# 7.0 Disturbance Processes (Threats) and their Impact on Sifton Bog ESA

Many natural disturbance processes, modified by human proximity and interaction, are currently disrupting the ecological integrity of the Sifton Bog ESA. This section describes nine threats and their effect on the bog. Some management options are presented here, with additional recommendations in Chapter 8. Timely intervention is needed to manage these threats to acceptable levels that will result in no further harm and, ideally, will allow the naturally resilient ecosystem an opportunity to recover. Many of these threats commonly occur in other natural areas. The relatively small size of Sifton Bog ESA compared with other ESAs in the City makes it an early indicator of ecosystem distress.

The disturbance processes discussed include:

- Changes to bog hydrology
- Overabundance of White-tailed Deer
- Invasive alien plant species and other bog invaders
- Human use effects (trails and vegetation and wildlife disturbance)
- Effects of adjacent land use and disturbance processes on bog succession
- Effects of tree hazard cutting on forest stand basal area
- Introduced Goldfish in Redmond's Pond
- West Nile Virus mosquito control program
- Effects of fire

## 7.1 Stress-Response-Intervention-Outcome Model

Urban wetlands such as the Sifton Bog require intervention to safeguard biodiversity and to sustain the habitat values that are desirable for educational and research purposes. One cannot assume that a natural park in an urban environment, if it is to remain in a natural, healthy state, can be left to nature unattended. If such lands are in public ownership, then wise and timely intervention are a responsibility. Sifton Bog, for many reasons, is on a trajectory of ecosystem decay (Laurance *et al*. 2002). In the case of this ESA, it would be inappropriate for a management plan objective to be "to restore the bog to pre-settlement conditions" as such an objective is both non-specific and unlikely to be achieved in the current urban environment. As a case in point, it has been demonstrated that the bog, in pre-settlement days, consisted of a larger kettle lake and fen-like wetland (i.e., dominated by sedges and absence of *Sphagnum* mosses) that has been shifting to ombrotrophic bog as the peat mound developed.

This section addresses some factors that influence management intervention options using a Stress-Response-Intervention-Outcome (SRIO) model (Bergsma and DeYoung 2007). The model guides thinking about issues and narrows the focus to achievable and timely interventions that will reverse degradation or remove and minimize disturbances, so as to allow for the re-establishment of natural succession or favourable ecosystem trajectory. The SRIO model (Figure 13) is an adaptive management model that identifies the trigger for ecosystem stress and the trajectory of response to this stressor. If the response is leading to ecosystem decay, a planned intervention is applied to affect the response in a positive manner to achieve a targeted outcome or conservation objective. This model is essentially an analysis of ecological viability and integrity, being applied to the bog ecosystem's essential characteristics of hydrology, biodiversity, disturbance and connectivity. Understanding ongoing changes to these essential functions is necessary to determine what the ecosystem complex needs to survive in the long term.

Bergsma and DeYoung (2007) described the first four stressors to the Sifton Bog ESA in the context of a SRIO model. The four stressors or disturbances that are having perhaps the largest impact on the Sifton Bog are: a) changes to bog hydrology (water quantity, water quality); b) overabundant deer population and ethology (behaviour) of deer; c) invasive alien species Glossy Buckthorn (*Rhamnus frangula*); and d) human use effects, both deliberate (vandalism) and incidental.

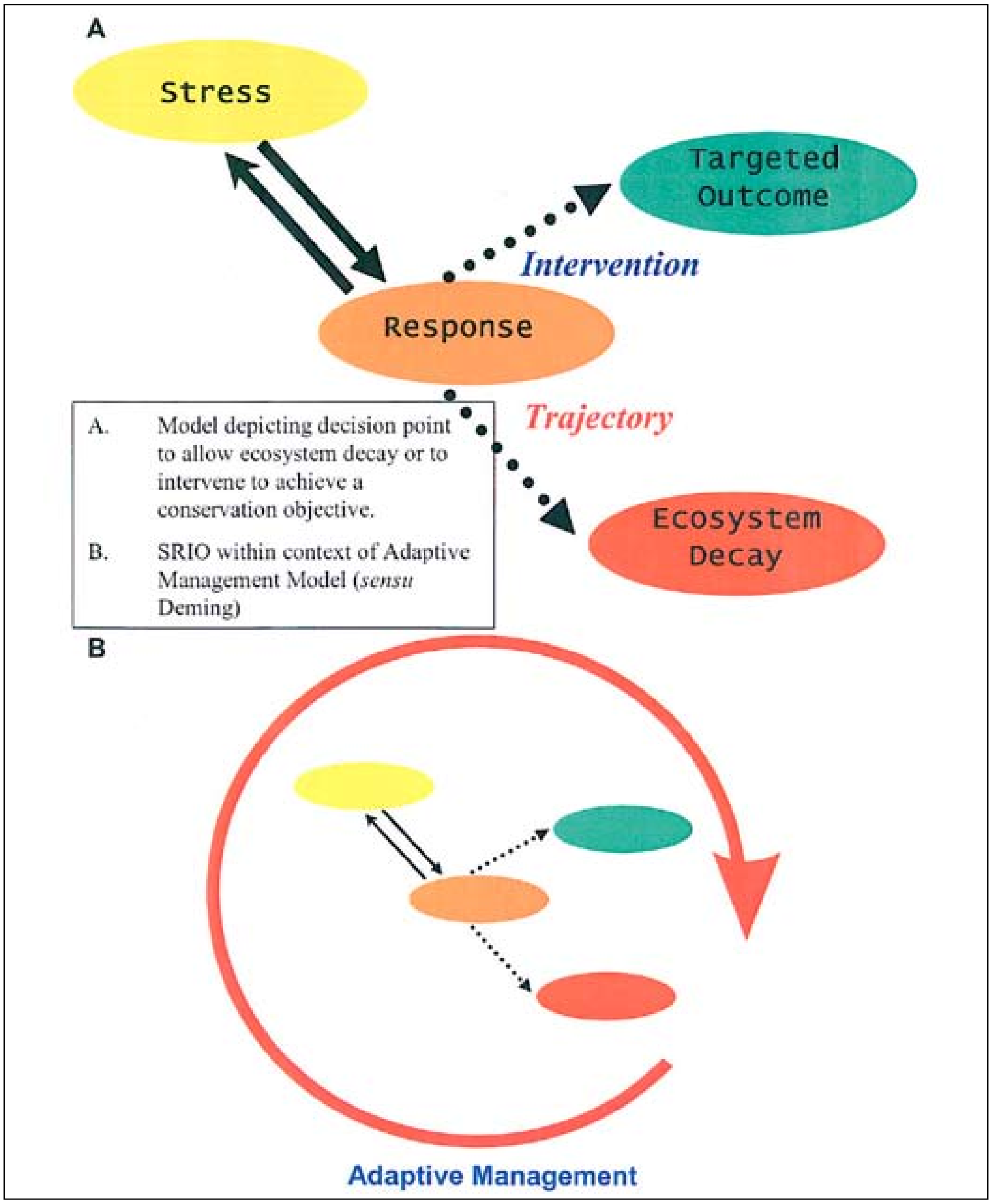


**Figure 13. Stress-Response-Intervention-Outcome (SRIO) Model**

## 7.2 Changes to Bog Hydrology

Hydrology exerts a primary control on raised bog ecosystems and their biophysical properties. Many factors affect hydrology including climate, geological features, drainage patterns, vegetation, and disturbance. Understanding basic hydrologic patterns in Sifton Bog provides insight into these factors vital to its ecological integrity. Understanding changes in hydrology and their consequences provides tools by which to assess risks to ecosystem sustainability and the factors that affect the level of risk.

Nicks, Bergsma and Briggs (2003) presented a paper at the Canadian Water Resources Association Water Stewardship Conference in 2003 entitled "The Sustainable Management of an Urban Wetland: Can Urban Development and Wetlands Co-Exist?" (Appendix J). The paper examined the role of urbanization and the long-term consequences of decreasing water levels in the Sifton Bog since 1990. Detailed hydrological/ hydrogeological studies that have been made at the Sifton Bog and supported by literature review of bogs demonstrate that fluctuating water levels influence species composition and the chemistry of the bog water. If the water level drops more than 30 - 40 cm within the active acrotelm zone over a season, then the accumulation and growth of Sphagnum will be compromised.

A photograph taken in 1926 shows a larger pond area (compared to today) with abundant growth of Southern Pond Lily (*Nuphar advena*), sometimes called Spatterdock, an aquatic species that grows best in shallow water. Bergsma (personal communication) recalls observing moderate growth of Southern Pond Lily in Redmond's Pond during field visits in 1993. A photograph from 2005 shows the pond having a large area of open water and very little Southern Pond Lily (Figure 14). Some of the hydrological changes in the bog were related to the installation of two drains, the Kirk Drain in 1896 - 1897 (southwest from the pond) and a second drain from the northwest corner of the bog mat that was dug for drainage and peat extraction several years later. More recent hydrological impacts may be related to a reduction in the hydrological catchment area due to development-related modifications in the size of the bog's watershed.

Seasonal variations in some environmental variables such as pH, calcium, chloride, phosphate, nitrate and conductivity are also related to the amount of water present in the bog. For example, Applegate Groundwater Consultants analyzed surface water and groundwater quality in the bog from 1990 to 1998. They found that the chemical concentrations of most parameters did not change significantly during the monitoring period except that the concentrations of some parameters were reportedly slightly higher in 1998. These slightly higher concentrations may be due to the low amount of precipitation that occurred in 1998 (Applegate 1998). Changes to water quality and quantity affect the competitive advantage of specialized bog vegetation that is adapted to thrive in acid- and nutrient-poor bog water. The trajectory of stress-response is towards an increase in number, abundance and extent of non-bog species such as cattail and Three-way Sedge. See section 7.5 for more discussion.

One of the first interventions to protect bog hydrology and maintain sufficient water levels in the bog was made in 1989 after Maaike Froelich raised concerns that the bog was losing too much water from the Kirk Drain. As a consequence, the drain was capped and water levels slowly rebounded. A follow-up step entailed the installation of monitoring wells, beginning in 1990, and the development of an extensive monitoring program from 1998 to 2001. This work was a requirement for development adjacent to the bog on the eastern tableland. Also required was the monitoring of storm water quantity and quality by piezometers (wells) (Figure 14) installed in boreholes at strategic locations around the bog perimeter (Map 3) as well as along a transect from tableland through each vegetation community to the bog pond. Targets for water quantity and quality were established to determine when intervention may be necessary; for example, a contingency plan was made for the storm sewer design, which would have the flexibility to increase or decrease the runoff directed to the bog as required, with adjustments occurring no more than once per year (McCormick Rankin 1999). The targeted outcome is to maintain the difference between the static water level in the aquifer and the water level in Redmond's Pond, such that Redmond's Pond must be higher than the aquifer.

