



## Great Lakes Forestry Centre research enhances understanding of boreal forest role in carbon cycle

### INTRODUCTION

Canada's forests play a significant role in the carbon cycle through the exchange of carbon dioxide with the atmosphere, by photosynthesis, which removes atmospheric carbon, and plant respiration and soil decomposition, which add carbon to the atmosphere. The net amount of carbon movement (flux) into or out of the forest determines its status as a source or sink (absorber). The boreal forest comprises close to 80% of Canada's forest area, and is thought to be an important carbon sink for the atmosphere, as carbon is taken up by growing trees.

Since the 1980s, the Canadian Forest Service has been tracking carbon stocks in our forests using inventories, and reporting on this information to the United Nations Framework Convention on Climate Change. In 2003 the Canadian Carbon Program (CCP) was initiated, to provide the scientific data needed to quantify the movement of carbon between the atmosphere and various Canadian ecosystems, including the boreal forest. Under this program, which is funded by the National Science & Engineering Research Council (see <http://www.nserc-crsng.gc.ca>) and the Canadian Foundation for Climate and Atmospheric Science (see <http://www.cfcas.org>), university and government researchers set up monitoring stations in various forest types across Canada, to measure carbon uptake and release. These stations are part of an international network of over 300 sites in North America, Europe and Asia that allow scientists to analyze the contributions of different geographical areas to atmospheric carbon exchange. Results from this research will lead to a greater understanding of the role of Canada's forests and other ecosystems in the global carbon cycle, and how their status as a carbon source or sink can be affected by various forest management practices and climatic conditions. The data gathered will also be employed in international reporting to the United Nations about Canada's forests and their role in the carbon cycle.

### GREAT LAKES FORESTRY CENTRE (GLFC) RESEARCH

The Ontario Flux Station (OFS) (Table 1) was set up in 2003 to study atmospheric carbon removal and release in boreal mixedwood forests, which is the major provincial forest type by area. The three constituent sites are located near Timmins, Ontario. The Groundhog River site was established in a lowland mature (80-year-old) boreal mixedwood forest about 30 m in height, with the aim of monitoring an intact mature stand for several years to quantify its status as a carbon dioxide source or sink as it ages. The Childerhose Township site is situated in an upland site planted to black and white spruce that is about 25 years in age and provides data on carbon exchange

for a mid-age forest (Image 1). The third site, near McKeown Lake, was established in a mature upland stand scheduled for harvesting. This site was first harvested in 1936. After 3 years of monitoring the site was harvested again during the winter of 2008–2009, to yield measurements of atmospheric carbon exchange for a newly harvested site as it ages (Image 2).



Image 1. Ontario Flux Station tower in boreal mixedwood forest at McKeown Lake site.

Meteorological instruments that measure wind speed, turbulence, air temperature and humidity are mounted on 15–41 m (50–133 ft) towers at each site. In addition, infrared gas analyzers are deployed to quantify the carbon dioxide and water vapour in the lower layer of the atmosphere (Image 3). Measurements are also made of the intensity of incoming and outgoing solar radiation, including the photo-synthetically active component. Soil conditions are also monitored, in

**Table 1.** Sites comprising Ontario Flux Station

| Site                 | Site description  | Species composition  | Site drainage   |
|----------------------|---|--|-----------------|
| Groundhog River      | Lowland mature forest, 80-year-old stand                        | Trembling aspen, white birch, white spruce, balsam fir and black spruce                            | Poor            |
| Childerhose Township | Upland 25-year-old plantation                                   | White & black spruce (planted) balsam fir, white birch, and trembling aspen (natural regeneration) | Moderately good |
| McKeown Lake         | Upland clear cut, harvested in 2008, formerly 75-year-old stand | White birch, white spruce, trembling aspen, balsam fir and black spruce                            | Moderately good |

particular soil temperature and moisture, along with carbon dioxide released from the soil as a result of microbial decomposition and root respiration. In aggregate, these measurements enable a continuous tracking of carbon dioxide uptake or release that may be integrated over a period of interest to determine the status of the stand as a source or a sink for carbon dioxide.



**Image 2.** Infrastructure at newly logged McKeown Lake site, in May 2009.

Permanent vegetation sampling plots have also been established at all three OFS sites to quantify the evolving composition and state of the stand; these data are used in estimating the standing biomass in the forest as the stand ages and in quantifying existing carbon stocks at these boreal mixed wood sites. Sap flow measurements on a range of tree species have also been made at the OFS sites to investigate transpiration and photosynthesis (see Frontline Express Note 43).

**CONCLUSION**

Now that the considerable initial effort and expense of setting up these sites has been completed, it is anticipated that operation of the OFS will continue for the next 5 years, in order to get a robust assessment of the effects of inter-annual variability in climate and the effects of forest harvesting on atmospheric carbon removal and release, thereby reaping optimal benefit from taxpayer investment. Guided McKeown Lake site tours are available to the public on request.



**Image 3.** Gas analyzer and sonic anemometer on McKeown Lake tower, above mature boreal mixedwood forest.

**SUGGESTED READING**

McCaughey, J.H.; Pejam, M.R.; Arain, M.A.; Cameron, D.A. 2006. Carbon dioxide and energy fluxes from a boreal mixed-wood forest ecosystem in Ontario, Canada. *Agricultural and Forest Meteorology* 140: 79-96.

**PRINCIPAL COLLABORATORS**

The OFS is a collaborative initiative undertaken by researchers from Queen’s University (Dr. Harry McCaughey), Canadian Forest Service (CFS), Great Lakes Forestry Centre (Dr. Nick Payne, Dr. Phil Reynolds and Al Cameron, R.P.F.) and the Ontario Ministry of Natural Resources (Drs. Jim McLaughlin and Stan Vasiliauskas).

**CONTACT INFORMATION**

Nick Payne  
 Great Lakes Forestry Centre  
 1219 Queen St. East  
 Sault Ste. Marie, Ontario P6A 2E5  
 Tel: 705-949-9461  
 Fax: 705-541-5700  
<http://cfs.nrcan.gc.ca/regions/glfc>  
 E-mail: [GLFCWeb@NRCan-RNCan.gc.ca](mailto:GLFCWeb@NRCan-RNCan.gc.ca)