Tradeoffs between forest productivity and carbon sequestration in a managed boreal landscape

Martin Simard[12]*, Nicolas Lecomte[13], Yves Bergeron[1], Pierre Y. Bernier[2], and David Paré[2]

[1] NSERC-UQAT-UQAM Industrial Chair in Sustainable Forest Management, Université du Québec en Abitibi-Témiscamingue, 445 boul. de l'Université, Rouyn-Noranda, Québec, Canada, J9X 4E5 and Centre d'Études sur la Forêt (CEF), Université du Québec à Montréal, CP 8888, Succursale Centre-ville, Montréal, Québec, Canada, H3C 3P8

[2] Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre, 1055 du PEPS, CP 10380, Succursale Sainte-Foy, Québec, Canada, G1V 4C7

[3] Present address: President, Valeur Nature, 2709 boul. McDuff, Local F, Valcanton, Québec, Canada, J0Z 1H0

* Author for correspondence. Present address: University of Wisconsin, Dep. of Zoology, Birge Hall, 430 Lincoln Dr., Madison, WI 53706. Tel.: (608) 265-8001; Fax: (608) 265-6320. Email: simard@wisc.edu.

Boreal forests around the world provide many ecosystem services, two of them being wood fiber production and carbon sequestration. The deep organic soils in boreal forests represent one of the largest terrestrial pools of carbon globally and are associated with low aboveground productivity. The objectives of this study were, for the black spruce-dominated forests of the Hudson Bay lowlands (Quebec, Canada), 1) to determine if paludification, i.e., the accumulation of peat layers with time, resulted in reduced forest productivity and 2) to determine how paludification influenced the amount and partitioning of biomass between the aboveground and belowground ecosystem pools. We measured biomass pools and calculated three different stand productivity indices in a chronosequence of 23 black spruce stands ranging in postfire age from 50 to 2350 years.

Chronosequence data revealed that the steady accumulation of soil organic matter with time (from 10 cm at 50 years to 60 cm at 2300 years) was associated with declines in black spruce productivity of 50 to 80%. Paludification increased soil moisture, reduced soil temperature, and altered the vertical distribution of roots. Belowground carbon stocks gradually increased with time since fire and were mirrored by a declining aboveground pool. Estimated total (aboveground + belowground) carbon pools were significantly larger in old, paludified stands that also showed the lowest forest productivity. At the landscape scale, both forest management and fire regime (frequency and severity) control paludification, forest productivity, and carbon sequestration through their effect on soil organic layer.

Key words: black spruce (*Picea mariana*), boreal forest, fire severity, long term forest productivity, soil organic matter