Surface water inputs from a section of Oxford Street and lands to the east of the site are necessary to maintain the water budget in the swamps that surround the bog. Runoff can be contaminated with salts, nutrients, petrochemicals such as car oils, and pesticides and these pollutants may be making their way into the raised bog area during periods of high water levels or when the bog is frozen (BioLogic, 1999). Future plans to widen Oxford Street must deal with this water issue (i.e., whether to take polluted runoff elsewhere or pre-treat it). The new development on the east side has incorporated stormwater management ponds to allow pollutant-laden sediments to settle out before the water flows into the bog. Continued monitoring of water quantity and quality is necessary to ensure proper operation of these ponds. Any additional changes within the surface water catchment area of the ESA must incorporate comparable stormwater treatment systems to maintain water quality and quantity.

Global change models predict a hotter and drier climate in the Great Lakes area, resulting in a net loss of water to the bog mound. If the water falls below the acrotelm, peat development will be negatively affected. Global and local actions to reduce carbon emissions and increase vegetation cover to take up atmospheric carbon can help slow down the rate of climate change.

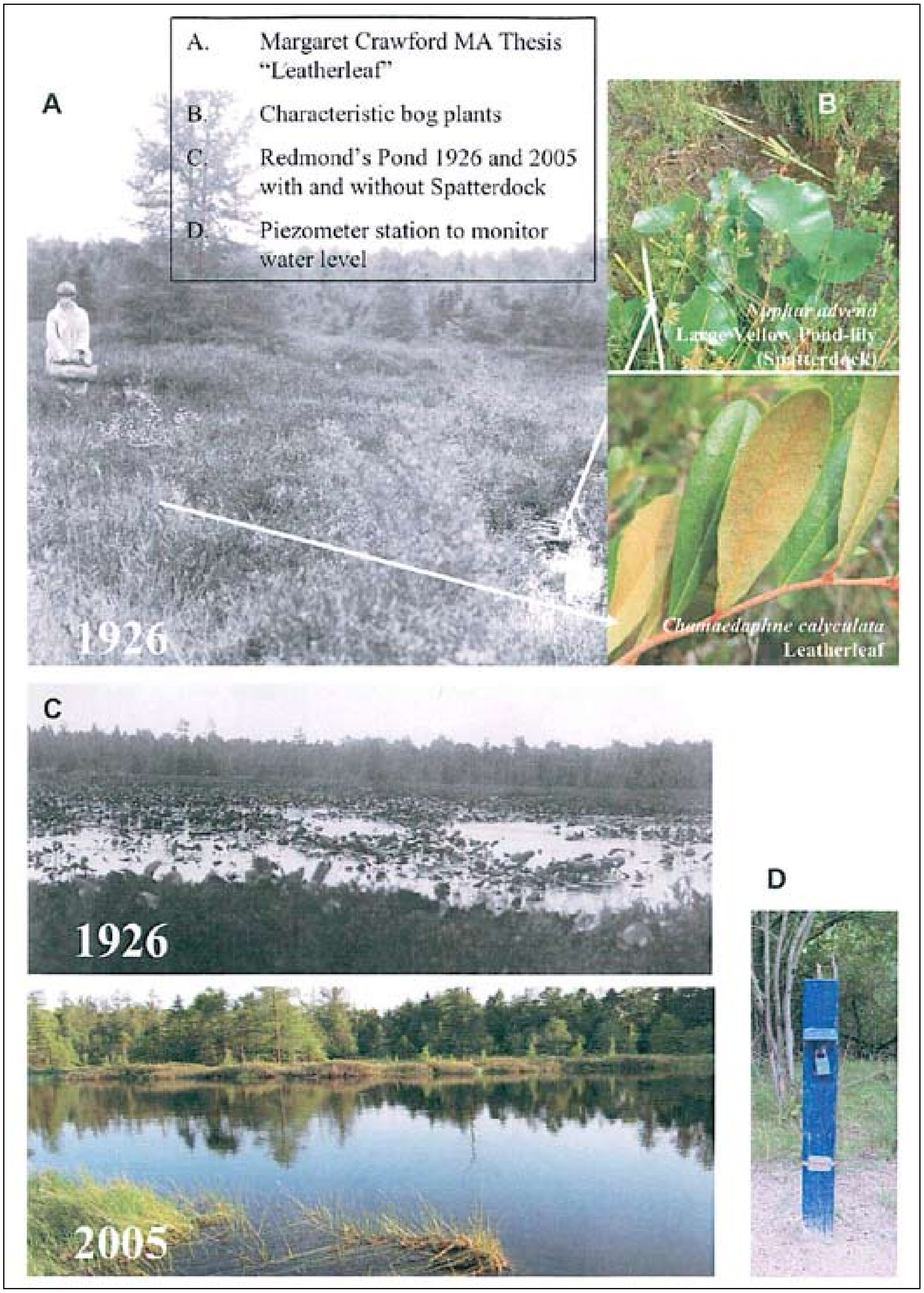


**Figure 14. Ecology of Sifton Bog in response to water levels**

## 7.3 Overabundance of White-tailed Deer

Changes in the landscape in the last 20 - 30 years, have contributed to the success of white-tailed deer in southern Ontario. Deer are adaptable and do extremely well in rural and urban landscape where forests are fragmented. Populations have increased over time while there has been a progressive conversion of regional habitats such as woodlands, wetlands, soybean and corn fields to other land uses. This, combined with a naturally high reproduction rate, few predators (e.g., wolves) and the absence of hunting in urban areas have led to deer overabundance in southern Ontario. As a result, white-tailed deer populations are being funneled into ever shrinking habitats, while their population continues to increase. Within urban areas, deer frequently are found within and adjacent to natural areas in subdivisions (Figure 15). Deer are adapted to humans and feed on horticultural plants on private properties. Deer are

| | |
|---|---|
| A. | Deer are accustomed to presence of humans and dogs |
| B. | Scraped bark of tree by rutting deer |
| C. | Deer are adapted to jumping fences to feed in residential area, all times of day |
| D. | Habit of following the herd develops trails throughout bog mat |

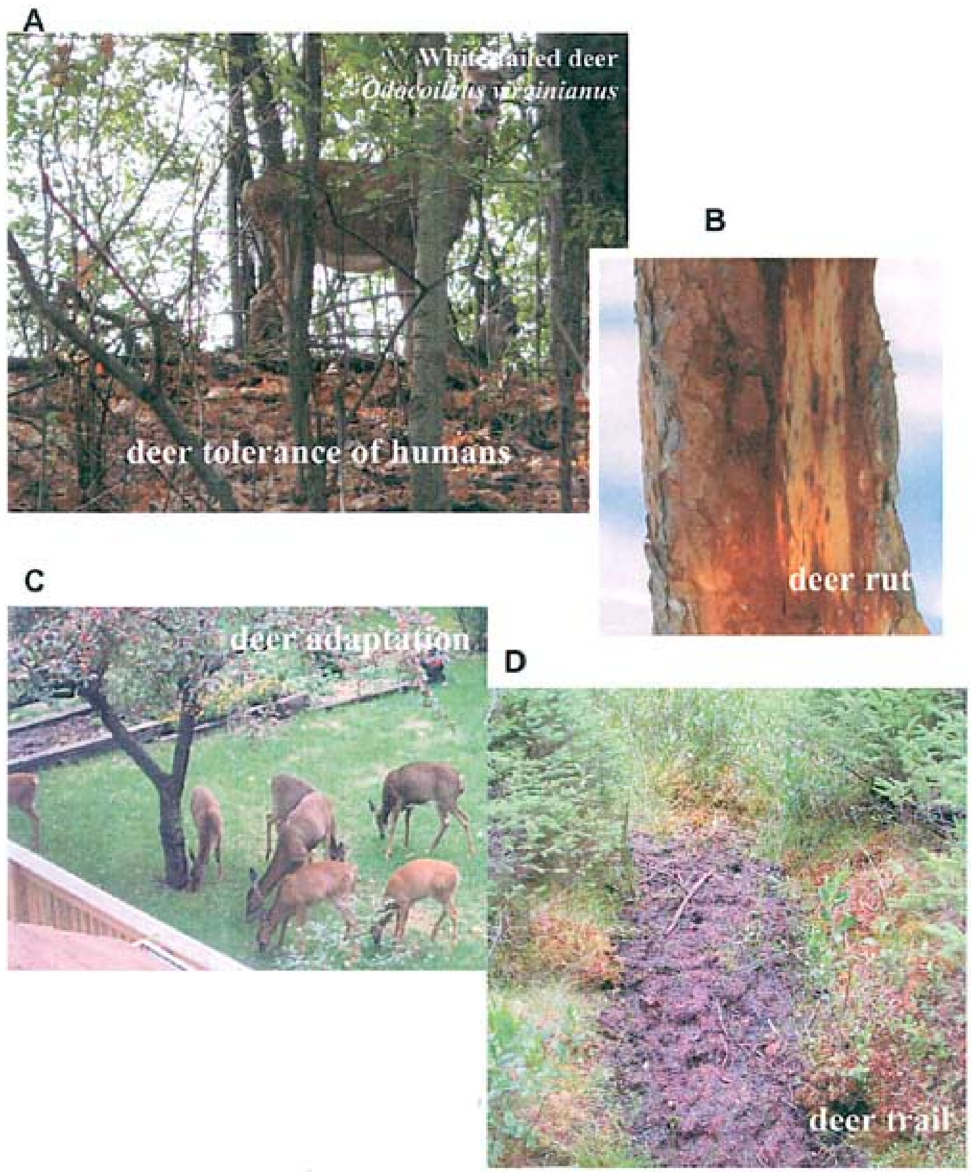


**Figure 15. Deer behaviour (ethology)**

herbivores and generalist feeders, consuming grasses, forbs (flowering plants) and the leaves and twigs of woody plants. Deer prefer young, newly emerging vegetation. Deer can change forest structure and plant community composition (Frelich and Lorimer 1985) especially at high grazing pressure, because few plant species can tolerate intensive defoliation (Bazely and Jefferies 1986).

### 7.3.1 Deer Population Size in Sifton Bog

In 2003, the City of London requested the UTRCA ESA Management Team undertake deer counts to estimate the population size in the ESA. Conservative population estimates over the period 2003 to 2008 are 24, 26, 53, 52, 52, and 35 deer, respectively (Table 12a). A summary of the methodology for the deer count is included in Appendix K5. The results for each count night are included in Appendix K6.

