora, Lycopus virginicus*, and *Viola nephrophylla* were absent or not nearly as common as in 1998.

*Bog F*: This bog was dominated *by Carex lacustris, Spirea tomentosa, Thelypteris palustris, Betula papyrifera,* and *Sphagnum sp. Vaccinium macrocarpon* and *Carex lasiocarpa* were more common in the interior of the bog. Some species were more dominant in the lagg portions. These included *Salix petiolaris, Polygonum sagittatum*, and *Epilobium leptophyllum.* Seventeen species were identified this survey which were not encountered in 1998. These included four members of the genus *Salix,* two *Eriophorums,* two grasses, and five forbs. Eleven species found in 1998 were not seen in this survey, many of them low-lying herbs. The noxious weed *Lythrum salicaria* was present in larger numbers than seen in 1998, mostly on the southern and western edges of the bog. No rare plants were observed.

*Bog O:* As with Bog F, this bog was dominated by *Carex lasiocarpa, Spirea tomentosa, Thelypteris palustris, Sphagnum sp*. and the marsh species *Typha latifolia.* Lagg species were dominated by *Sagittaria latifolia, Polygonum sagittatus, Thelypteris palustris, Bidens cernua, Typha latifolia, Urtica dioica, Carex lacustris*, and *Onoclea sensibilis*. The interior of the bog contained more of the true bog species, including *Sphagnum sp.*, *Drosera rotundifolia*, *Vaccinium macrocarpon,* and *Pogonia ophioglossoides.* These latter two species were not found in the surveys of 1998). Fourteen new species were encountered in this survey and sixteen species found in 1998 were not seen in this survey. Some of these absent species were inconspicuous, low-lying forbs. This bog had the biggest diversity of species of all of the bogs and the largest component of *Typha* of all of the bogs. The edges of the bog were the locations of the most diversity and included numerous invasive species. The noxious weed *Lythrum salicaria* was present throughout the bog, especially on the northern, western, and southern margins. It appeared to be an expansion of range from the surveys in 1998. Another weed, *Cirsium arvense,* was seen this season. The golf green extended one or two meters onto the bog mat on the southwestern edge of this bog. Literally hundreds of golf balls were found in the bog. No rare plants were observed.

Bog Y: This bog was dominated by *Carex lacustris, Meyanthes trifoliata, Spirea tomentosa, Thelypteris palustris, Vaccinium macrocarpon*, *Sphagnum spp*. and the marsh species *Typha latifolia*. More true bog species were present within this bog than others, particularly within the bog center. These included species such as *Pogonia ophioglossoides, Carex paupercula, Eriophorum gracile, Scirpus hudsonianus, Rhyncospora alba, Drosera rotundifolia* and *Vaccinium macrocarpon*. Twenty-three new species were encountered in this survey, many of them found in the quintessentially boggy interior. Ten species found in 1998 were not in evidence during this survey, many of them low-lying herbs. The noxious weed *Lythrum salicaria* was present on the western bog margin. No rare plants were observed.

**Potential and Observed Damage**

Nearly the same observations were made in this survey as were in the survey of 1998.

As was the case in 1998, the bogs in the Bearpath Golf and Country Club varied from the characteristics seen in the typical open bogs described above. Specifically, these bogs exhibited 1) greater species diversity, 2) abundant marsh species, 3) greater numbers of alien, or nonnative, plant species and 4) greater number of noxious alien plant species than would be expected in typical open bogs.

Specifically, the exterior of the bogs was being invaded by seemingly increasing numbers of *Typha latifolia, Lythrum salicaria, Urtica dioica, Polygonum* species, and *Rumex* species. This survey found the alien and noxious species *Lythrum salicaria* and *Rhamnus frangula* within the bogs themselves and *Alliaria officinalis, Euphorbia esula*, and *Rhamnus frangula* on the uplands surrounding the bogs. *Lythrum* appeared to increase in numbers in Bogs F and O since the surveys conducted in 1998. All bogs were invaded by several new, annual exotics, namely *Sonchus arvensis, Rumex crispus,* and *Lactua serriola*. And the southern edge of Bog O - where the impact of golf course construction was particularly acute, the golf green and tee actually overlapping the peat – displayed the greatest abundance of noxious and alien plant species and the most species diversity, just as it did in 1998. The wooded or herbaceous margins around the bogs remain

suspect as seed sources for some of the noxious weeds that have invaded the bogs. Upland weeds such as Son*chus arvensis, Rhamnus frangula,* and *Lactua serriola* were common in the wooded, herbaceous margins.

