The Effect of Moisture on the Decomposition Processes in the Disturbed Peatlands of the Wainfleet Bog

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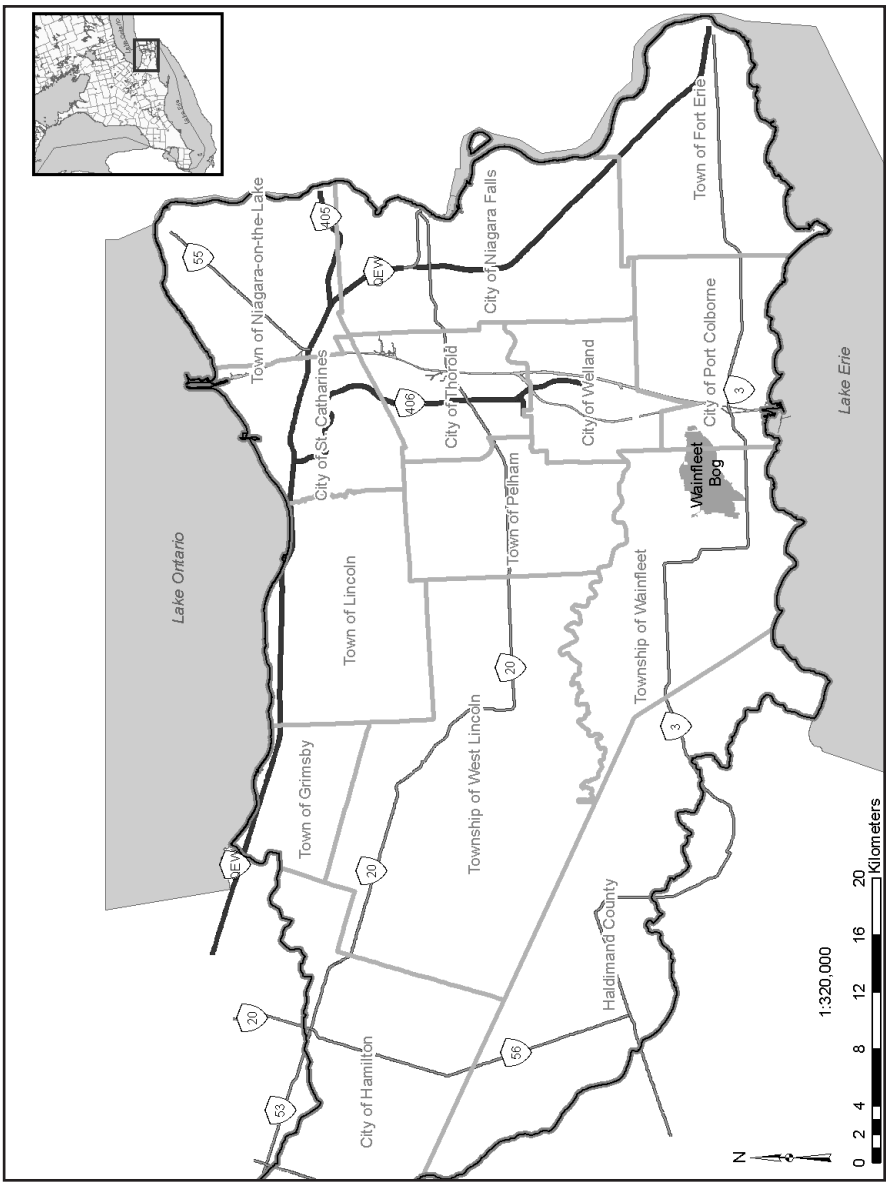
Abstract

The Wainfleet Bog, in the Niagara Peninsula, is home to many species designated as "at risk" in Ontario. The bog, however, has been negatively impacted by drainage and peat mining. Over the past decade, stong efforts have been made toward managing, preserving and restoring the bog ecosystem. Study suggests that remediating moisture levels is an important aspect of restoration. This paper reports on research into the effects of moisture on decomposition processes. Two hypotheses were tested: (1) that increased soil moisture will decrease decomposition rates, and (2) that increased soil moisture will reduce the abundance of macroinvertabrate decomposers. Research results supported the first hypothesis, but did not fully support the second one. Based on these results, recommendations relevant to restoration efforts are made.

Introduction

The Wainfleet Bog is the largest protected wetland (1500 ha) in the Niagara Peninsula (Figure 1). This ecosystem sustains many floral and faunal taxa with a Species at Risk designation in Ontario (MacDonald 1992; Niagara Peninsula Conservation Authority 1997). Prior to its protection by the Ontario Ministry of Natural Resources, Niagara Peninsula Conservation Authority and Nature Conservancy of Canada, this ecosystem was highly impacted by drainage and peat mining. In the last 10 years, there has been a strong effort to manage, preserve, and restore this ecosystem. Research into peatland restoration is a relatively new science, but evidence from the scientific literature suggests the first step to restoring a disturbed peatland, such as the Wainfleet Bog, is to remediate soil moisture levels. This study examined the effect of increased soil moisture levels on the decomposition processes in the highly disturbed peatland of the Wainfleet Bog.