The biological carrying capacity (the number of deer that an area of land can support over an extended period of time to allow for normal deer survival and reproduction without causing negative effects on native plant communities succession and regeneration) of an area the size of Sifton Bog ESA (50 ha or 0.5 km²) is estimated (by Ministry of Natural Resources) to be 3 adult deer (6 deer/km²).This number is within the range of estimated deer densities for Southern Ontario (Table 12b).In the Provincial Parks where high deer populations have been an issue for many decades and routinely undergo controlled hunting/culling, population densities of 25 - 30 deer/km² have permitted recovery of habitats. Therefore, a reduction of the deer herd at Sifton Bog to a density of 25 - 30 deer/km² may be sustainable. This would require reducing the herd to 12 - 15 individuals (60 - 70% of the population).

**Table 12a. Deer Count Results for Sifton Bog ESA**

| Year | Estimated Deer Population | Highest Nightly Estimated Deer Population | Number of Count Nights | Notes |
|---|---|---|---|---|
| 2003 | 24 | 68 | 6 | Agricultural field still present on east side. |
| 2004 | 26 | 45 | 4 | Agricultural field still present on east side. |
| 2005 | 53 | 58 | 4 | Development of agricultural field begins. |
| 2006 | 52 | 65 | 5 | Development of former agricultural field continues. |
| 2007 | 52 | 57 | 5 | Development of former agricultural field almost complete. |
| 2008 | 35 | 57 | 5 | Development complete. |

1. The estimated deer population is an average of each night's estimated deer population for that year.
2. The highest nightly estimated deer population is the highest estimated population on one night that year. Each night the deer count is conducted, a population estimate is calculated.

**Table 12b. Deer Densities in Selected Ontario Regions and Sites**

| Area | Estimated Deer Density (# deer per sq. km) | Estimated by |
|---|---|---|
| Northern Ontario | 1 - 5 | MNR, through hunter deer tag returns. |
| Southern Ontario | 4 - 10 | MNR, through hunter deer tag returns. |
| Pinery and Rondeau Provincial Parks | 25 - 30 | MNR, through actual count. (Deer herd reduction programs underway for many years.) |
| Manitoulin Island, Ottawa region | 25 - 30 | MNR, through hunter deer tag returns. |
| Sifton Bog | 100 | UTRCA, through actual count. |

Source: Ranta 2007

### 7.3.2 Urban Deer Ecology and Ethology

Deer in urban environments have an uncertain ecology that is influenced by human intervention and proximity. For instance, some people feed deer and thus encourage them to stay in a habitat that cannot independently support them. In the absence of predators, White-tailed Deer numbers can reach stability at extraordinary densities. However, long before deer numbers have reached an equilibrium determined by their food supply, the effects of heavy browsing are noticeable on vegetation (McCullough 1984). Vegetation communities within Sifton Bog ESA, especially the upland woods, are showing signs of over-browsing. The elimination of plant regeneration and the reduction in plant diversity leads to an impoverished habitat for many other species of wildlife that live in the ESA. There are very few saplings in the understorey and a browse-line is evident (i.e., no foliage or vegetation lower than 2 m). The disappearance of spring flowers such as Red and White Trillium and Mayapple is most likely the result of over-browsing. A community naturalization planting of native trees, shrubs, wildflowers and grasses to replace asphalt at the Oxford Street entrance was largely consumed by hungry deer. Deer seem to ignore the prairie grasses as some of these plants (e.g., Big Bluestem, Little Bluestem) have survived at the Oxford Street entrance and are now widespread on the former gravel pit on private land to the east of the public ESA boundary.

The response of swamp communities to deer overpopulation has been a decrease in structural integrity of the vegetation communities and an increase in non-bog and alien invasive species (e.g. cattail, buckthorn). Even the young leaves of Glossy and Common Buckthorn, normally rarely eaten because of their purgative properties, are browsed by hungry deer. When deer graze on young buckthorn, they nip off the top of the main stem. Not only does the shrub not die, it also regrows more aggressively with a coppiced stem (multi-stem) making the plants harder to remove. There are openings in the Glossy Buckthorn thicket where tall buckthorn shrubs have been replaced by a "lawn" of buckthorn plants only 15 cm tall. It is hypothesized that, when large trees topple over, an opening in the canopy is created that allows buckthorn seedlings to germinate. As the seedlings grow, the deer chew off the new, palatable leaves and soft green stems. The shrub responds by branching and growing even more vigorously. On a positive note, Miller (2005) noted buckthorn dieback after three successive years of heavy browsing. Deer generally avoid the larger woody buckthorn shrubs.

In the shrub bog mat, numerous deer tracks can be seen. Trampling compacts the organic soils, altering the process of Sphagnum growth and favouring species adapted to disturbance and higher nutrient levels (Figure 15). Deer droppings add extra nutrients to the nutrient poor bog ecosystem. Some of the Tamarack trees at the bog have been browsed. Ericaceous bog plants, however, are not preferred food for deer because many members of the heath family possess compounds (acetylandromedol) in their tissues that are toxic to animals. Research in other areas (e.g., Anticosti Island, Gulf of St. Lawrence) has shown that, if hungry enough, deer will browse almost any available food source including ericaceous shrubs such as Leatherleaf (Rochette *et al.* 2003 and Viera 2003). In the open bog mat of Sifton Bog, the Leatherleaf, Highbush Blueberry and Black Huckleberry are lightly browsed. In winter or early spring, when food supply is limited, the green leaves of these ericaceous plants may attract deer. The deer may also be feeding on the flowers of Pitcher Plants and orchids. The impact of deer browsing on the growth of Sphagnum is not known.

Another deer behaviour that affects bog vegetation is bark scrapings on conifer trees. Such activity is associated with the rut (sexual excitement of male deer) (Figure 15). The most devastating results of deer overpopulation are the lack of regeneration of trees and shrubs, and possibly the selective grazing of orchids and other uncommon species.

Social impacts of overabundant deer have been reported with increasing frequency. In a suburban setting, it is common for deer to wander out of the Bog into the surrounding subdivisions and feed on horticultural beds, destroying gardens and causing property damage to fences and even backyard swimming pools. They move to and from the Thames River Corridor across busy streets, and sometimes are hit by motor vehicles. In 2004, 205 deer occurrences (incidents involving deer and vehicles or property) were investigated by City Police across the entire

City. In 2007 there were 149 reported incidents of deer-vehicle collisions, 16 of these incidents occurring in a one kilometer radius of Sifton Bog. The annual costs of carcass removal across the City are up to $25,000 ($175/deer).The incidence of deer mortality on roads is being replicated across Ontario. In 2004, 13 676 collisions with wildlife were reported across the province, 90% involving deer (Ranta 2007).

Over the past six years, as the number of deer has increased, these impacts have extended further from the Bog and affect more people in the community. Similar impacts are being reported City-wide – this is not just a Sifton Bog issue.

### 7.3.3 Deer Management Strategies

In response to an increasing number of complaints, the UTRCA and City of London established a White-tailed Deer Community Steering Committee in 2001 to explore options, strategies and actions for management around the Bog. The group compiled information on deer ecology and ethology and discussed various lethal and non-lethal management techniques. Appendix K1 includes a chronology of the work done to date to deal with this issue. Although the Community Steering Committee recommended a recreational hunt to reduce the deer population to a minimum of eight (8) deer and this recommendation was endorsed by the UTRCA Board, London's City Council has not endorsed any lethal deer management strategy to date (Appendix K2 and K3). The Council recommendations supported seven non-lethal strategies. Some of these strategies have been explored and found to be either not feasible or not effective in helping to control deer populations. Others are still being implemented and assessed as to their success in scientifically quantifying the extent of the problem and/or in reducing actual deer numbers.

One of the strategies is the continuation of the deer count. Another strategy was the implementation of a scientific research project to determine the impact of deer on different vegetation communities in Sifton Bog and two other ESA's. The research will use deer exclosure fencing and will take 2 - 5 years to complete (Appendix K7). Data from this research will be used to determine if there is scientific justification to support a herd reduction and to substantiate any future management decisions. The harvest approach has been used in numerous other parks within southern Ontario (e.g., Point Pelee National Park, Rondeau and Pinery Provincial Parks). In these parks, it has taken 10 - 30 years for the forest to recover following deer herd reduction (Bazely, personal communication).

No special approvals are required from the Ministry of Natural Resources (MNR) for deer hunting in urban areas, provided all applicable City By-laws and legal hunting procedures are followed. Discussions between the MNR, the provincial agency responsible for wildlife management, and the City of London are ongoing. The MNR directs few resources to the issue of urban deer at this time. The MNR released a draft strategy called Strategy for Preventing and Managing Human-Deer Conflicts in Southern Ontario, 2006. This strategy was completed by the MNR in collaboration with other government and non-government interested parties and was posted on the Environmental Bill of Rights website in November 2006. Most of the recommendations in this report have been or are being implemented at Sifton Bog already (e.g., avoidance practices, repellants, landscape plantings to discourage browsing, etc.). Recently, the MNR has increased the number doe tags issued in the hopes of reducing the number of deer in Ontario, though the focus will be on rural Ontario.

In 2009, City Council approved the Sifton Bog ESA Conservation Master Plan 2009-2019, with direction to staff to report back on four matters related to deer management (Appendix K4).

## 7.4 Invasive Alien Plant Species

One of the main threats to global biodiversity is the introduction of species that are not native to a location outside of their natural geographic range. These are referred to as alien, exotic, or non-adventive species. Some of these plants were brought to North America as food or as ornamental garden plants and others were brought in accidentally in traded goods. In both cases, the plants have spread into the wild, transported by birds, animals, water, vehicles and foot traffic. In North America, the majority of invasive alien plant species comes from Europe or Asia. They have characteristics that allow them to quickly invade new habitats and successfully displace native species because the natural predators that keep them in check in their homelands are not present here. They reproduce at high rates (i.e., may produce thousands of seeds per plant), and often do not provide the type of cover and food that native wildlife require, so their presence degrades the quality of the habitat for birds and animals.

Many exotic species are also classified as highly invasive because they are so hardy and tolerant of disturbance that they can overtake and displace native plant species within a vegetation community. The rapid spread of some exotics results in a homogenization of ecosystems. Glossy Buckthorn (*Rhamnus frangula*) is an aggressive invasive exotic species of shrub that spreads quickly. It forms an impenetrable understorey that shades out and replaces whole guilds of native species, to the detriment of species diversity, community structure and natural succession trajectories.