All of the trends observed or speculated in this survey, while given a measure of certainty, are also given a measure of subjectivity and *can be illuminated by the statistical analysis* of the data contained in this report.

It may be argued that there is little information about the condition of the three bogs prior to the first surveys of this program in 1994 so it is impossible to state that the bogs have been altered. However, it is possible to determine the changes the bog has experienced through direct observation, as in studies of pollen in the bog strata. And inferences may be drawn from what has happened to the landscape in the Minneapolis metropolitan area as a whole. The general conditions in the area are a radical alteration from those of the presettlement past. Although presettlement or predevelopment baseline data was not available, it is known that the original plant communities surrounding the bogs were virtually eliminated through farming, housing development, and golf course construction. Interestingly, a display of early settlement conditions was shown this past summer at the Burwell House in Minnetonka, Minnesota (off of Minnetonka and Baker Roads). One photo showed Minnehaha Creek in its role as a logging chute for the logs processed at mills in the area. A sawmill was located across the creek. Another photo showed clearcut forests in the same vicinity.

Also, it may be argued that bogs naturally undergo transition from lake to fen to bog to treed bog. While this is true, it is entirely possible to accelerate this transition. And it is more possible to reverse this transition back toward a more nutrient rich, oxygenated, alkaline environment, a process called retrogression. It is possible, through mismanagement, to accelerate this transition to a rate far beyond that accorded by nature.

In view of this, it appears that the bogs have undergone alteration in tandem with the alteration of the surrounding landscape. So how has this apparent change in the bog condition come about?

*1) Elimination of Surrounding Community:* The elimination of the original plant communities surrounding bogs could be expected to have an adverse impact upon the characteristics of the plant community within the bog. There are four ways in which this impact may have occurred:

a) The surrounding land disturbance would alter which pollinators, predators, and seed dispersing species would have access to the bogs. Plant species dependent upon the species that once dwelled within the surrounding environs would likely experience a decline in vigor or numbers.
b) With the elimination of the original old growth forest community that surrounded the bogs, there would be an alteration in shading and microclimate within the bogs. This may have created conditions unfavorable to species that required the light or climate conditions found in the original bogs.
c) Alteration of the surroundings of the bogs may have reduced or eliminated seed sources of edge species normally found in the bogs.
d) Intense ground disturbing actions along the perimeter has invited alien and noxious plants.

During the course of this survey, ground-disturbing activities continue around the perimeter of the bogs. Two or three more homes exist around the bogs than did in 1998.

*2) Changes in Hydrology:* Judging from topography and plant inventories, most of the water received by these bogs is indeed from rainwater. However, suburbanization usually brings with it increased runoff from lawn watering. Furthermore, the elimination of native and original ground cover and the exposure of soil through farming and construction would likewise increase runoff. Any alteration of the hydrology supporting the bogs or runoff that enters the bogs could have an impact upon the species composition of the bogs. Runoff would be expected to increase the minerals, oxygen, and pH of the bog, especially in the perimeter. As a result, species diversity would increase, true bog species would decrease.

*3) Changes in Sedimentation:* With lawn watering, elimination of native and original ground cover, and the exposed soil of farming and construction, runoff would increase, and with it, sedimentation. The reduction or elimination of the barrier woods or prairie that once ringed the bogs reduced or eliminated the trapping of sediments before they reached the bog. Additionally, one function of a bog mat is to serve as a barrier to mineral and sediment laden waters from the exterior lands. Consequently, an increase in water movement and sedimentation would be seen along the perimeter of the bog. This would favor the establishment of plants more often found in wetland types requiring higher oxygen, pH, and minerals. And this would favor the

introduction of noxious and alien plant species. Also, a moderate level of disturbance is generally indicated by an increase in species diversity as compared to undisturbed sites.