Figure 1. Regional map illustrating the location of Wainfleet Bog



Research Objectives

1. To test the hypothesis that increasing soil moisture levels will significantly decrease decomposition rates of natural and artificial substrates.
2. To test the hypothesis that increasing soil moisture levels will significantly reduce the abundance of macroinvertebrate decomposers such as collembola.

Methods

Decomposition studies were conducted in 2003-2004 using microcosms at study plots throughout the peat-harvested areas of the Wainfleet Bog. Microcosms (Figure 2) were randomly assigned a specific moisture treatment. Moisture treatments included a Control (existing bog conditions), Container Wet (temporary inundation), Container Wet Cover (temporary inundation with shade) and Container Saturation (near undisturbed conditions). Container Wet and Container Wet Cover treatments received approximately 4L of bog water every 14 days during ice-free conditions in addition to naturally occurring sources such as precipitation. Microcosms assigned the Container Saturation were designed to mimic the saturated soil moisture conditions of an undisturbed bog. Microcosms assigned the Control received the naturally occurring soil moisture conditions.

Decomposition was measured using two methods:

1. Litter bags containing wooden toothpicks (n=960), Whatman 1 filter paper (n=480) and *Betula pendula* leaves (n=40) were buried for specific time intervals (up to one year), removed and weighed. Mass-loss of litter was interpreted as a measure of decomposition.
2. To measure the effect of moisture on macroinvertebrate decomposers, the abundance of collembola was monitored for eleven weeks (880 observations) within each of the microcosms.

Figure 2. Photographs showing examples of the microcosm setup in the field

Results

The results of litter bag study found the Container Saturation treatment significantly reduced the mass-loss of toothpicks ($p<0.001$) and Whatman 1 filter paper ($p<0.001$) over one year (Figures 3A and 3B). Also, the Container Saturation significantly reduced the mass-loss of *B. pendula* leaves ($p<0.01$) over one year (Figure 4). The Container Saturation treatment reduced the mass-loss of toothpicks by 30%, filter paper by 20% and *B. pendula* leaves by 18% when compared to the Control. The Container Wet Cover treatment was also found to significantly reduce the mass-loss of toothpicks by 7% ($p<0.05$) and filter paper by 15% ($p<0.01$) when compared to the Control.

Figure 3. Mean toothpicks (A) and Whatman 1 filter paper (B) mass remaining at 1, 2, 3, 4, 6 and 12 months in the treatment variants: Control, Container Wet, Container Wet Cover, and Container Saturaton. Mean values with standard deviations, n=40

