Natural Resources Canada | Ressources naturelles Canada

Bulletin 84

FRONTLINE EXPRESS

Canadian Forest Service – Great Lakes Forestry Centre

Boreal mixedwood forest potential for carbon uptake and storage

INTRODUCTION

The world's forests are an important reservoir for carbon and are estimated to contain roughly 80% of aboveground carbon stocks and 40% of belowground carbon stocks. Canada's forests are a large and important reservoir for carbon and have a significant role in carbon sequestration (removing it from the atmosphere). In particular, the boreal forest ecosystem is Canada's largest, holding massive carbon stocks and having potential to accumulate more, making it an important tool for helping deal with climate change. Natural Resources Canada - Canadian Forest Service (NRCan - CFS) researchers have been carrying out studies to gather information for use in forest management planning to ameliorate climate change through carbon management and for meeting annual reporting obligations for the United Nations Framework Convention on Climate Change, which includes quantifying carbon sequestration. The data gathered can also be employed in carbon budget modelling to explore different scenarios for forest management and their effect on carbon stocks and carbon sequestration

GREAT LAKES FORESTRY CENTRE (GLFC) ROLE

In this study, which was conducted as part of the Natural Sciences and Engineering Research Council of Canada's Fluxnet-Canada initiative, carbon stocks in a boreal mixedwood forest biome were measured at different stages of development. This mixedwood ecosystem includes both coniferous and deciduous tree species (trembling aspen, white birch, white and black spruce and balsam fir) and is common and widespread in the Canadian boreal forest, resulting from harvesting, forest fires and insect infestations such as spruce budworm.

Experimental methodology

Starting in 2003, researchers from GLFC set up multiple National Forest Inventory sampling plots in boreal mixedwood stands, in which protocol measurements were made to allow the carbon present in the forest to be quantified. Recently harvested (2-year-old), mid-age (about 25 years old) and mature boreal mixedwood forest stands (about 75years old) were selected in the Timmins area of northern Ontario and eight sampling plots were established in each stand. Measurements were made on trees and shrubs in the plot and the herbaceous plants were harvested. Woody debris from fallen trees, branches and twigs was also quantified. Leaf litter was collected annually and the organic and mineral soil layers sampled and soil layer depths quantified. These measurements were repeated after a five-year time interval. The carbon stocks present in trees and shrubs were calculated with published equations relevant to the geographical area and leaf litter was collected and weighed annually. Soil samples were analysed for carbon content. Calculations from the sampling plot measurements collected enabled the total carbon content of the forest to be estimated and the values at different times were employed to estimate the annual carbon uptake.

Carbon stocks and uptake

We found total carbon stocks in the mature mixedwood stands ranged from 193 to 224 Mg carbon/ha and the recently harvested stand held stocks of about 60% of those present before harvesting. By comparison, the published value for the mean carbon content of Canadian boreal forests (e.g., pure jack pine) is 193 Mg carbon/ha, showing that total carbon stocks are typically higher in mixedwood forests compared to those in coniferous forest.

A breakdown of the carbon components in the study sites showed that vegetation (live and dead trees, shrubs and herbaceous plants) held about 27, 34 and 62% of carbon stocks at the recently harvested, mid-age and mature sites. Detritus (leaf litter, woody debris and the organic soil layer) held a further 34, 29 and 13% of total carbon in recently harvested, mid-age and mature forest, compared to mineral soil, which held 39, 37 and 25% of total carbon in those stands. A significant fraction of carbon is found in the forest floor (in the present study, 38-73% for detritus and mineral soil layers combined), providing relatively stable carbon storage over the stand lifetime, including harvesting.

Percentage of carbon in forest components in three different ages of mixedwood forest in northern Ontario

	Recently harvested (2-year-old) stand	Mid-age (25-year- old) stand	Mature (75-year- old) stand
Vegetation	27	34	62
Detritus	34	29	13
Mineral soil	39	37	25

A comparison of carbon uptake showed the highest in the mid-age stand, at 3.7 Mg carbon/ha/year, compared to 2.1 and 2.6 in the recently harvested and mature stands. Analysis of published results shows this to be typically the case, with higher uptake in mid-age stands (20-60 yr) as compared to young (<10 yr) and mature stands (>75 yr). Also, carbon sequestration is typically higher in boreal mixedwood stands as compared to coniferous stands. Thus, both carbon stocks and carbon uptake in mixedwood stands are generally greater than other Canadian boreal forest ecosystems, which is an important factor to take into account in climate change mitigation strategies. Other desirable characteristics of mixedwood stand are the variety of available species (often a commercial advantage) and less frequent forest fires that are easier to suppress due to their slow spread. In addition, the plant diversity can be a benefit through the range of ecological services they provide.

CONCLUSION

GLFC researchers working in the CFS-Forest Climate Change program have been collecting data to prepare for climate change mitigation measures applied through forest management planning. The data gathered will inform forest management decisions to enable enhanced carbon stocks and carbon sequestration. A comparison of data from the present study and previous publications show that boreal mixedwood forests typically holds higher carbon stocks per hectare than other boreal forest types, highlighting the value of mixedwood forests as an effective boreal ecosystem for carbon uptake. Measurements from the present study, together with those from other Canadian boreal forest ecosystems, can be employed in decision making with regard to management practices followed in Canada's boreal forest, e.g., in relation to restocking and timing of harvesting to optimise carbon sequestration and climate change mitigation. More information on this study can be found in the scientific journal publication.

CONTACT INFORMATION

Nicholas Payne
Great Lakes Forestry Centre
1219 Queen Street East
Sault Ste. Marie, ON P6A 2E5 Canada
Tel: 705-949-9461
E-mail: GLFCWeb@nrcan-rncan.gc.ca
Web site: nrcan.gc.ca/forests/research-centres/glfc/13459

POLICY PERSPECTIVE

NRCan - CFS conducts research relating to climate change mitigation and adaptation, in particular for use in forest management planning to mitigate climate change effects. Climate change adaptation has been identified as a priority for the forest sector by the Canadian Council of Forest Ministers.

Boreal mixedwood stands are an important reservoir of carbon stocks and sequestration.

*Aussi disponible en français sous les titre : **Nouvelle Express, Bulletin N° 84**.*

ISSN 1496-7847 (Print) ISSN 1496-7855 (Online)