### 7.4.1 Glossy Buckthorn (*Rhamnus frangula*)

Glossy Buckthorn is a wetland shrub that is tolerant of the low pH and low oxygen conditions that exist in the Sifton Bog. A buckthorn thicket does not undergo succession, but rather establishes a self-replacing colony to the exclusion of native species (Figure 16). The presence of Glossy Buckthorn in the Sifton Bog was not reported by Crawford in 1926. However, early descriptions of the bog made by Judd in 1957 noted a dense growth of *Rhamnus frangula* in zone B (lower damp woods) (SWT3, Map 10b), forming dense thickets and producing many seedlings beneath the mature seed-bearing shrubs. Judd (1966) reported that during the war from 1939 to 1945 many buckthorn shrubs were removed by the Department of National Defense, as the charcoal from this wood was an excellent source of a component for fuse powder. In spite of this extensive removal, the growth had returned to its former abundance by the mid-1960s. We can only assume that buckthorn has been present in the bog since at least the late 1930s since it was large enough to harvest during the early 1940s.

**Glossy Buckthorn (Photo: Brenda Gallagher)**

Waldron (1972) recorded Glossy Buckthorn from several plant communities found in the muck soils surrounding the floating mat, including the wet closed deciduous shrubland, wet closed deciduous swamp forest and mesic deciduous forest. In addition, seedlings grow on the hummocks within the narrow band of wet closed coniferous forest on peat. In 1977, vegetation mapping and a description of five main plant communities was made by Small *et al*. for the Ministry of Natural Resources Significant Sensitive Areas of Middlesex County. Buckthorn was recorded from two communities outside of the Black Spruce-Tamarack forest zone: in the north and northeast corner the vegetation was described

A. Areas dominated by *Rhamnus frangula* or *Rhamnus cathartica*
B. Low light conditions of buckthorn thicket
C. Bog mat blanketed by emergent buckthorn seedling; evidence of deer browse

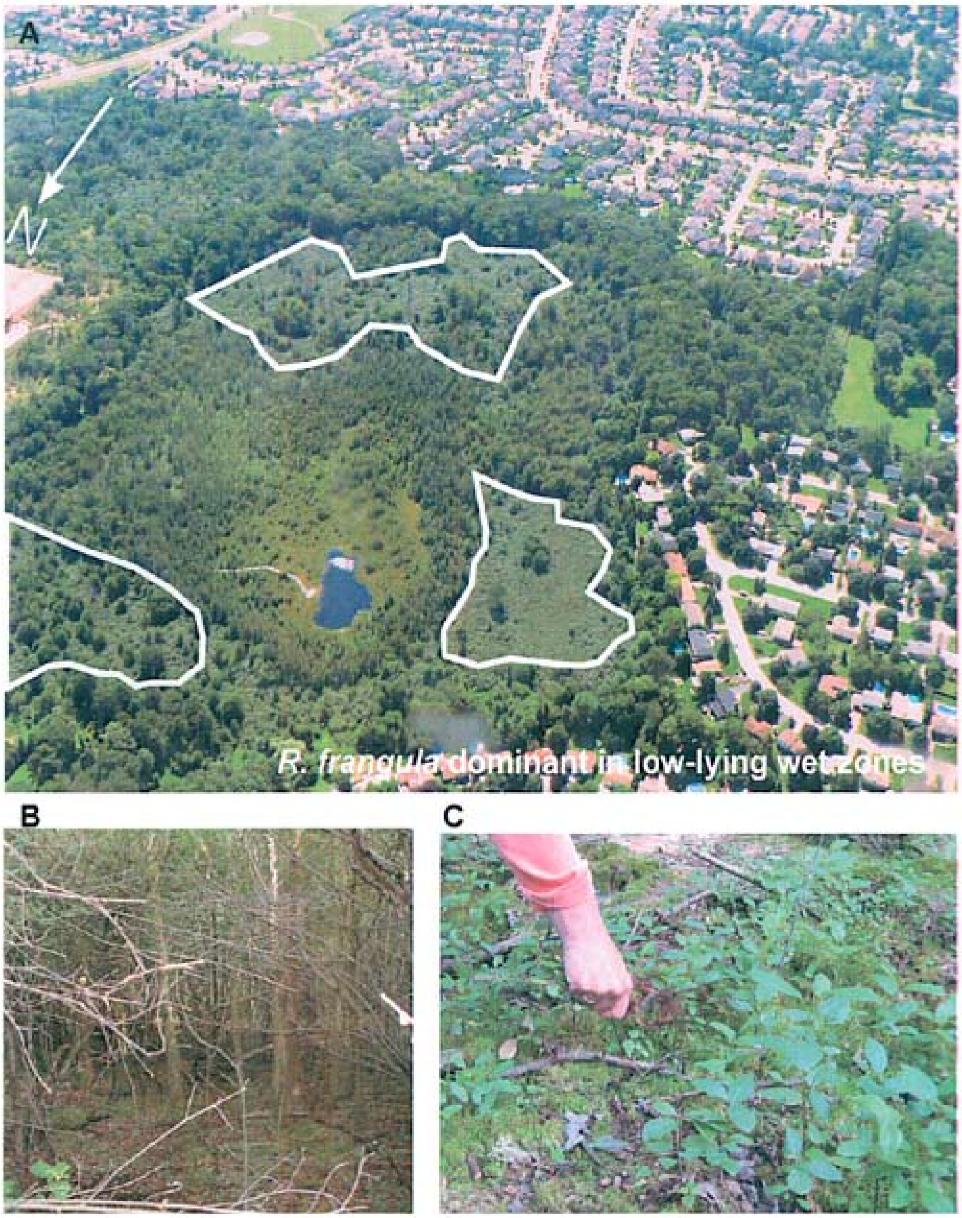


**Figure 16. Invasive alien species: Glossy Buckthorn and Common Buckthorn**

as "a dense shrub thicket with buckthorn-dogwood-salix" and to the south and surrounding the bog was a "closed deciduous maple-birch swamp forest with a dense underbrush composed almost entirely of buckthorn."

In 1979, Proctor and Redfern Limited prepared an environmental appraisal (similar to an Environmental Impact Study) to support development adjacent to the Sifton Bog (the Hazeldon Subdivision). They identified 16 sampling stations within five vegetation zones in the area extending from the old fields at the south end of the bog to Redmond's Pond. Buckthorn abundance was recorded from the wooded slopes (16% cover), the lowland zone (62.5% cover), the treed bog zone (67% cover) and the open bog zone (4% cover).

R. Graham (1987 unpublished) completed a quantitative vegetation survey limited to the open *Sphagnum* bog areas. Qiang Wu (1989) used these vegetation data to identify and quantify the vegetation pattern of the bog and to relate some environmental factors (pH, nitrate and phosphate) to the vegetation structures using multivariate analysis, principal component analysis and canonical correlation analysis. *Rhamnus frangula* was found to be the first ranked species contributing the most to the division of vegetation Group A (open bog with no buckthorn) and the other Groups B + C + D (communities with buckthorn). Group B (treed bog with immature buckthorn only) was distinguished from Groups C + D (woodlands with mature buckthorn). Thus, *Rhamnus frangula* provides a marker that traces the invasion of buckthorn from the non-bog woodland habitat zones outside the bog, to inside the treed bog zone. In 2008 seedlings of buckthorn were found present in the open bog zone, and it remains present in all other zones. It is uncertain whether the true bog environment has properties that prevent buckthorn from successful establishment. Continued monitoring of the permanent vegetation plots will assist in answering this question.

In 1992, McLeod conducted a very detailed life science inventory and prepared accompanying maps for the Integrated Resource Management Study. He reported "*Rhamnus frangula* is the greatest threat to the native flora as it was found throughout the entire study area in abundance," and even noted that "seedlings have begun to show up in the *Sphagnum* of the floating mat in the core area of the bog." He recommended that "test plots be established in areas of dense buckthorn growth away from the central bog to experiment with various mechanical and manual extermination techniques such as girdling, pruning of sucker growth and pulling." Some limited testing of herbicide occurred on the eastern tableland shrub thicket for Common Buckthorn and Tartarian Honeysuckle.

The most recent quantitative study of the bog flora was completed by BioLogic from 1998 to 2000. It established 13 permanent plots, 10 m x 10 m, within the natural bog and swamp communities as defined by McLeod (1992). Most of plots were located east of Redmond's Pond with roughly two plots in each of the following communities: Bog (3a, 3b, 3c) and Swamp (4a, 4c, 4d and 4f) (Map 10a). Glossy Buckthorn was present in the Maple-Birch deciduous swamp and thicket swamps, the mixed swamp, the Black Spruce-Tamarack swamp, the treed bog and the Leatherleaf shrub bog. These plots were located and sampled in 2008 by Bradwill Ecological Consulting to assess long-term vegetation response in the bog and adjoining swamp communities. The results of this survey will be published in a separate report.

Figure 16 illustrates the extent of buckthorn in the ESA. The presence and abundance of buckthorn in the Sifton Bog was confirmed by field surveys in 2006 and 2007 by Bergsma, Quinlan and Gallagher. Glossy Buckthorn has formed a monoculture in several locations around the bog perimeter, indicated by a dense canopy of mature shrubs, a dense shaded understorey, young shrubs and seedlings on moss. In some locations within the non-bog swamp zone there are no seedlings of any other species and scattered trees in the canopy are either dead or dying. This monoculture of buckthorn represents a very significant stress to the health of the local plant community, which is clearly on a trajectory of ecosystem decay, as evidenced by a decrease in structural diversity (forbs, shrubs, trees) and a decrease in richness and abundance of native species.

For this particular stress, intervention must begin immediately. Hand pulling of buckthorn seedlings that have become established on the open bog mat is needed. A way must be found to mechanically remove shrubs within the Black Spruce-Tamarack zone that separates bog from non-bog vegetation. Within the sensitive peat zone, the buckthorn is still quite young and manageable. Small seedlings, < 20 cm tall, can be carefully pulled by hand but care must be taken to remove the entire root.

The goal of a buckthorn removal strategy is to beat back the advancing line of buckthorn invasion to protect the integrity of the unique bog vegetation. Removal (by cutting then applying a proven herbicide, if necessary and permitted) of the largest, seed-bearing shrubs will control seed dispersal.

