

CLIMATE CHANGE



Research Information Note No. 1

December 2003

Carbon Storage in Ontario's Wetlands

B.G. Warner¹, J.C. Davies^{1,2}, A. Jano², R. Aravena¹, and E. Dowsett¹

¹ Wetlands Research Centre, University of Waterloo, Waterloo, Ontario, N2L 3G1, Canada

² Applied Research and Development Branch, Ministry of Natural Resources, P.O. Box 7000, Peterborough, Ontario, K9J 8M6, Canada

Introduction

Wetlands are distinctive features that cover more than 35% of Ontario's surface area. Among their many important values to society, wetlands store significant quantities of carbon. For example, the carbon stored in peatlands and other organic-rich wetland soils far exceeds the carbon stored in forests and agricultural soils, and the annual global wetland carbon burial rate exceeds oceanic sequestration (Dean and Gorham, 1998). It is expected, therefore, that wetland management will factor into future decisions and associated actions designed to manage the impacts of rapid climate change.

Ontario's wetlands are classified into three groups according to their origin and degree of human impact:

- *Natural wetlands* function in their natural state. The Canadian Wetland Classification System identifies at least 100 distinctive natural wetland types, and at least half of these types exist in Ontario (Warner and Rubec, 1997).
- A *restored wetland* has been re-established or rehabilitated to some pre-existing, desired state (Lewis, 1990). Restoration is completed in wetlands that existed within the last 100 years. Passive restoration techniques are used where natural wetland processes can resume once human disturbances are eliminated, and active restoration techniques are used in significantly disturbed sites requiring various forms of physical, chemical, and biological intervention (Middleton, 1999).
- A *created wetland* is designed and constructed on a site that has not functioned as wetland for at least 100 years. A created wetland is constructed once and exists as a self-functioning system thereafter while an artificially created wetland exists only as long as there is continuous human intervention (Lewis, 1990). Artificial wetlands are constructed in gardens, urban parks, or other human-dominated landscapes and waterscapes.



(p.a. gray)

Project Objective

This project provides a baseline estimate of the quantity of carbon stored in natural, restored, and created wetlands in Ontario.

Methods

Natural Wetlands

Estimates of area, depth of peat, and bulk density of carbon in Ontario's wetlands followed techniques used by Gorham (1991). Natural wetland carbon stocks in Ontario were classified according to the five major wetland classes represented in the province: bog, swamp, fen, marsh and shallow open water. The Ontario Provincial Landcover Database (MNR, 1999), the Canadian Forest Inventory Database (Haddon, 1988), and the Canadian Peatland Database (Tarnocai *et al.*, 2000) were used to estimate total wetland coverage in the province.

An average peat depth of 2.3 metres (m) was used. This seems reasonable based on fieldwork results and the peat depth data from the Ontario Centre for Remote Sensing on 232 bog and fen sites in the Hudson Bay Lowlands (A. Jano, unpublished data). This estimate is similar to Gorham's (1991) estimate of 2.2 m for Canada, but is lower than Tarnocai's (1984) estimate of 2.7 m. A mean bulk density estimate of 112 grams/litre (from Gorham, 1991) was employed in the calculation. The total carbon estimate for wetlands in Ontario was then calculated based on these estimated variables.

Restored and Created Wetlands

Dowsett (2002) characterized the carbon cycle of a representative, recently created wetland in northern Ontario. The site is located in the Hilliardton Marsh Provincial Wildlife Area near New Liskeard, Ontario (Figure 1). The wetland is six years old and encompasses approximately 210 hectares (ha). The wetland was constructed on agricultural pastureland and some secondary forest of white birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloides*). The restored wetland is comprised primarily of *Typha latifolia* marsh, and secondarily of willow (*Salix* sp.) and alder (*Alnus* sp.) tall shrub swamp, floating *Brasenia* marsh, and shallow open water with submergent macrophytes.

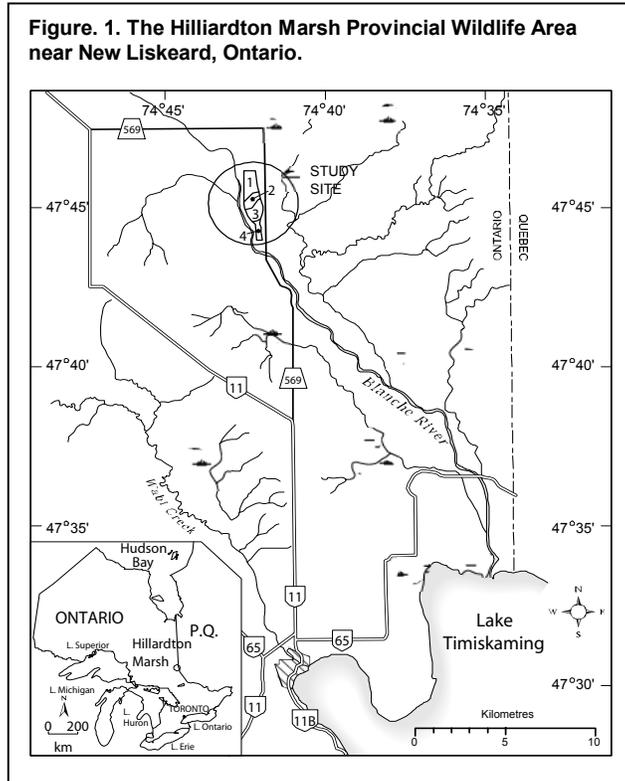


Table 1. Estimated carbon stocks in Ontario's natural wetlands.