During the course of this survey, silt fences were still in evidence at some locations around the bogs, but not at all locations with potential for siltation. Barrier woods or grasses were evident at some locations and absent in others.

*4) Nutrients:* Bogs are characterized by extreme acidity and low nutrient availability. The surrounding farmland, golf course, and housing developments have been well fertilized. The increased runoff noted above would have the effect of allowing an increased transport of fertilizers into the bogs. Thus, the pH and nutrient availability within the bog would be inclined to rise. This would give rise to greater species diversity, most notably sedges, grasses and shrubs. Ultimately, according to the common theory of bog succession, this would accelerate the retrogression of the bog into wetlands enjoying higher pH and nutrition, namely fens, marshes, sedge meadows, and wet shrub communities.

Additionally, *Sphagnum spp.* is especially sensitive to a combination of high calcium availability and high pH (Crawley 1997). Lawn and farm fertilization normally attempt to increase the availability of calcium to plants. Were this to result in the conditions of high calcium availability and high pH, *the Sphagnum spp.* would decline.

*5) Pesticides and Herbicides:* It is highly likely that the developed areas are also sprayed with pesticides and herbicides. It is a very common and accepted practice to use herbicides on lawns and golf courses to maintain the horticultural standards of design and beauty. The increased runoff noted above would have the effect of allowing an increased transport of pesticides and herbicides into the bogs. This would have the potential of altering their species composition and diversity.

*6) Other Pollutants:* Suburbanization often brings other pollutants that may have an adverse impact upon bog ecology. For example, auto emissions contain high quantities of sulphur dioxide. Many plants within open bogs are sensitive to the deposition of this chemical. These include *Sphagnum spp., Drosera spp.*, and *Andromeda spp*. In some regions, *Sphagnum spp*. has seen a distinct decline since the advent of industrialization, being replaced with *Eriophorum spp*. (Crawley 1997). The increased auto emissions in the vicinity of the bogs may have a similar impact upon the species composition of the bogs.

**Safety**

*A word of caution:* A bog can be a dangerous place to walk. This is due to the fact that water or an endless unconsolidated muck lies beneath the floating mat. The mat. is not everywhere able to support the weight of a human, and at times this is discovered by experimenting with one's step, which at times proves fatal. Many bogs provide a fine historical record of missteps since the high acidity, low mineral content, low oxygen, and cool climate tends to preserve victims well. About 2000 bog people have been exhumed by archeologists in Europe alone, some of them dating back 2800 years. (Neiring 1985) In the course of this project the surveyor plunged one or both of his legs into the inky darkness no less than four times. It might be noted that most if not all of these hazards were none other than the water sampling pits carved by unnamed technicians to fulfill the mandates of this monitoring project.

It is the course of wisdom to wear chest waders and to carry a pole when venturing out into a bog. The waders are for those occasions when a misplaced foot descends below the bog mat into the black bottomless water and the pole is to arrest that descent and assist in extraction. Snowshoes have been suggested by some as a way of preventing the breach of the bog mat, but this added safety results in more trampling of the bog mat than that of ordinary boots. Enlisting the support of another explorer is a wise step as well. Should you go under, he or she could assist in your escape, and should you disappear, he or she could notify the proper authorities. Perhaps the best advice is to stay out altogether or to contract any surveys to experienced personnel with little or no regard for danger.

## CONCLUSION AND RECOMMENDATIONS

The conclusions and recommendations of the report of 1998 are relevant in 2000.

The interconnectedness of ecosystems is difficult to refute. The decline of several species of neotropical birds in the United States, for example, has been attributed not to degradation of their habitat within the United States but to degradation of their habitat in the tropics. So it is difficult for an ecosystem to maintain its integrity in the face of the elimination or drastic alteration of the ecosystems that surround it, particularly ecological units as small as these three bogs. It is likely that the observed and suspected changes within the bogs will continue as long as there continues to be the alteration of the surrounding environments.

