Park and Species Protection at the Wainfleet Bog Conservation Area: Adaptive Ecosystem Management Approach to Wetland Rehabilitation

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Abstract

*The Wainfleet Bog Conservation Area (800 ha) protects the largest (1480 ha) least disturbed peatland in southern Ontario. Influenced by 80 years of peat extraction and drainage, this degraded wetland is subject to fires and extensive colonization of European white birch (*Betula pendula*). Protection efforts involve an adaptive rehabilitation plan including Species at Risk needs and baseline and long-term monitoring of biotic and abiotic factors. Slow successional processes are observed. Sphagnum moss (*Sphagnum papillosum*) sowing with re-created micro-topography has significantly increased moss cover. European birch dieback has also increased in areas of improved soil moisture and summer drought. Moreover, decomposition of woody debris/cellulose is rapid in peat-mined areas and significantly decreases in improved soil moisture areas. Studies of the threatened Massasauga rattlesnake (*Sistrurus catenatus*) also indicate use of several habitat types which are protected. An ecosystem approach to management appears to have been effective in rehabilitating and protecting this peatland and its species.*

Keywords: *Wainfleet Bog, species protection, sphagnum moss, adaptive ecosystem management.*

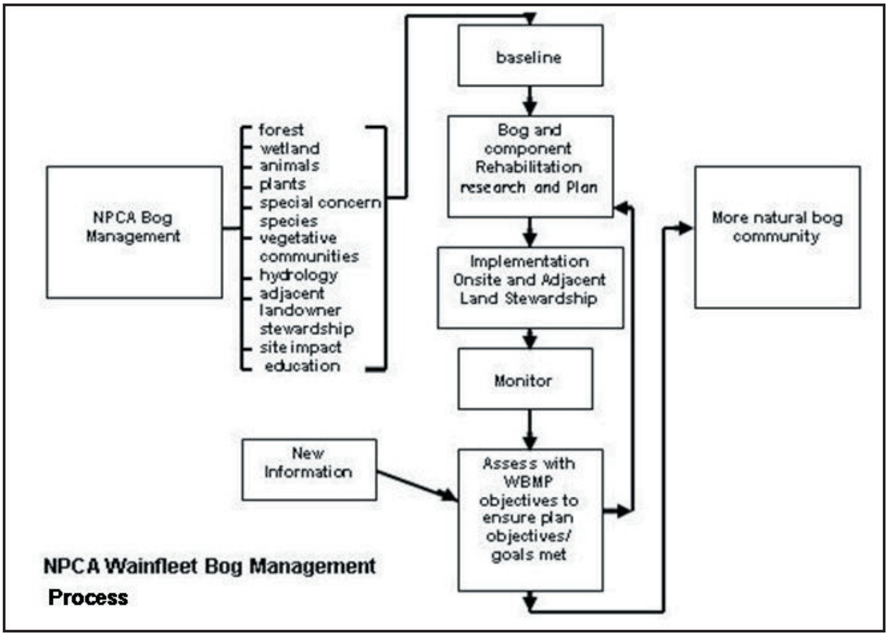
Purpose

The Wainfleet Bog Conservation Area was developed to protect on-site ecological significance and re-establish a more natural bog ecosystem on a peat-mined site. The bog ecosystem and species at risk are key aspects for protection at the site, while also permitting educational and passive recreational opportunities where appropriate. The Wainfleet Bog Management Plan has been developed to achieve a balance of hydrological, biological, and cultural aspects to ensure successful site protection and rehabilitation (NPCA, 1997) (Figure 1).

Methods

As part of the implementation of the Wainfleet Bog Management Plan (NPCA,1997) pre-existing studies and data were reviewed and various scientific studies were completed to examine the hydrology, flora and fauna, and decomposition rates at the bog (Figure 2).