Pulling buckthorn out of the ground with a tool called a Weed Wrench™ has been successful in other areas of the city, but this tool is not effective in the spongy, soft organic soils at the Sifton Bog. Other removal methods will need to be explored. Extensive work on buckthorn removal across North America has shown that herbicides are often the only effective treatment (see Appendix N). Use of herbicides, however, is not permitted in wetlands currently. Ongoing management is a necessity because the ground is saturated with seed waiting to germinate. In areas of high-density buckthorn growth, after the buckthorn has been removed, it is advisable to install replacement plantings of suitable native species to occupy the vacant ecological niche. Such plantings would need to be fenced to prevent deer browse. Much of the buckthorn closest to the bog zone is not mature enough to produce seed. If and when this population does begin to produce seed, the bog invasion will be complete.

Removal of the large stands of Glossy Buckthorn will be challenging and costly, but needs to be done if the goal of the management plan to protect the unique bog vegetation is to be achieved.

### 7.4.2 Common Buckthorn

Common or European Buckthorn (*Rhamnus cathartica*), a close relative of Glossy Buckthorn, is prevalent on the upland slopes and drier woodland habitats of the Sifton Bog ESA. It behaves much like Glossy Buckthorn. Common Buckthorn has spread widely throughout eastern North America since its introduction in the 1880s from Europe and Asia. Studies have shown that breeding birds do not nest as successfully in habitats dominated by non-native shrubs such as buckthorn and Tartarian Honeysuckle (Schmidt and Whelan 1999).

**Common Buckthorn (Photo: Brenda Gallagher)**

Like Glossy Buckthorn, Common Buckthorn must also be managed in Sifton Bog. Herbicides and Weed WrenchesTM, however, effectively work on the tablelands. Recent Common Buckthorn removal trials conducted by the ESA Management Team have demonstrated very high soil disturbance from pulling, and buckthorn re-growth from root fragments left underground or left touching the soil (Brandon Williamson, pers. com.). Herbicide treatment must remain an option to effectively remove and control the largest seed-bearing shrubs (see Appendix N). Cutting without applying herbicide causes the buckthorn to sucker and form an even more robust and difficult-to-remove root and multi-stem structure. Most conservation and restoration land managers include herbicides as part of their arsenal in the battle against invasive plants. Herbicides and pesticides must always be used as a last resort and only when the risk posed by the invading species exceeds the risk of using a chemical in a sensitive area. Safe application methods are available that allow the chemical to be applied sparingly and directly on the target shrub (e.g., basal bark application) in sensitive areas. The best time to apply herbicide is late summer to fall when the shrub is actively transporting energy back into the roots.

### 7.4.3 Tartarian Honeysuckle and Autumn Olive

Tartarian Honeysuckle (*Lonicera tatarica*) and Autumn Olive (*Elaeagnus umbellata*) are other non-native shrubs that occur in the upland areas of the Sifton Bog ESA, but to a lesser extent than Common Buckthorn. They are mainly found in the south end close to walkways and houses. Like buckthorn, Tartarian Honeysuckle and Autumn Olive also sucker when cut. The methods used to control Common Buckthorn also apply to Tartarian Honeysuckle and Autumn Olive.

### 7.4.4 Purple Loosestrife

Purple Loosestrife (*Lythrum salicaria*) is a herbaceuous wetland plant from Europe. It has become a problem in many North American marshes. In Sifton Bog, Purple Loosestrife was found in the meadow marsh / moat area in the early 1990s. Volunteers and staff of the UTRCA completed a loosestrife pull in 1992 that was surprisingly successful. This plant is not a problem today and only a few stems are seen from time to time. The site should continue to be monitored and any plants that are found should be pulled or cut prior to seeding.

### 7.4.5 Garlic Mustard

Garlic Mustard (*Alliaria officinalis*) is another European plant invader of North American forests. This herbaceous plant was probably brought to North America by early settlers to use as medicine and a flavoring for food. It has spread prolifically across eastern North America. It is found in the upland woods of the Sifton Bog ESA, especially in areas of high disturbance but low management along fencelines. This plant displaces native ground cover and tree saplings by crowding them out. It may suppress the growth of tree seedlings by disrupting mutualistic associations between native canopy tree seedlings and below-ground arbuscular mycorrhizal fungi (Stinson *et al*. 2006). The fungi make soil nutrients biologically available to trees and without it, seedlings do not thrive.


**Garlic Mustard**

Mechanical methods of control for Garlic Mustard include cutting the plants before they bear seeds or pulling them out of the ground, or burning the immature seedlings with a propane torch. These methods usually need to be repeated for several years because pulling plants will open up the soil, exposing more Garlic Mustard seeds.

There has been some success using a glyphosate-based chemical (e.g., Roundup™) sprayed early in the growing season when the Garlic Mustard is green but before the native flora has emerged. However, the Round-up will not kill the seed bank, from which seeds will continue to germinate.

#### 7.4.6 Goutweed

Goutweed (*Aegopodium podagraria*) is a green and white variegated European plant used as groundcover in gardens. It readily spreads by rhizomes and invades nearby natural areas, reverting back to its solid green colour. At Sifton Bog ESA, it is found in the drier woods, especially at access points and behind houses, but it is not widespread at this time. It is even more difficult to control than Garlic Mustard. Neighbouring landowners should be educated about avoiding the use of this plant in gardens.

#### 7.4.7 Management Options for Invasive Species Control

Managing invasive plants is complex and requires long-term, multi-faceted collaborative efforts. The problem requires far greater effort and resources than are currently committed.

Resource managers have spent countless hours and dollars removing invasive alien species, sometimes with limited success. We need to continue these control efforts and learn from successful management experiences. The simplest, but not necessarily the lowest cost, method of control is chemicals. The use of chemicals poses uncertain health risks, requires trained applicators and is generally not recommended for use in wetlands.

Another tactic is biological control of invasive species, which requires finding insects that feed on specific invasive plants without harm to other vegetation (Minnesota DNR 2004). Decade-long trials are required to demonstrate that the introduced insects will not only control the targeted species, but also not become pests themselves. In successional and evolutionary terms, 10 years is not very long. Biological control species must receive government approval for release into the environment. For example, beetles that feed on Purple Loosestrife have been approved for release in Canada and were introduced into Walker Pond at Westminster Ponds ESA by the Western Ontario Fish and Game Protective Association, with positive results.

Another management tactic is mechanical control. Positive results were achieved at the Sifton Bog by a community effort to remove Purple Loosestrife by digging, cutting and removal.

The complicating factor at Sifton Bog is that even if the non-native plants (especially buckthorn) can be removed, replacement native plants will be subject to very high deer browse pressure. Therefore, alien invasive plants and deer must be managed as part of an integrated pest management strategy involving multiple tactics. The following section discusses some of the more threatening invasive alien plant species for Sifton Bog.

## 7.5 Other Bog Invaders

Some species of native plants and animals can pose a risk to the bog's biodiversity when they are present in large numbers and occupy habitats not natural to their distribution. Past and/or present human disturbances often allow such non-bog plants to enter and spread.

#### 7.5.1 Common Cattail

Common Cattail (*Typha latifolia*) has been present around the pond for more than 70 years, during which time it has had a relatively stable population. It is found around the pond margin and within tracks made by humans and deer. Cattails are not bog plants, but instead are typically found in emergent marshes and some roadside ditches. Their presence indicates some nutrient enrichment from burning fossil fuels, possibly nitrogen, which is carried in precipitation (United States Geological Survey website). McLeod (1992) recommended that cattails in the bog proper be monitored and perhaps removed. The population has not been increasing significantly since then. Control by preventing seed set (e.g., cutting the tops off) may be effective. However, there is some argument that, since cattails are locally native, the process of cattail invasion is also natural and should be allowed to proceed.


**Common Cattail (left) and Three-way Sedge**

### 7.5.2 Three-way Sedge

Three-way Sedge (*Dulichium arundinaceum*) is a native plant that has formed a dense stand north of Redmond's Pond in the open bog mat but is also found throughout the shrub bog. It is a grass-like perennial herb with extensive rhizomes (roots) found in swamps, bogs, ponds and sedge meadows. The seeds are eaten by waterfowl. This sedge may have spread after Black Spruce trees were cut in the 1940s and 1950s. Alternatively, it may have been introduced since the time of peat-harvesting. This plant should be monitored to see if it is aggressively displacing other bog species. No action needs to be taken to control this plant at this time.

## 7.6 Human Use Effects

Humans can influence the ecology of natural areas in many ways. Walking trails have impacts, but within most natural areas only passive human uses are permitted. For safety reasons, dead tree hazards are cut and, more recently, wet areas are treated with *Bacillus thuringensis* to kill larvae of mosquito that may transmit West Nile Virus. This section elaborates further on human use effects of trails, and effects of vegetation and wildlife disturbance.

### 7.6.1 Trails

The location of Sifton Bog within the City of London makes it convenient and easy to access. One of the challenges of managing a natural area within an urban setting is to accommodate visitors while protecting the sensitive ecology and wildlife habitats. Sifton Bog is accessible year round. Most of the trails, including 2.5 km of managed trails on public land and 1 km of unmanaged trails on public and private land, are long-standing trails that have been used for years.

The main stress to the environment from trails is due to the number, length and location of trails. The principles of trail design include carefully balancing environmental responsibility while accommodating limited pedestrian use. As trail creation is a fairly permanent and costly investment, long-term plans are needed to predict impacts on ecological integrity. Narrow foot-trails cause the least damage to the environment. Trails in wet areas tend to get wider as users avoid wet terrain; thus, boardwalks are a reasonable solution in these areas. As much as possible, trails should be directed to drier, gently sloping areas. Trails and access points must also be well marked so visitors can follow them easily and know the rules. Neighbours prefer trails be set back from rear yard property lines; however, this may increase habitat fragmentation.

| | |
|---|---|
| A | Year-round, daily visitors for dog-walking, personal enjoyment or research |
| B | Narrow setback, limited buffer between residential and natural area |
| C | Environmentally Significant Area hemmed in on all sides; no linkage to Thames |
| D | Boardwalk, parking, interpretive story boards and entrance improvements to limit access points |