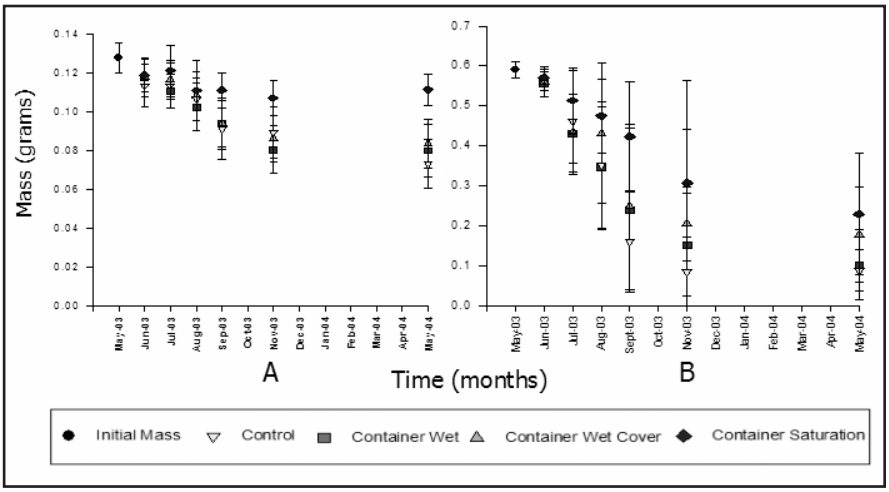
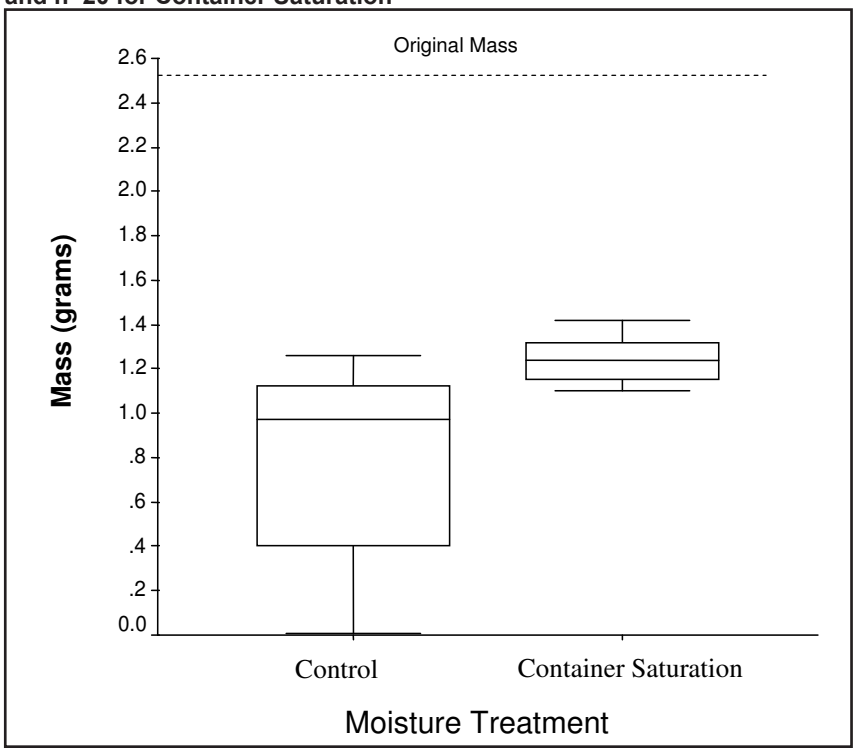
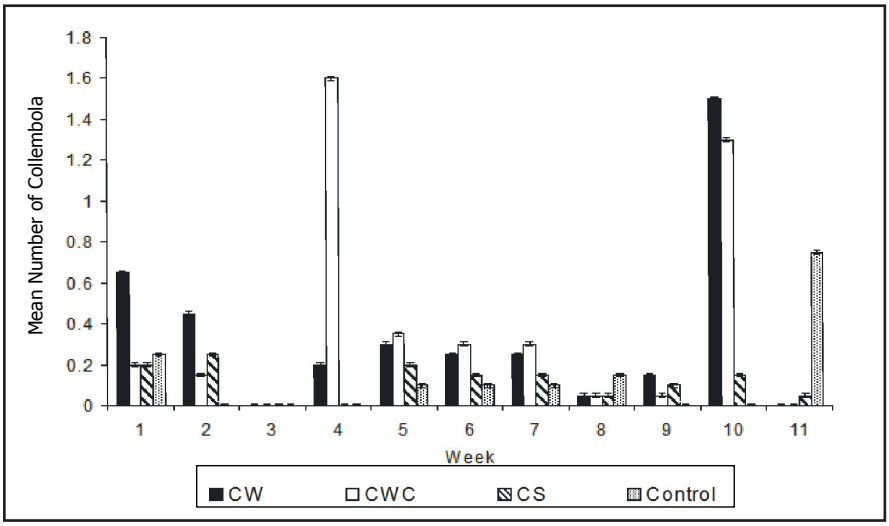


Figure 4. Median mass of *B. pendula* leaves with upper and lower quartiles, and maximum and minimum range values with n=18 for Control and n=20 for Container Saturation



The results of the collembola macroinvertebrate decomposer study found that the wet moisture treatments did not significantly ($p>0.05$) reduce the abundance of collembola decomposers when compared to the Control (Figure 5).

Figure 5. Mean number of observations (n=880) of collembola over 11 weeks (May-October 2003) in teh moisture variants: Control, Container Wet, Container Wet cover, and Container Saturation. Mean with standard error n=20



Conclusions

The results of this study support the hypothesis that increasing soil moisture levels will significantly decrease decomposition of artificial and natural substrates found within the soil. Rewetting soil to moisture levels near those of undisturbed conditions demonstrated the greatest reductions in decomposition compared to temporary inundation. However, rewetting alone may not fully influence the directional shift of nutrient turnover and signify a shift towards a peatland vegetative community. Girard *et al.* (2002) found considerable regeneration of vegetative community in a peat-mined bog with restored soil moisture conditions; however this community was not indicative of a fully functioning peatland. Other restoration techniques that ensure the reestablishment of Sphagnum mosses are necessary to returning disturbed peatlands to carbon accumulating ecosystems.

The results of this study do not fully support the hypothesis that increasing soil moisture levels in a disturbed peatland will reduce the abundance of collembola macroinvertebrate decomposers. It is clear other variables need to be considered before this relationship can be fully understood. However, soil ecologists estimate that macroinvertebrates are responsible for only approximately 2-10% of organic matter decomposition in terrestrial ecosystems

(Adl 2003). Therefore, reductions in microbial populations are likely more significant in affecting directional change in decomposition within the bog.

Recommendations

1. Ensure restoration efforts of degraded peatlands are directed to retaining soil moisture levels through blocking drainage ditches and improving ground cover.
2. Create conditions that are favourable to re-establishing a healthy Sphagnum moss vegetative community.
3. Examine the potential impact of rewetting on Species At Risk that may have become adapted to the dry conditions.
4. Initiate a complete hydrologic study that clarifies the water budget for the Wainfleet Bog.

References

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