Impact of the Mountain Pine Beetle on the Carbon Balance of Lodgepole Pine Stands in Western Canada

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The implications the current outbreak of the mountain pine beetle (MPB) on the carbon (C), water and energy balances of lodgepole pine forests is unknown.

Rationale

The current outbreak of the mountain pine beetle (MPB) on the carbon (C), water and energy balances of lodgepole pine forests is unknown.

Objectives and techniques:
- To measure the net ecosystem productivity (NEP) of lodgepole pine stands over the course of a MPB attack.
- To partition NEP into gross ecosystem productivity (GEP) and ecosystem respiration.
- To measure the effects of harvesting on growing season NEP.

This study is utilizing the eddy covariance technique, which calculates the covariance between vertical wind velocity and CO₂ concentrations over a 30 min period, to quantify the NEP above the forest canopy.

Study sites

MPB-KS: When measurements began in July 2006 the site was in the initial stage of MPB attack. Since then, the stand has progressed to the red stage of attack.

MPB-CR: Measurements began in March 2007 in a red attacked stand (attacked between 2002 and 2004). Since then this forest has progressed into the grey stage of MPB attack.

Clearcut’97: In July 2007, NEP measurements were made in a naturally regenerating stand that was harvested 10 years ago.

Clearcut’06: NEP measurements were conducted in a two year old salvage logged stand in order to determine if harvesting compromises the regeneration of forest stands following MPB attack.

Hypothesis: NEP will decline gradually due to tree mortality increasing with the severity of attack. This would result in a gradual decline in GEP and autotrophic respiration. The decline in GEP could be offset by the release of secondary structure due to the changing microclimate. The increase in decomposable biomass will likely lead to an increase in heterotrophic respiration.

Carbon Status of MPB attacked and harvested stands

In July 2007, MPB-KS was a C sink of 0.38 g C m⁻² day⁻¹; while MPB-CR was a larger sink of 0.89 g C m⁻² day⁻¹. During the nighttime, both sites are C sources, as respiration is the only flux taking place. In the morning, photosynthesis begins resulting in a net uptake of CO₂.

After 10 years of natural regeneration the clearcut’97 site remains a C source of 0.43 g C m⁻² day⁻¹. During the daytime this stand is characterized by a net uptake of CO₂; however, this is offset by high rates of respiration during the night. Two years after harvesting, the clearcut’06 stand is a relatively large carbon source of 0.85 g C m⁻² day⁻¹.

Significance

The CCIS projects winter and summer air temperatures in BC to continue to warm by 0.4 – 1.0 °C and 1.2 – 1.5 °C, by the 2020s. Such a warming could result in:
- A spread of the MPB outbreak eastward, particularly if the beetle can establish jack pine and other boreal species as hosts.
- An increase in forest fires due to large areas of dead pine stands. Either of these scenarios could lead to a reduced ability of Canada’s forests to sequester C.

Kennedy Siding Mountain Pine Beetle Research Field Trip, Oct. 30, 2007