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CUT WITH CARE

An aerial view of 75 per cent retention partial cutting treatment in the EMEND project [1] in Alberta (www.emendproject.org)

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Lead author Arun Bose provides a précis of the award-winning ICF Silvicultural Prize paper on the constraints to partial cutting in the boreal forest of Canada, in the context of natural disturbance-based management

Over the past 50 years, Canada's commercial boreal forest has been managed almost exclusively under a basic even-aged regime of clear-cutting – or careful logging with regeneration protection. While the area of forest harvested annually may be impressive by UK standards, it is generally less than that affected by fires, insects and other natural disturbance agents (Table 1).

Monitoring and research have provided evidence of the differential effects of these disturbance regimes, including effects on residual forest structure and composition which, cumulatively, affect wildlife habitat, biodiversity and other ecosystem services. Largely as a result of biodiversity concerns, the natural disturbance paradigm has been recommended by the scientific community as an underlying objective to forest management in the boreal region.

One tenet of this approach is that silvicultural practices should be more diversified to produce residual stands and landscapes that more closely resemble the variety of forest conditions which characterise natural landscapes. Thus, over the past 20 years, considerable effort has been devoted to testing partial cutting (PC) in different stand types and conditions in the boreal forest.

Partial cutting is a generic term which refers to a range of harvesting intensities from clear-cutting with minimal retention to selection systems. While numerous beneficial effects of PC in the boreal forest have been documented, constraints do exist to their broad-scale application. Success of PC treatments can be measured by three

Figure 1. Partial cut in a black spruce stand favoured seedling establishment on skid trails

processes: survival of retained and recruited stems, recruitment of desirable species and growth of retained and recruited stems. Here, we give a brief overview of some constraints to PC in the boreal forest:

Mortality

Reduced stem density following PC increases wind penetration into stands, often affecting tree stability and causing uprooting or stem breakage. As well, winter insolation and repeated abrupt temperature changes on exposed residual tree trunks following stand opening by PC can cause partial cambial mortality and render stems vulnerable to fungal and other pathogens which eventually lower stem resistance to wind breakage. The degree of damage incurred by trees depends on numerous factors including:

- individual tree characteristics such as age, health, wood density, total and relative height within the stand, taper, crown dimensions and rooting characteristics
- harvest intensity and pre-harvest site and stand characteristics including stem density
- landscape or regional particularities such as wind conditions, extreme weather events, topographic position and wind fetch.

Growth stagnation

High-intensity PC, in particular, can cause initial stagnation in growth of retained stems during the post-harvest period. This is due to abrupt changes in canopy opening that expose retained stems to environmental stress resulting from extreme temperatures, higher radiation, increased wind speeds and evapotranspiration rates. Larger trees are generally more prone to growth stagnation because of their higher non-photosynthetic biomass.

Limited regeneration recruitment

Conifer seeds disperse further in open environments than in intact or partially cut stands. The distribution of seed trees is, therefore, key to natural seedling regeneration following PC. Seed viability for all boreal tree species is very short. If the surface organic layer is not sufficiently disturbed during or following harvest, suitable, well-distributed seedbed may limit successful natural regeneration (as shown in Figure 1). In addition, boreal forests contain a number of woody shrub and grass species that persist in the understory but respond aggressively to canopy opening and constitute a serious constraint on a variety of sites to both natural and artificial regeneration.

Productivity of lowland sites

In the more northerly continuous coniferous boreal forest, especially, flat or low-grade lowland sites are susceptible to slow organic matter decomposition in the absence of severe fires. Disturbance, and, in particular, severe disturbance of the organic layer, is thus very important for maintaining or restoring the productivity of these sites. While the irregular structure that is characteristic of old black spruce stands commonly found on these sites lends itself well to PC, this treatment tends not to disturb the organic layer enough to increase decomposition rates (and increase site productivity) or favour natural regeneration (see Figure 2).

Operational constraints

Unlike less dense stands in temperate forests where harvesting machinery can manoeuvre through a stand without systematically felling merchantable stems in its path, PC in many parts of the boreal forest involves the use of clear, roughly parallel trails where all trees are removed, just to provide passage for the machinery. The relatively small size of harvested stems in much of the boreal forest translates into high per unit costs to

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About the Silvicultural Prize

The Percy Stubbs, John Bolton King and Edward Garfitt Prize for Silviculture (The Silvicultural Prize) is awarded annually by the Institute to the author(s) of the paper published during the year in its journal *Forestry - an international journal of forest research*. The selection is made by the editors of *Forestry* based on which, in their opinion, best meets the criteria set down by the anonymous donor of the Prize Fund.

Table 1. Some summary statistics of Canadian forests

	Statistics
Forest land	350,000,000ha
Growing stock	47,000mcm
Forest ownership (%)	
Provincial	76.6
Territorial	12.9
Private	6.2
Aboriginal	2.0
Federal	1.6
Disturbance	
Forest harvesting (2012)	594,000ha
Area harvested	152mcm
Volume harvested	
Insects: Defoliation & beetle infested (2012)	8,600,000ha
Fires: Area burned (2013)	4,200,000ha
Number of fires(2013)	6,250
Regeneration	
Area planted	347,000 ha
Area seeded	10,600 ha

Source: Natural Resources Canada (Values rounded for simplification) mcm: million cubic metres

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Figure 2. Growth response following diameter-limit cutting in old black spruce stands on poorly drained organic sites can be minimal

process – in the forest, in transport and in mills – a factor that inevitably influences the economic feasibility of these treatments. Finally, because PC removes less volume per area harvested than clear-cutting, more forest area must be harvested for a given volume of wood, a fact that has important implications beyond the stand scale for road construction and maintenance, harvest costs and effects on wildlife.

Conclusion

Post-treatment mortality is probably the greatest silvicultural concern regarding partial cutting and we can probably generalise that the rate of residual tree mortality tends to follow the intensity of crown removal. In the short term, mortality of retained stems is mainly caused by windthrow but other environmental and pathogenic stresses may induce additional mortality over the longer term. Proper identification of site conditions and stand properties before harvesting is essential to tailoring treatments to specific conditions.

The authors of this paper are: Arun K Bose, Brian D Harvey, Suzanne Brais, Marilou Beaudet and Alain Leduc

Read more....

Download *Constraints to partial cutting in the boreal forest of Canada, in the context of natural disturbance-based management: a review* by Arun K Bose, Brian D Harvey, Suzanne Brais, Marilou Beaudet and Alain Leduc, at: http://bit.do/pcboreal

Reference

[1.] The Ecosystem Management Emulating Natural Disturbance (EMEND) project is a large-scale ecosystem-based research initiative looking at boreal forest management. www.emendproject.org

Glossary

The commercial boreal forest can be divided into the southern mixedwood and the more northerly continuous conifer zones. Besides the obvious rigours of the climate, PC is limited, to varying degrees, by high post-fire stem densities and even-aged stand structures, limited pre-commercial stand tending, few long-lived, shade-tolerant species, relatively low site and stand productivity.

Natural disturbance paradigm (NDP): Based on the assumption that, within an extensive region, existing animal and vegetation species have survived and evolved over the millennia under natural disturbance regimes, industrial forest management should strive (within economic and social constraints) to reduce the differences between managed and natural forest stands and landscapes. The 'natural template' may include parameters of forest age structure and composition, stand structure, post-disturbance legacies (residual patches) and spatial distribution of regeneration areas.