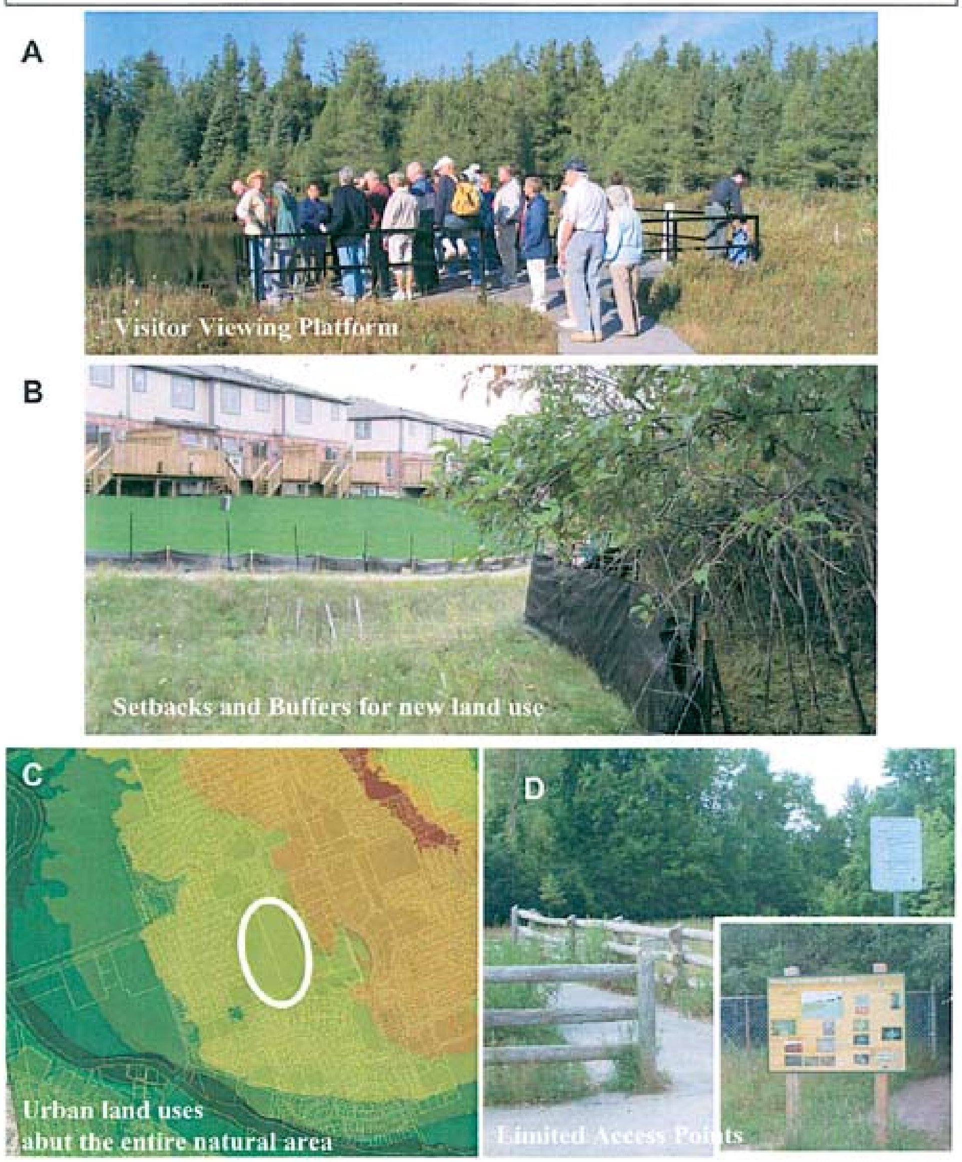


**Figure 17. Effects of human use and encroachment**


**Managed trail**

Sifton Bog has been a highlighted natural area to show off to the public through Natural Areas Day hikes organized by the McIlwraith Field Naturalists and, more recently, through the Doors Open annual event. That event brought 1000 visitors on a single weekend in 2007 (Figure 17).

Now that the bog is surrounded by residential and commercial developments on all sides, the increase in population places a higher recreational demand on this resource. Fortunately for this site, the most sensitive zone, the floating *Sphagnum* mat, is accessible only by a boardwalk. Interpretive signs at the entrance explain the history and uniqueness of the Sifton Bog. Most visitors stay on this boardwalk and view the bog from the platform at the edge of Redmond's Pond. There is a wilderness feeling at Redmond's Pond, as other trails and buildings cannot be seen from the floating platform. This aesthetic experience needs to be protected. Maintenance of the boardwalk involves replacing boards when they rot or are vandalized.

Even well designed and managed trails have impacts on natural environments. Most native plant communities can withstand some disturbance from foot traffic and, in fact, many plants produce sticky seeds so that they can be transported on passing animals (human or otherwise). Negative impacts of trails and access points may include:

- soil compaction in the immediate area of the trail and access points,
- introduction of non-native species carried on shoes and clothing,
- excessive widening of trails, especially in wet areas as people avoid getting wet feet,
- soil erosion, especially on sloping land,
- too dense a network of trails that fragments the habitat and opens up the canopy,
- tree cutting (of tree hazards) for human safety, and
- disturbance to wildlife because of constant human presence.

As the number of trails and access points increases, the number of users and the potential for damage to ecological integrity also increase. Additional stress to the environment is caused by illegal human activities such as littering, vandalism, bonfires, dogs-off leash, encroachment from neighbours, removing flowers or other plants, and riding bicyles.


**Illegal trail**

The number of illegal trails in the south end of the ESA is a problem. These illegal trails need to be closed as the official trail is improved. It is important to provide boardwalks over sensitive/ wet areas to keep people from compacting the soil or peat. The open bog mat is the most sensitive habitat in the ESA and, thus, should have the most minimal boardwalk trail system. Minimizing the network of trails in ESAs is also important to limit the area subject to negative impacts.

The trails in the other areas of the ESA may not be in the best locations; many were created by hikers and not planned by land managers. There are opportunities through the master planning process to move and restore some sections of trail for safety reasons and/or to avoid sensitive or wet areas. In the past, the trails were probably used by small numbers of people but today, more people are interested in walking through natural areas, so it is very important that the trails be in appropriate locations. Closing trails takes time and ongoing management as signage, barracades and obstacles (e.g., thorny shrubs planted or branches laid over the trail) are required to prevent people from re-using the closed trails. Re-establishing vegetation over old trails is hampered by the deer browse pressure and soil compaction. Increased effort will be needed to fence-off new plantings.

### 7.6.2 Vegetation and Wildlife Disturbance by Humans

There are indications of deer tracks as well as human tracks on the bog mat, where some people may venture to view or photograph bog plants. Trampling on the sensitive bog mat destroys the plant life rooted there, creating a watery path for non-bog species such as cattails. There is a small but serious probability that some visitors may wish to collect specimens for their gardens. Most recently, non-native Goldfish have been deposited into Redmond's Pond (Chapter 7.9). These fish have probably uprooted the Southern Pond Lilies and disturbed the native amphibians and reptiles living there.

The ecosystem response to trampling, flower-picking and the introduction of non-native species is a reduction in the number and spatial extent of uncommon species (e.g., orchids), and an increase in non-bog wetland species (e.g., cattails). Many beneficial interventions have been achieved through management activities of the ESA Team, including improvement of the boardwalk, consolidation of trails and access points, and educational activities. Other development driven interventions have included the extensive monitoring of environmental variables and vegetation, and the requirement for vegetation buffers and setbacks (Figure 17).

**Illegally mowed area**

It is important to protect the most sensitive zone(s) of Sifton Bog ESA from new trails/ boardwalks. There is a need to accommodate the recreational, educational, and scientific research values that this ecosystem offers. Permitted uses in ESAs are limited to passive recreation for education, aesthetic appreciation and as a tonic from urban conditions on trails that are not detrimental to the ESA's natural heritage features or functions.

The Conservation Authorities Act and the Parks By-law describe prohibited activities within the ESA (see chapter 7). While most people obey the rules, it takes only a few who break the rules to damage areas. The most commonly encountered prohibited activities include:

- Vegetation removal or destruction (e.g., cutting trees for bonfires, picking or harvesting flowers and orchids),
- Riding bikes on boardwalks and trails,
- Allowing dogs off-leash in the natural area, resulting in dog faeces, dogs chasing wildlife, and vegetation damage from digging and trampling,
- Encroachments beyond private property limits onto public land (e.g., structures or yard waste, compost, lawn clippings, vegetation mowing),

- Vandalism and littering,
- Feeding wildlife (e.g., deer),
- Introducing non-native species (e.g., goldfish).

These prohibited activities have been policed by the ESA Management Team in all ESAs in London since 2001. Signs posted at all entrances list the permitted and restricted activities (Figure 12). Controlling restricted activities is an ongoing management task.

### 7.6.3 Impacts of Domestic Dogs on Wildlife

Domestic dogs frequently accompany recreationists to protected areas. Despite by-laws prohibiting dogs off leash, dogs are often allowed to run loose under "voice and sight control." Dogs are a major component of impacts to wildlife, particularly when they are present in high densities. Dogs behave differently than native canid species (e.g., coyotes). Unlike wild canids, dogs are inefficient hunters, but avid chasers. They have high energy levels and are active during daylight hours. They behave as predators and are capable of catching and killing prey species such as white-tailed deer, small mammals, herpetofauna, and ground-nesting birds. Animals that are prey of wild canids perceive dogs as predators and may be subject to non-lethal, fear-based alterations in physiology, activity, and habitat use. Wild canids may also perceive dogs as a threat to their territories and may be attracted or repelled by the presence of dogs.

A recent research study investigated the effects of dogs on wildlife communities by comparing the activity levels of wildlife in areas that prohibited dogs with areas that allowed dogs. Wildlife activity was measured on trails and up to 200 m from trails using five methods (Lenth and Knight 2008). The results showed that wildlife species that are the prey of wild canids exhibited sensitivity to the presence of domestic dogs. In areas that prohibited dogs, mule deer were active within 50 m of the trail. In areas that allowed dogs off-leash, deer showed reduced activity within at least 100 m of the trail. Similar results were observed for small mammals including squirrels, rabbits, chipmunks and mice. These areas represent a loss of otherwise suitable habitat for certain species of wildlife. In addition to these altered spatial patterns of wildlife activity, dogs also alter temporal patterns of wildlife activity including the patterns of other predators such as coyotes.

Trails that are kept dog-free or on leash could protect against the demonstrated ecological impacts that dogs have on wildlife communities and could facilitate increased wildlife viewing opportunities for trail users. The issue of whether to prohibit dogs completely or to enforce leash by-laws should consider the ecological values of the natural area, particularly the presence of wildlife species that have wild canids as natural predators, as well as the area's recreational values (e.g., trail densities and rates of visitation). The authors recommend before-after control-impact studies be undertaken as new trails are created to further explore the effects of dogs on wildlife communities (Recommendation 2.1.6).

