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Boreal mixedwood management: minimizing risk in a changing climate

Highlights

- Post-fire stand dynamics in mixedwoods are generally characterized by a gradual shift in canopy composition from broadleaf to coniferous-dominated stands over time.
- Current policy focuses on replacing what we cut. This may maintain the current proportion of stand types found in boreal mixedwood landscapes, but it does not respect the natural successional dynamics of these forests. This may be risky.
- A precautionary approach to managing boreal mixedwoods should allow the tree composition of some stands to change through time.
- Boreal mixedwood management strategies designed to ensure adaptation to climate change should assist species to colonise favourable sites north of their current extent.

Synthesizing mixedwood knowledge

Over the last few decades, forest managers and research scientists have come to appreciate the importance of the mixed nature of the boreal forest and to understand the need to focus on joint management, within some stands, for both broadleaf and conifer tree species.

Although many research initiatives and operational trials have occurred in the boreal mixedwoods, the absence of an integrated understanding of the knowledge gained from these efforts may be hindering the application of ecosystem management in boreal mixedwood forests. As part of the 'State of Knowledge' program of the Sustainable Forest Management Network (SFMN), a group of research scientists across Canada examined the current state of knowledge with respect to the potential ecological implications of altering boreal mixedwood landscapes. Specifically, the research team addressed the significance of a change in composition of mixedwood landscapes on biodiversity, tree productivity and soil processes.

This research note is one of a series from this project and demonstrates how mixedwoods could be managed by keeping in mind natural stand and disturbance dynamics as well as past and projected global climate change.

Replacing what we cut: risky?

Once a certain mixedwood stand type - always the same stand type?

In the absence of fire, the natural stand dynamics of boreal mixedwoods are characterized by a gradual shift from broadleaf-dominated to conifer-dominated stands (Figure 1). As a result, unmanaged stands 0-80 years old vary in composition from 'pure' broadleaf to 'pure' conifer, and the presence of conifer-dominated stands on the landscape increases with age (time since disturbance > 80 yrs). This effect

of time on forest composition has not been considered in previous forest management policy, but is predicted to be a critical consideration in successful long-term management of boreal mixedwood landscapes.

Stand dynamics imposed by current policies

Current forest management regulations across Canada are focused on re-establishing the stand type that was harvested; however there is some concern that mixed stands are being converted to either broadleaf- or conifer-dominated stands. Guidelines are also designed to maintain the *proportion* of each stand type on the landscape over time. This approach fails to embrace the natural stand dynamics described above, and can lead to management approaches that are expensive and difficult because they are at odds with this natural succession. In addition, given current rotation lengths, eventually most stands within the managed portion of the landscape will be younger than 80 years. Thus, even if current forest management policy does maintain the proportion of stand types on the landscape, the proportions of stand age classes will almost certainly be altered as compared to an unmanaged landscape (Figure 1).

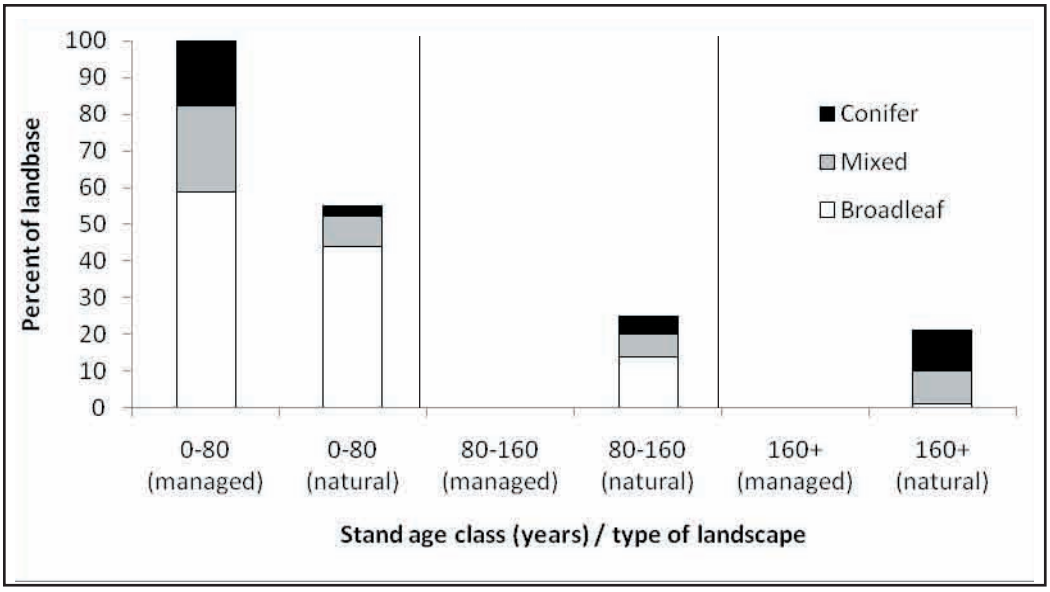

Figure 1. Comparison of the proportion of stand composition types in an unmanaged boreal mixedwood landscape under a 100-yr fire cycle (natural) (from Lieffers et al., 2008 and using method of Bergeron et al. 1999), and in a theoretical managed boreal mixedwood landscape under current forest policy.