Wetland Class	Area (ha)	Stored Carbon (gC)	Source
Ontario ¹ Bog	15,865 x 10 ³	17.6 x 10 ¹⁵	This study
Fen	9,961 x 10 ³	11.0 x 10 ¹⁵	
Swamp	307 x 10 ³	3.4 x 10 ¹⁵	
Marsh	209 x 10 ³	2.3 x 10 ¹⁵	
Open Water	178 x 10 ³	2.0 x 10 ¹⁵	
Total	26,520 x 10 ³	29.4 x 10 ¹⁵	
Canada	122,383 x 10 ³	156.0 x 10 ¹⁵	Tarnocai et al., 2000 Gorham, 1991
	119,000 x 10 ³	152.0 x 10 ¹⁵	
World	346,000 x 10 ³	455.0 x 10 ¹⁵	Gorham, 1991

¹Cover estimates are derived from the Ontario Provincial Landcover Database (MNR, 1999).

Results and Discussion

Natural Wetlands

Ontario wetlands contain approximately 29.4×10^{15} grams of carbon (gC), which represents about 19% of Canada's wetland carbon and 6.6 % of the global total depending on the estimate used for comparison (Table 1). The largest proportion of wetland carbon occurs in fens and bogs. These estimates are based on carbon occurring in the near-surface and deeper layers of wetlands. Accordingly, estimates indicate that bog and fen peatlands are the most carbon-rich wetlands. However, if values for carbon in the living vegetation were available and included in these estimates, it is likely that total carbon estimates for swamps, marshes, and shallow open water would be several orders of magnitude greater. In addition, it is possible that there are significant quantities of carbon sequestered in microbial and planktonic biomass in some marsh and shallow open water wetlands, which are not included in these estimates.

Restored and Created Wetlands

Different wetlands transform and bury carbon in different ways and store it for different lengths of time. Much of the carbon cycle research in wetlands around the world has been focused on estimates of total carbon in natural, freshwater peatland systems. Little is known about wetland carbon cycling in restored and created wetlands. No estimate of the area of restored and created wetlands or the amount of carbon in these wetlands is available for Ontario. Most of the wetlands that have been restored and created in the last 25 years in Ontario are marshes and shallow open water areas. For example, in the Great Lakes Basin area, approximately 13,000 ha were restored and created between 1994 and 2000 (Environment Canada *et al.*, 2000).

A carbon estimate for restored and created wetlands was calculated by assuming that *Typha* marsh comprises the greatest proportion of the 13,000 ha and adopting a conservative value of $300 \text{ gC}\cdot\text{m}^{-2}\cdot\text{yr}^{-1}$ (a conservative estimate derived from the Hilliardton wetland study) (Table 2). Accordingly, it is estimated that approximately 39×10^9 gC have been sequestered each year since 1994 in these restored and created wetlands systems. This quantity of carbon is many orders of magnitude greater than would have been stored in the pre-existing abandoned pastureland and forested land.

Table 2. Estimated growing season carbon stocks for 2000/2001, Hilliardton Wetland, Hilliardton Marsh Provincial Wildlife Area.

Wetland Type	Area (ha)	Net Carbon Stored (gC)
Typha Marsh	45.8	461.0×10^6
Brasenia Marsh	3.3	7.4×10^6
Tall shrub Swamp	12.0	-3.9×10^6
Submergent Open Water	13.7	-1.1×10^6
Total	74.8	465.6×10^6

Summary

Wetlands bury vast amounts of carbon, and their elimination and/or modification can potentially add significant amounts of carbon dioxide and other greenhouse gases like methane into the atmosphere. Accordingly, wetland restoration and creation could significantly increase a jurisdiction's carbon sink potential.

Future Work

Technical issues include the need to:

- Improve classification methodologies and inventory of the extent of natural, restored, and created wetlands in Ontario.
- Refine estimating procedures designed to calculate the amount of sequestered carbon in wetlands.
- Increase awareness of the value of wetlands as important greenhouse removal mechanisms

Acknowledgements

Funding for this project (CC-020) was provided through the Ontario Ministry of Natural Resources by the Ontario Government Climate Change Fund. P.A. Gray served as editor for this note.

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(.2k P.R., 03 12 01)
ISBN 0-7794-5560-6

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