## 7.7 Effects of Adjacent Land Use and Disturbance Processes on Bog Succession

Crawford (1926) noted that the bog had been mainly covered by Sphagnum around 1900, some of which had been "scalped" (i.e., for peat extraction), according to Dr. Dearness. The shrubs she saw in 1926 had grown up in the intervening 25 years. Some 20 years later, around 1945, the Black Spruce trees were cut and sold as Christmas trees. The 1950 aerial photograph in Map 7a shows no mature conifers present. Thus, the peat bog communities present today have rebounded from many major human-induced disturbances over the years. These harvesting activities may have disrupted the natural successional process. Table 13 summarizes the major land use activities adjacent to the bog over the last 60 years.

**Table 13. Major Land Use Activities Adjacent to the Sifton Bog, 1945 to 2007**

<table>
<tr><th rowspan="2">Year</th><th colspan="4">Adjacent Land Use</th><th rowspan="2">Drainage</th><th rowspan="2">Trails</th></tr>
<tr><th>North</th><th>South</th><th>East</th><th>West</th></tr>
<tr><td>1945</td><td>Farm N of Oxford Street</td><td rowspan="3">Farm Market Gardens / greenhouses<br><br>Pond in SW corner used for irrigation</td><td rowspan="2">Redmond Farm</td><td rowspan="2">Foster Farm</td><td rowspan="2">North drain and southwest ditch from Redmond's Pond to SW pond</td><td rowspan="2"></td></tr>
<tr><td>1955</td><td>3 residences S of Oxford Street</td></tr>
<tr><td>1972</td><td>Commercial and residential N of Oxford Street<br><br>Parking lot and entrance to ESA<br><br>2 more homes S of Oxford St.<br><br>St. Aidan's Church</td><td rowspan="2">Gas station at NE corner of Oxford Street and Hyde Park Road</td><td rowspan="4">Sifton Oakridge Subdivision<br><br>Loss of some forest and marsh</td><td>Ditch improved, Kirk Drain open</td><td>Boardwalk to bog installed</td></tr>
<tr><td>1993</td><td rowspan="2">Church and 9 homes S of Oxford St.<br><br>ESA entrance modified</td><td>Norquay Subdivision<br><br>Buffer added</td><td rowspan="2">Kirk Drain capped<br><br>Stormwater Management Pond outlet from eastern tableland</td><td></td></tr>
<tr><td>2007</td><td>Eadie Willcock Subdivision;<br>12 swimming pools adjacent to bog; no buffer added</td><td rowspan="2">Commercial and medium density residential<br><br>Buffer added</td><td>Boardwalk to bog extended</td></tr>
<tr><td>Future</td><td>Oxford Street widening</td><td></td><td></td><td></td></tr>
</table>

Maps 7a and 7b show the changes to the bog and surroundings over the last 60 years. They present a series of air photos taken in 1950, 1955, 1974, 1982, 1989, 1993, 1998 and 2006 (air photos are available at the UWO map library).

Bunting *et al.* (1998) theorized that a *Picea mariana – Sphagnum* (Black Spruce swamp) community represents the most mature point in wetland succession based on pollen samples at Oil Well Bog near Cambridge, Ontario. They hypothesize that Black Spruce swamp is present as a result of changes in the wetland hydrology induced by deforestation in the AD 1830-1845 pioneer period. They also concluded the low shrub vegetation community (which contains locally rare plant species) represents a relic of the pre-European settlement wetland community.

Aerial photographs were scanned from the years 1945, 1955, 1972, 1993 and 2007, which represent years in which species inventories occurred. They were georeferenced and reproduced at the same scale. Generalized community mapping was interpreted by B. Bergsma from the air photos and from community mapping completed by other authors. The successional sequence of the bog from the central pond to the lagg zone shows generally as concentric rings or zones, each representing a slight variation of the previous. Over the years some general trends have emerged in response to adjacent land uses and successional processes (Table 13, Figure 18).

In 1945, the area occupied by graminoid and low shrub bog communities was extensive, occupying more than two-thirds (2/3) of the wetland area including the northeast and northwest corners (Figure 18). It is presumed that there was some buckthorn present in the NE corner as it had been harvested from the bog for many years during WWII. A large area of deciduous and mixed swamp was present at the south end of the bog. Most of the bog was surrounded by forested slopes. There were old field and shrub thickets in the southeast corner and marshes in the southwest corner. Farming was the only land use adjacent to the bog.

By 1955, the area of moraine in the southeast was extracted for gravel and sand (Figure 18). Evidence of the Kirk Drain was present (see also Map 7a). To the east of Redmond's Pond the vegetation succeeded to treed bog. The swamp forests expanded along the western edge. In the northern section of the bog, buckthorn was increasing at the expense of the swamp forests and open bog mat. Some of the cultivated land on the eastern tableland south of Oxford Street was established as apple orchard, and subsequently populated with hawthorn after the orchard was abandoned.

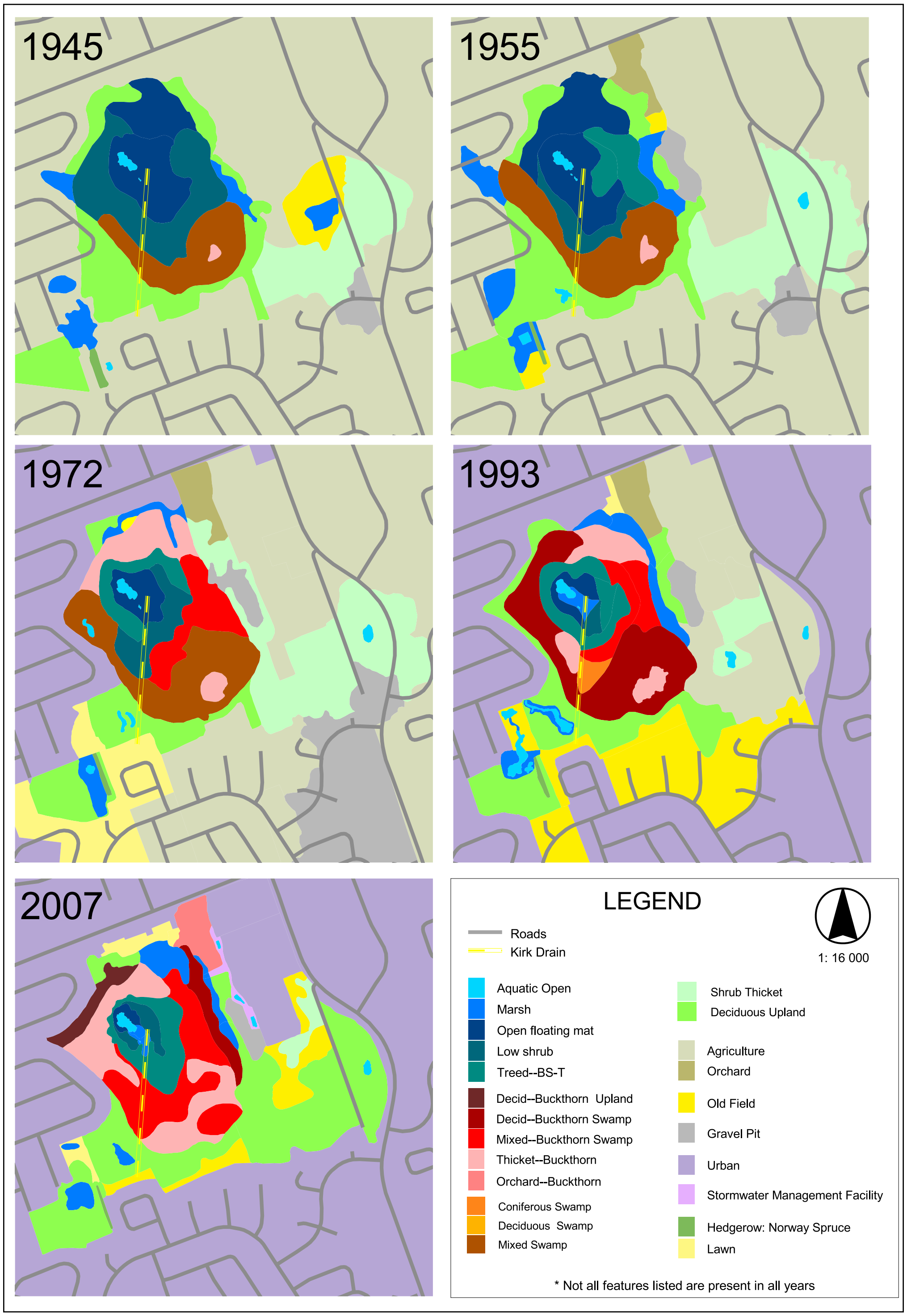


**Figure 18. Changes in land use and vegetation communities, 1945 - 2007**

By 1972, the first Sifton subdivision development had occurred on the western side of the bog on the former Foster Farm (Figure 18). This development saw much of the bog protected and put into public ownership. There was some loss of upland forest and marsh habitat associated with this development. Buffers were not a requirement of development at the time. Redmond's Pond and the overall area of open bog were relatively unchanged, but there was succession of treed bog to coniferous swamp and shrub bog to treed bog. The area of open graminoid bog was smaller. A gas station had been built at the NE corner of Oxford Street and Hyde Park Roads. Several homes were built along the south side of Oxford Street and St. Aidan's Church was built on the northwest corner of the ESA.

After another 20 years, in 1993, the second Norquay subdivision was built south of the bog (Figure 18). Mitigation of development impacts included the establishment of buffers adjacent to the mature slope forests. The Kirk Drain was capped to stop the draining of the bog. Buckthorn was a dominant and abundant shrub in the northeast corner of the bog and was identified as occasional to abundant in every bog and swamp community around Redmond's Pond. No action was taken to control buckthorn despite a recommendation from the Integrated Resource Management Study (Golder 1992). The spread of cattails along drainage ditches and tracks was obvious, and the three small ponds south of Redmond's Pond were filling in with more fen-like vegetation. Many of the rare orchid observations were located in this zone. The area of open graminoid bog was smaller, while the area of shrub bog and treed bog expanded. The lagg zone continued to be present as isolated marsh and swamp habitats along the outer margins of the wetland.

Today, in 2008, land development adjacent to the bog is complete (Figure 18). The last two developments provided some set-back between the property lines and the natural area. The Crich-Drewlo subdivision and commercial development on the east side of the ESA addressed stormwater management requirements by the construction of a stormwater management pond facility (see Map 2). This pond is on the tableland at the outer edge of the slope and buffer vegetation and outlets directly into the lagg zone. Now, about two-thirds (2/3) of the wetland area is occupied by swamp communities and only one-third (1/3) by open bog communities. Many of the mature trees in the swamps have died or are dying and there are several very large patches of monoculture Glossy Buckthorn in the canopy, sub-canopy and ground layer surrounding the bog mat. The thicket and field habitats in the southeastern end have succeeded to woodland habitat.