Does a change in age structure matter?

As a result of the policy-induced change in age structure, forests may lack the structural and environmental features that provide critical habitat for a diversity of species. Is this risky? While many forest ecologists may answer yes, there is little scientific data to support this inference. Few studies have compared boreal mixedwood forests of similar composition but different age. Further, given the relatively short history of management in the boreal mixedwoods of Canada, comparisons between older managed versus unmanaged conifer forests are not possible.

We know that biotic communities vary with mixedwood canopy composition because of species-specific habitat requirements, as was described in SFMN Research Note No. 59 ('Biodiversity and canopy composition in boreal mixedwoods: different roofs - different inhabitants?'). Further, mixedwood forests of varying composition and age differ in terms of the habitat features they provide. On this basis, we can predict that, to the extent current forest management policies affect the composition and age structure of boreal mixedwood forests, they may be risky from a biodiversity point of view. For

example the structural and species diversity associated with old stands may be lost, if these stands no longer exist. Further research is needed in this area.

The pre-industrial forest obsession

Once a boreal mixedwood landscape - always a mixedwood landscape?

Forest managers need guidance in determining what proportion of each stand type and stand age class should be maintained in boreal mixedwood landscapes now and in the long term. Forest ecologists, as well as forest certification standards (e.g., Forest Stewardship Council), suggest using the pre-industrial forest condition as a benchmark. In boreal mixedwood landscapes this forest condition usually represents what existed prior to intensive forest operations, i.e., about 50 years ago in much of Canada. Adoption of the pre-industrial forest condition as a guide, however, represents a fairly static view of forest landscapes. Indeed, it implies that the composition of boreal mixedwood landscapes in the recent past is the single objective we should strive to maintain into the future.

This approach to landscape management, which can be characterized as the 'pre-industrial forest obsession', fails to embrace the following: 1) the arrangement of boreal mixedwood stands on the landscape was not always as it appears today; and 2) projected global climate change may favour an encroachment of boreal mixedwood forest further north, in turn altering stand types and stand dynamics in a given area. For example, during the early parts of the Holocene (6000 years ago) when the Earth's temperature was warmer than it is today, areas in the eastern boreal region of Canada that are currently dominated by boreal mixedwoods were occupied by species that are currently found further south in the Great-Lakes St-Lawrence biome (Figure 2).

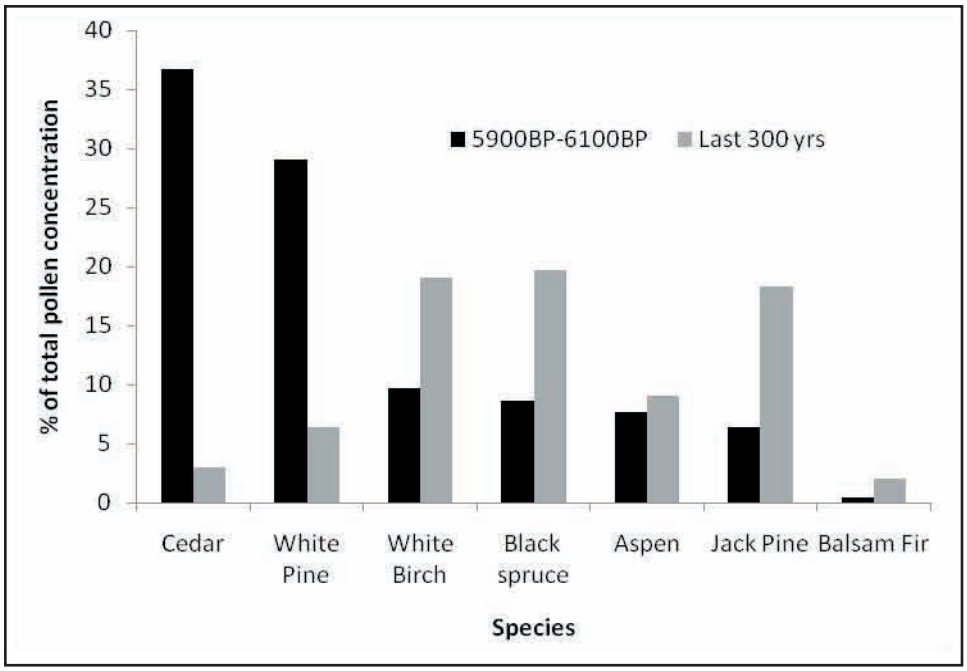

Figure 2. The past (between 6100 yrs before present (BP) and 5900 yrs BP) and current (last 300 years) relative abundances of tree species' pollen from a core of a lake that is currently in the boreal mixedwoods of northwestern Quebec (data adapted from Carcaillet et al., 2001).