Figure 1. Niagara Peninsula Conservation Authority Wainfleet Bog Adaptive Management Process.



i) Hydrology

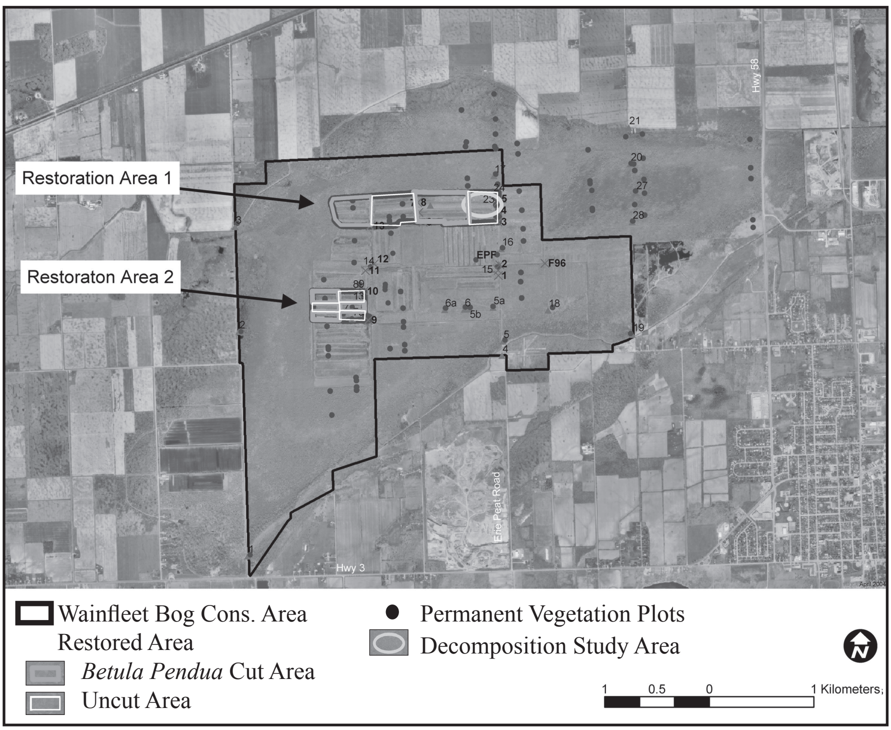
To evaluate existing and future hydrologic conditions at the bog various studies had to be undertaken.

To date, a network of 21 water wells have been established throughout the bog. Groundwater levels have been taken on a monthly basis from 1998 to 2005. Soil moisture levels were also measured on a bi-monthly basis at the same stations.

In addition to baseline monitoring, water wells were used to determine if European Wwhite birch (*Betula pendula)* was impacting watertable levels through evapotranspiration. Comparisons were made among water well data and vegetation data in order to determine if a significant relationship exists between these two variables.

A preliminary water budget for the bog was also developed. Pressure transducer loggers have been installed at two of the main outflow drains. Measurements were taken continuously (every 15 minutes) at these drain out-

Figure 2. Wainfleet Bog Conservation Area and rehabilitation sites.



lets, from 2003 to present, to determine total outflow and site water levels in addition to the flow direction of existing surface drainage of the area.

As part of determining the efficacy of peat dam restoration work, staff gauges were installed above and below dams. Gauges are measured weekly to assess the dam blocking effectiveness.

ii) Flora and Fauna Monitoring

A variety of studies were undertaken to assess existing and future conditions of the flora and fauna at Wainfleet Bog. To determine trends in plant community assembly and succession 110 permanent 10 m x 10 m vegetation plots were established throughout the bog. Each consisted of three groundcover plots, a shrub plot, and a tree plot. Species frequency scores were taken at four different height categories to assess community structure. Corresponding environmental variables were also measured, which included slope angle, aspect, wood and litter accumulation, peat density, and volumetric water content.

As part of rehabilitation, artificially created hummocks and hollows (shallow surface indentation) were created. Another 576 permanent plots were established on these areas to assess the impact of microtopography, white birch cutting, mulching, and planting of bog species on plant succession.