The bog peat will continue to consolidate and succeed from shrub to treed bog and eventually to swamp forest. The size of Redmond's Pond has not changed much over time, although the depth of water has decreased. If buckthorn control is not started immediately, the entire swamp could become a monoculture buckthorn thicket.

## 7.8 Effects of Tree Hazard Cutting on Forest Stand Basal Area

Basal area analysis is a measure of live tree density in a stand, expressed in $m^2/ha$. In February 2007, a UTRCA Forestry Technician carried out basal area analysis in three plots in the mature upland forests in the south and southwest ends of the ESA. The results are summarized in Table 14 (full details in Appendix I). The location of the stands and plots is shown on Map 8.

**Table 14. Basal Area ($m^2$/ha) of Upland Forests in Sifton Bog ESA (February 2007)**

| Plots | Polewood 10 - 24 cm | Small 26 - 36 cm | Medium 38 -4 8 cm | Large 50 - 0 cm | X-Large 62+ cm | Total |
|---|---|---|---|---|---|---|
| Plot 1 | 8 | 11 | 8 | 6 | 0 | 33 |
| Plot 2 | 8 | 11 | 3 | 2 | 1 | 25 |
| Plot 3 | 1 | 8 | 11 | 15 | 3 | 38 |
| **Ideal Sawlog BA** | **4** | **5** | **5** | **4** | **2** | **20** |
| **Old Growth BA** | | | | | | **28** |

**Notes:** Size is measured as diameter at breast height (DBH); e.g., Polewood 10 - 24 cm DBH
Plot 1 – 60% Sugar Maple, 20% White Ash, 10% Red Oak, 10% Black Cherry
Plot 2 – 30% Black Cherry, 20% White Ash, 20% Sugar Maple, 10% Black Walnut and Silver Maple
Plot 3 – 40% Red Oak, 25% White Oak, 15% Black Cherry, 15% Silver Maple

The total basal area ranged from 25 to 38 $m^2$/ha for the three stands. These values are close to the ideal of 28 $m^2$/ha for maintaining old-growth characteristics (OMNR 2000). These communities contain a dense stand of sizeable trees. It is rare to find basal areas above the ideal in the larger size classes in southwestern Ontario, as many woodlots are over-harvested and dominated by younger trees. However, many trees in the sampled plots are declining or dying, perhaps due to crowding or age. About 30% of the trees fell into the category of "unacceptable growing stock," which means they probably will not be alive in 10 years. Very few tree saplings (<10 cm DBH) are present. Two factors of influence are likely deep shade conditions under mature canopy and excessive deer browse.


**Conducting basal area measurements**

While no harvesting of living trees has taken place in these forests since the 1950s, dead trees that pose a hazard of falling onto managed trails are cut down and left to decompose. Tree hazards are trees that pose a safety risk to the public because of location, lean, size or deterioration. For risk and liability reasons, the City of London asked the ESA Management Team to design and implement a tree hazard management program for the ESAs. Currently, a tree is deemed to be a hazard if it will impact an identifiable target such as a trail/boardwalk, parking lot or house. Tree hazards are dead trees tall enough to land on a trail or other target.

The ESA Management Team carries out an annual inspection for tree hazards; several members of the team have years of forestry experience. Each year, the managed trails are walked and all tree hazards are mapped and later felled with chain saws at ground level. The trunks and limbs are left on-site to decompose.

Many species of wildlife depend on both living and dying or dead trees. Standing dead trees, called snags, are an important part of a forest. Insects invade the dead wood and are, in turn, eaten by birds. Birds and small mammals nest in the cavities of snag trees. They are also used as perches for larger birds. They are sometimes called "wildlife trees."

A small percentage of tree hazards (dead trees) could be left standing if it were possible to remove only the most hazardous limbs. Selective limbing entails climbing the tree, and this is not always a safe activity. It is also more time-consuming and, thus, expensive. It is sometimes difficult to bring the needed equipment into the ESAs. The City contracts an arborist company to remove or delimb ESA trees that impact backyards (e.g. private property), when the ESA Team cannot do the work because of time constraints or when climbing is needed. At this time, the ESA Management Team is not licensed to climb.

It is important to minimize the number of tree hazards that need to be cut and to create signage to inform visitors of the contribution dead trees provide to maintaining biodiversity. Minimizing the number of trails in an ESA reduces the area subject to the tree hazard management program and the potential loss of dead wildlife trees.

Recently, the UTRCA conducted a study to determine how many wildlife trees were left in the ESAs in light of the tree hazard cutting program. The study focused on areas within the ESAs that were not impacted by trails and so would never be subjected to tree hazard removal. Several 1-ha wildlife tree plots were located at least 25 m from the official trail network (i.e., outside the tree hazard zone) within forested vegetation communities in each of the ESAs. Map 8 shows the location of the wildlife tree plot in Sifton Bog ESA. Early results showed that all of the study plots, with the exception of plots in Kains Woods, exceed the minimum standards recommended by the Ontario Ministry of Natural Resources for cavity and snag trees. As well, all study plots in the ESAs, with the exception of the Kilally Meadows plot, exceeded the minimum standards recommended by the MNR for mast (fruit and nut-bearing) trees (OMNR 2000).

The MNR's minimum standard is to retain snags, cavity and mast trees to achieve the following distribution per hectare:

- snags - at least four smaller (< 50 cm DBH) and one larger (> 50 cm DBH) snags/ha;
- cavity trees (live) - at least six > 25 cm DBH/ha, including one > 50 cm DBH;
- mast trees - minimum seven to eight healthy mast trees/ha with DBH > 25 cm, at a spacing less than 50 m apart.
- Preference should be given to retaining trees that perform both cavity and mast.

It is hoped that follow-up studies can be carried out to reveal more information on the overall state of forest health in London's ESAs, both near and away from trails.

## 7.9 Effects of Introduced Goldfish on Redmond's Pond

Fish are typically excluded from bogs because of a lack of oxygen. Snails and mollusks are usually absent because of low calcium. Goldfish (*Carassius auratus*) were discovered in Redmond's Pond in the summer of 2006. Most likely they were dumped into the pond by someone who had too many in their own garden pond. Goldfish are members of the minnow family (of which carp are also members) and are not native to Ontario. Goldfish negatively alter the aquatic ecosystem by increasing turbidity, and uprooting and eating aquatic plants. The abundance of Southern Pond Lily on Redmond's Pond has

**Goldfish in Redmond's Pond, spring 2008 (Photo: Brenda Gallagher)**


Abundant aquatic plants, Redmond's Pond, 2000

been very low the last few years, coincident with the introduction of the Goldfish. There is no historic record of any fish species being found in the pond.

Experience has shown that when Goldfish are thrown into a small pond, they reproduce at an alarming rate (John Schwindt, personal communication). Fisheries biologists recommended removing the Goldfish immediately. The ESA Management Team experimented with several techniques to remove the Goldfish; the only practical method found was electroshocking in combination with some trapping. Fisheries biologists use electroshocking equipment to temporarily stun fish so they can be quickly netted, identified and released. In this case, the stunned fish were netted, euthanized, and removed from the site. In 2007, more than 1,500 Goldfish between one and four years of age were removed from this small pond. The largest fish were 15 cm long. No other fish species were found. There are no known impacts of electroshock on other aquatic species at any life stage (egg to adult). Frogs can be temporarily stunned by the electroshock but they quickly recover and move away. Snapping Turtles seem unaffected by the electroshock (Schwindt, personal communication).

## 7.10 Effects of the West Nile Virus Mosquito Control Program

Control of the West Nile Virus is a public health issue. The Ontario Ministry of Health and Long Term Care, in association with the Middlesex-London Health Unit (www.healthunit.com) and its agents, undertake the West Nile Virus control program.

The primary transmitter of the virus is an urban-dwelling mosquito that lives and breeds in small, stagnant pools of water that collect in rain gutters, buckets and storm sewers. Sometimes the mosquitoes are found in natural small bodies of water. Identified areas of standing water are treated with bacterial biological agents called *Bacillus thuringiensis israeliensis* (Bti) and *Bacillus sphaericus* (Bs) (under the trade name Vectobac) that are absorbed by the mosquito larvae. The mosquito larvae fail to mature, and die. Signs are erected at the ESA entrance to inform the public that this pesticide treatment is ocurring.

Two sites in or near the Sifton Bog ESA are treated with Vectobac. The sites include the Silver Maple swamp near the Oxford Street entrance and a catchbasin along Old Hyde Park Road.

It is important to note that healthy wetlands have many features that can reduce the number of mosquitoes naturally. Mosquitoes are part of the food chain and are eaten by birds, dragonflies and damselflies, though they are not the dominant food source of these creatures. Carnivorous bog plants, such as Pitcher Plant and sundews, trap and digest mosquitoes as well as other small insects. Other bog dwellers that rely on mosquito larvae for food include larval salamanders and frogs. At this time, there is no information on the impact of the West Nile Virus mosquito control program on other species in the food chain.

## 7.11 Effects of Fire

Fire is a natural occurrence in many ecosystems, but can be very damaging to a bog, which is not fire-tolerant. A carelessly tossed cigarette, unauthorized fire, or lightning may ignite dry peat during a dry summer. Peat can burn and smolder underground for days, as it did in Sifton Bog in the mid-1980s. Contingency planning is needed to direct firefighting in the case of a fire in the Sifton Bog. Communication of this plan with neighbours is also needed.

## 7.12 Stress-Response-Intervention-Outcome Model Summary

It is important not to lose our perspective and "love the Sifton Bog to death." Therein lies the paradox: Significant and unique natural areas such as Sifton Bog ESA are heavily used and sometimes abused; substantial management interventions are required in order to keep "nature" in the Natural Area, to maintain biodiversity and ecosystem integrity now and into the future. The natural trajectory of the bog ecosystem is toward the filling in of the pond, and consolidation of *Sphagnum* communities to conifer peat forest. This trajectory has been altered in the past 150 years by drainage, fire, peat harvesting, Black Spruce harvest for Christmas trees, introduction of invasive non-native species, agriculture, residential and commercial developments, road runoff, overpopulation of White-tailed Deer and increasing human uses.

The key objective of the Conservation Management Plan is to develop recommendations and timely interventions with achievable strategies identified to manage the multitude of disturbances that threaten the integrity of the bog ecosystem and to continue supporting scientific research that will aid in the understanding of this unique ecosystem so that we may better protect it. Four principal management targets have been identified: deer overabundance, invasive alien plant species, changing hydrology and human use effects. The following chapter introduces intervention recommendations to address the identified stresses.