These are the anticipated effects of unbridled or unbuffered land-altering human activity in the lands surrounding the bogs:

1) A continuing stress upon the native and original bog plant species such as *Pogonia ophioglossoides, Scirpus hudsonianus, Drosera rotundifolia, Eriophorum gracile*, and *Vaccinium macrocarpon*.
2) An increase in noxious and alien plant species such as *Lythrum salicaria, Rhamnus lanceolata*, and *Sonchus arvensis.*
3) A decrease in pollution intolerant species such as *Sphagnum spp*. *Drosera rotundifolia*, and *Andromeda spp.*
4) An increase in nutrient demanding fen and sedge meadow species such as *Typha*, *Salix, Calamagrostis*, and other sedges, grasses, and shrubs.
5) And a general increase in plant species diversity.

It is true that some of these events are already occurring. But this is not the inevitable outcome. The alteration of these bogs could be restrained. Their conversion into *Lythrum* dominated wetlands, *Typha* dominated marshlands, or *Salix* dominated wet shrub communities could be forestalled. The same recommendations of 1998 are presented here:

1) The introduction of minimum 75-foot buffer zones between the bogs and the developments. This is an acceptable distance. Various state, county, or city regulations in the region require setbacks from waterways, lakes, rivers, and the likes in the neighborhood of 75 feet. Some counties require as much as 125 feet (O'Neill, 1998).
2) Reconstructing the buffers with native and original species and removal of noxious, alien species such as *Lonicera japonica, Rhamnus frangula, Alliaria officinalis*, and *Euphorbia esula.*
3) Restrictions on the application of fertilizers, pesticides, and herbicides in the bog micro-watersheds.
4) Since runoff and its associated sedimentation and chemical loading threaten the bogs from all sides, installation of silt barriers around the *entirety* of the bogs is recommended. Monitoring these barriers for integrity is a must. While barriers are seen in the residential area, the most damaged bog of all, Bog O, appears to have no silt barriers at all. This would be most valuable along the contact between the bog and the tees and greens of the 8$^{th}$ hole and along the eastern edge of the fairway for the 9$^{th}$ hole.

   Conversations with golfers on the 8$^{th}$ hole were interesting. There does not appear to be a great deal of admiration for the design of that particular fairway. While surveying the bog, literally hundreds of goofballs were found underfoot. Probably a dozen shots launched from the tee during the course of the survey never made it to the green. Several near-misses initiated interviews and the consensus was that the decommissioning of the 8$^{th}$ hole would not be mourned. Some golfers stated that they have never made a shot that actually cleared the bog, some joked that most of the balls that the surveyor found were the ones that they had lost, and one stated that it is common belief that someday the bog will fill up with so many balls that you will be able to walk across the bog all the way to the green without so much as wetting a sole. So another suggestion is the dismantling of the accursed 8$^{th}$ hole and relocating it to some less environmentally sensitive locale.

5) The elimination of the *Lythrum* specimens is recommended. Removal of *Lythrum* might be one of the most attainable goals presented. It is understood that a *Lythrum*-eating beetle has already been introduced into the bogs and this move is to be applauded. While its effect was not readily apparent in this survey, this is no cause for alarm. It may take several years for a decline to become apparent. Releases of Lythrum-eating beetles around the United States have met with great acclaim and equally great success. Reports of ninety percent reductions of *Lythrum* infestations are common.

   Four insect species from Europe are approved by the U.S. Department of Agriculture for use as biological control agents. These species are *Hylobius transversovittatus* a root-mining weevil, *Galerucella calmariensis* and *Galerucella pusilla*, two leaf-eating beetles, and *Nanophyes marmoratus*, a

flower-feeding weevil and *Nanophyes brevis,* a seed-feeding weevil. However, *Nanophyes brevis* specimens are infested with a nematode, and this infection has prevented its introduction.

Other methods are available, but are not as highly esteemed, due to costs, long-term results, and labor. Removal can be accomplished done manually and chemically. In isolated areas, uprooting the plant by hand and the removal of all vegetative parts can eliminate the plants. For chemical treatment, older plants should be spot treated with a glyphosate type herbicide such as Rodeo. A mid summer and late season application is most effective.

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