Natural Resources Canada
Ressources naturelles Canada

83
2013
Branching Out
from the Canadian Forest Service - Laurentian Forestry Centre

Spruce and Climate Change: A Question of Yield?

How will the boreal forest react to climate change? How will higher carbon dioxide (CO_2) concentrations and warmer temperatures affect the growth and productivity of forest species? Answering these questions is a complex exercise. Over the years, researchers with the Canadian Forest Service (CFS) have been able to provide some answers, especially pertaining to black spruce and white spruce.

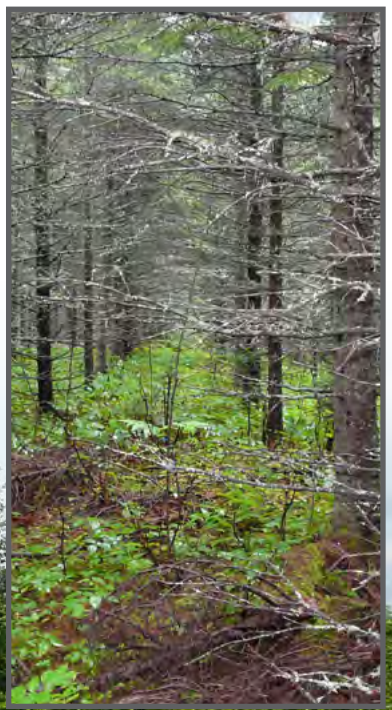
The case of black spruce

Black spruce is the primary softwood species found in North American boreal forests, and plays a key role in the global carbon budget. First, CFS researchers used controlled conditions to assess the reaction of black spruce in a scenario with twice the amount of our current CO_2 levels. They found a reduction in the growth season, but an increase in timber yield. The researchers also noted that the provenance of the trees affected the results. Trees from the south, which naturally bud later in the season, are the most likely to benefit from the temperature and increased carbon dioxide concentrations in the atmosphere. The seed source is therefore a key factor for species like black spruce, whose natural range is between latitudes 45 and 63 degrees north.

Next, the researchers used data collected from provenance trials to study the effect of climate warming on black spruce yields. They concluded that there would be a slight increase in short-term yield at the tree level (between 2046 and 2065) in balsam fir–spruce bioclimatic domains. In sugar maple domains, black spruce productivity declines by a third.

The case of white spruce

White spruce is a sought-after species due to its high plantation survival rate, its excellent yield, its size, the straightness of its trunk and its timber quality. It is the third most-used species for reforestation in Quebec (after black spruce and jack pine).



Photos: NRCan

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Photo: NRCan

With the prospect of increased temperatures, the overall yield of white spruce plantations in Quebec should increase slightly in the short term, mainly in spruce–balsam fir bioclimatic domains. Over the longer term (from 2081 to 2099), white spruce will be more productive in spruce domains.

Provenance selection: an important decision

The ability of species to disperse, migrate and adapt is a critical factor for their survival in the face of climate change. The ability of a species to adapt to new environmental conditions depends mainly on genetic diversity within its populations. This process will require several generations. It is unlikely that tree populations will migrate as quickly as the accelerated pace of climate change requires. Human intervention might therefore be necessary to encourage the establishment of adapted stands in new areas.

To evaluate the potential response of trees to rapid climate change, geneticists use provenance tests with seedlings of various geographic and climatic origins. Using this data, researchers from the CFS and the ministère des Ressources naturelles du Québec created seed source transfer models for black spruce and white spruce. These transfer models can be used not only to predict plantation heights, but also future productivity throughout Quebec and in various climate scenarios.

In addition, in order to assist forest managers in the selection of black spruce provenances for reforestation, a team of researchers from the CFS and Université Laval have developed a spatial reference information system to map probabilities for success in the transfer of a black spruce provenance[1]. Adaptation to elevation, latitude and drier conditions will have the greatest impact on the survival and development of these provenances.

1. For more information, see *Branching Out* No. 55, *http://scf.rncan.gc.ca/entrepotpubl/pdfs/31544.pdf*

For more information, please contact:
Jean Beaulieu
Natural Resources Canada
Canadian Forest Service
Canadian Wood Fibre Centre
1055 du P.E.P.S. P.O. Box 10380, Stn. Sainte-Foy
Quebec City, Quebec G1V 4C7
Phone: 418 648-5823
Fax: 418 648-5849
E-mail: jean.beaulieu@nrcan-rncan.gc.ca
Website: cfs.nrcan.gc.ca/centres/cwfc

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