An analysis of fauna was carried out using a bird species point count survey and a reptile presence/absence survey. Habitat requirements for all known species at risk were also obtained.

iii) Decomposition

To assess the effect of re-wetting soil on the bog decomposition process, 40 microcosms of 20 cm x 40 cm x 30 cm were established in a one hectare area of extracted peat area. Twenty microcosms representing existing bog conditions (as control) were established in this area using randomly selected GPS coordinates. Another 20 microcosms representing re-wetted conditions were established within a perforated plastic container of the same size, fitted with four wooden legs, and placed within a bog drainage ditch that maintained water year round. Heights of these microcosms were adjusted throughout the study period to ensure a constant water level of 10 cm below the top of each container. Container perforations ensured peat within the container remained saturated. Under these two moisture variants of existing conditions (control) and artificially rewetted/saturated conditions, litterbags containing wooden toothpicks and European white birch leaves were incubated in the top 10 cm of peat for up to one year to determine the effect of moisture on litter decomposition rates.

Results

Rehabilitation Success Principal Findings

The limiting factors affecting bog heath/integrity were determined as water loss (hydrological), loss of bryophyte and ericaceous shrub cover, increased soil temperature, and the lack of public environmental awareness.

In response to these factors, a rehabilitation plan was developed incorporating all habitat and ecosystem needs of the recorded Species at Risk. The plan incorporates areas dominated by low shrubs, tall shrubs, bog species, open areas, brush piles, Sphagnum moss mounds, and moist areas. Site rehabilitation focused on the western half of the bog, which contained larger areas of barren peat and greater water resources to work with in the restoration process. Leaving the eastern half alone provided a reference area to aid our assessment of restoration techniques and a transition zone for species requiring time to adapt to changing site conditions.

Rehabilitative measures included the blocking of selected interior peat canals (i.e., on the west half) to maintain water at the site, re-saturation of the dry peat and the facilitation of bog plant re-growth using planting and mulching. In the bare, extracted areas, shallow surface indentations (<0.5 m deep) were created and planted with bog species to provide additional cover and to help enhance existing habitat. Half of the non-native European white birch trees were also cut and placed on the surface of the bog to decrease water loss and provide cover and habitat for small mammals and reptiles (i.e., reduce the site migration barrier). Brush piles were also created to provide additional cover and foraging opportunity. As well, an annual newsletter, community workshops, site tours, area landowner contacts, and factsheets were and continue to be used to help increase the awareness of this biologically significant ecosystem.

i) Hydrology

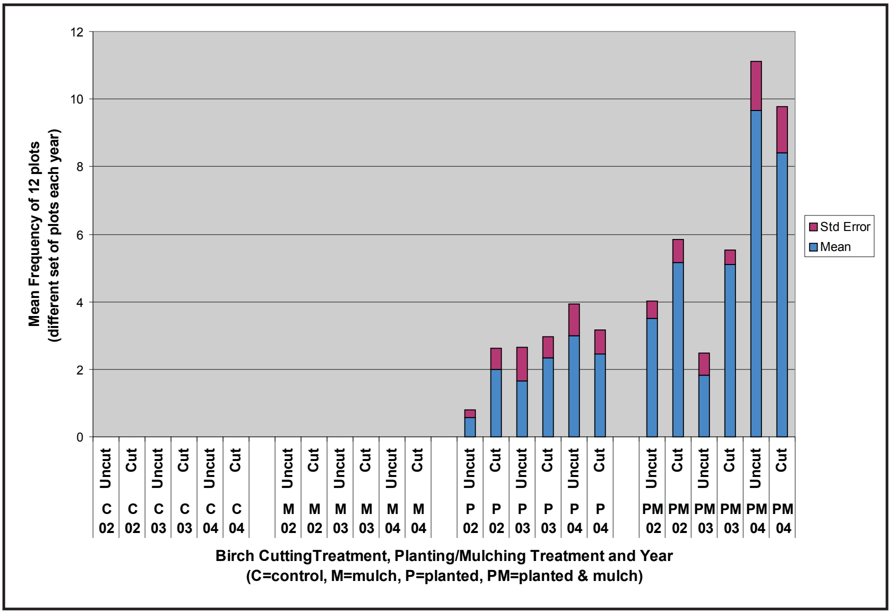
Results indicate that water levels are being maintained in the restored areas for longer periods of time throughout the year in the bog. An analysis of water and white birch trees also did not find a significant relationship ($p>0.05$) between birch trees and the groundwater levels (Diamond *et al.*, 2003). Further assessment is being completed to determine the impact of birch trees on surface peat moisture. Preliminary work has been completed on a water budget for the bog showing overall gain from precipitation and losses due to evapotranspiration and surface drain outflows.

ii) Flora and Fauna

Site studies reveal that overall vegetative succession is slow compared to other harsh and highly disturbed ecosystems such as gravel pit floors (Browning and Tan, 2001). In re-created micro-topography, the sowing of Sphagnum diaspores has significantly increased Sphagnum moss colonization in surface hollows (Figure 3). Moss cover has also improved in restored areas where white birch have been cut. White birch dieback has increased in areas of improved soil moisture (e.g., along blocked drains) and in areas subject to summer drought. As well, areas of severe white birch dieback appear to be the foci for the colonization of new plant species (Table 1). A significant increase ($p<0.001$) in the frequency of all raspberry species (*Rubus* spp.) was also found over the last 4 years in permanent plots where European white birch mortality was >80% (Table 2).

The presence of Massasauga rattlesnakes (*Sistrusus catenatus*) and other reptilian species were also noted in rehabilitation areas, with additional studies underway to gauge population health and recovery. Plant species at

Figure 3. Mean Frequency of *Sphagnum papillosum* in Divot Plots with different birch cutting, planting, and mulching treatments for years 2002, 2003, and 2004.



risk have also increased since the time of restoration, especially in wetter years (2000, 2004). Population monitoring is on-going to ensure appropriate protection and learning.

Table 1. Number of new plant species colonizing (>2) in relation to *Betula pendula* mortality in re-surveyed permanent plots at Wainfleet Bog, 2000 to 2004. R x C Test of Independence using G-Test.

Category of E. Birch Decline	> 2 new species colonizing the plot	≤ 2 new species colonizing the plot	Total Number of Plots	% of plots with >2 new colonizing species
Severe decline (>80% mortality)	17	16	33	51.5
Intermediate decline (>20% ≤80% mortality)	12	24	36	33.3
Little decline (≤20% mortality)	3	18	21	14.3
Open plots (no birch in tree class)	11	37	48	22.9
Total Number of Plots	43	95	138 (n)	

$G\ adj = 10.52$, $p < 0.025$

Table 2: Change in *Rubus* spp. frequency in relation to *Betula pendula* mortality in re-surveyed permanent plots at Wainfleet Bog, 2000 to 2004. R x C Test of independence using G-Test.

Category of E. Birch Decline	Increase in *Rubus* species	No increase in *Rubus* species	Total number of plots	% of plots with increased *Rubus*
Severe decline (>80% mortality)	21	12	33	63.6
Intermediate decline (>20% ≤80% mortality)	10	26	36	27.8
Little decline (≤20% mortality)	5	16	21	23.8
Open plots (no birch in tree class)	3	45	48	6.2
Total Number of Plots	39	99	138 (n)	

$G\ adj = 32.19$, $p < 0.001$

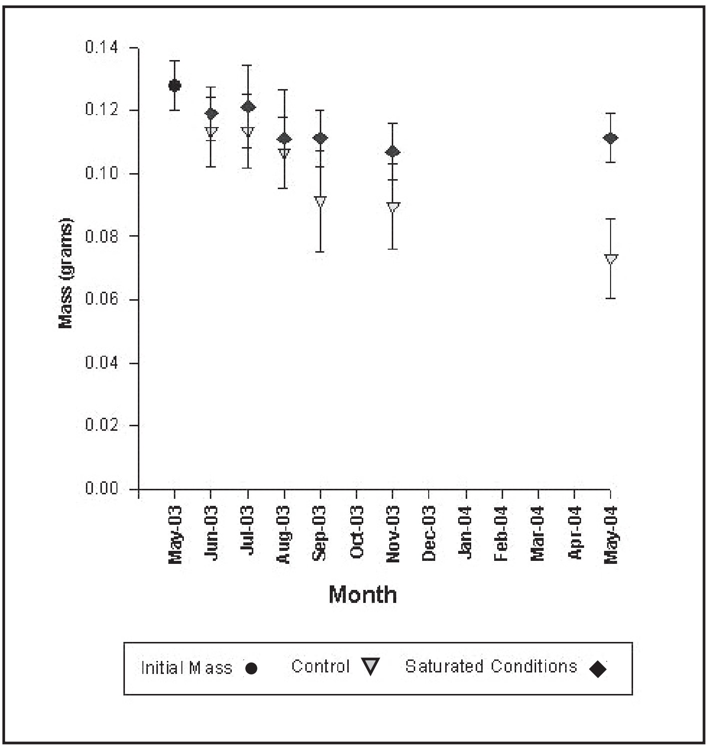
iii) Decomposition

Re-wetting peat significantly reduced the mass loss of toothpicks by approximately 30% ($p<0.01$) (Figure 4) and approximately 15% for white birch leaves (Figure 5) after one year of soil incubation. Decomposition of woody debris/ birch leaves was rapid in peat-mined areas and significantly decreased in areas of improved soil moisture.

Conclusions

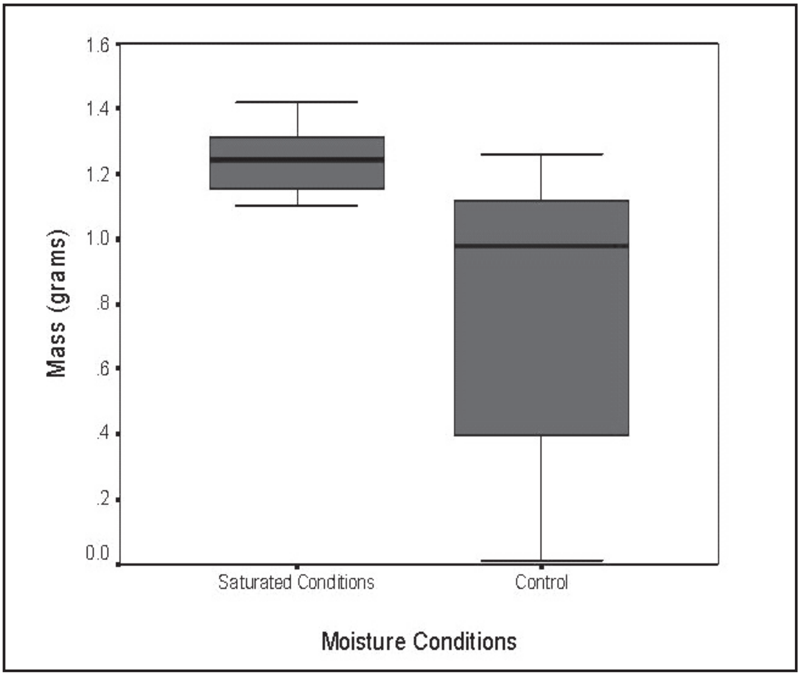
At Wainfleet Bog the survival and enhancement of species at risk (both flora and fauna) have been accommodated for in the bog ecosystem succession/management plan and monitored to ensure success through an adaptive management strategy. Monitoring shows the bog is progressing towards a more natural sphagnum moss ecosystem. Limitations include the follow-

Figure 4. Decomposition of wooden toothpicks after 1, 2, 3, 4, 6 and 12 months of soil incubation under control and artificially saturated conditions from 14 May 2003 to 14 May 2004. Means values with standard deviations, n=40.



ing: water levels; a lack of saturated surface peat (in dry summers); low dispersal rates of sphagnum; and possibly re-growth and competition from the non-native European white birch. Improvements are ongoing to restore the required water levels.

Figure 5. Decomposition of *Betula pendula* leaves after 12 months of soil incubation under control and artificially saturated conditions from 18-Nov-2003 to 18-Nov-2004. Median values with 25th and 75th percentiles and minimum and maximum values, n=20.



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