In western Canada during this period, some areas in the southern portion of the current boreal mixedwood forest were occupied by aspen parklands and grasslands while boreal mixedwoods were found further north than they are today (Figure 3).

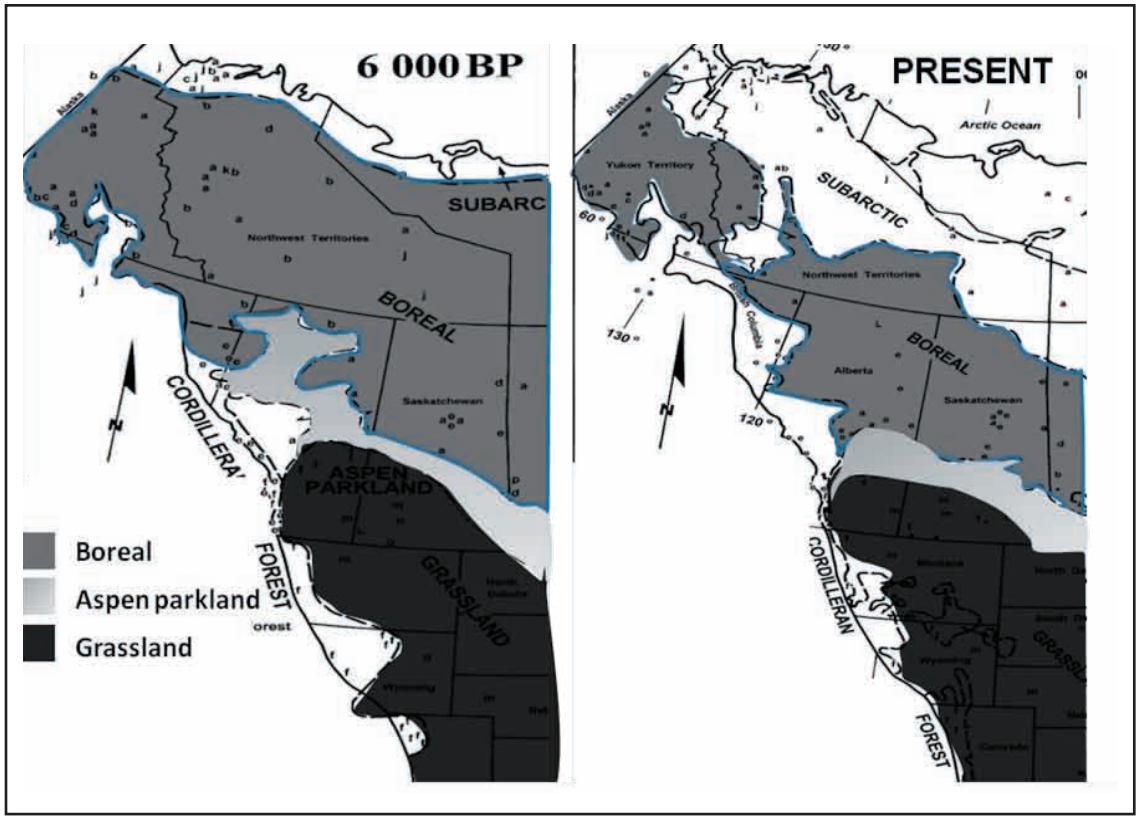

Figure 3. The extent of boreal, aspen parkland and grassland landscapes in western Canada (A) 6000 yrs before present (BP), and (B) at present (adapted from Strong and Hills, 2005).

Planning in the face of uncertainty

It is increasingly likely that, regardless of mitigation measures, the next century will be characterized by shifts in global weather patterns and climate regimes. Considerable uncertainty remains about the direction and extent of climatic change at a regional scale, and this poses significant challenges for forest ecosystem managers. Nonetheless, we need to incorporate expected future environments into ecosystem management planning. Within the next century, or much sooner in some regions, projections indicate that using the recent historical landscape as a template for forest ecosystem management may lead to failure. Is our focus on maintaining the landscape-scale pattern of mixedwood forest composition risky? In theory, likely yes, given that trees planted today will determine the stand composition for at least the next 60-80 years, and many of these species and populations may no longer be adapted for the future climate.

Rather than only being inspired by the stand dynamics that currently occur in the boreal mixedwoods and the landscape patterns of the recent past, managers and policy makers could, on a limited portion of the landscape, adopt practices that are inspired by the stand dynamics that occur south of boreal mixedwood landscapes. Similarly, to maintain the proportion of Canadian landscapes that will be characterized by boreal mixedwood dynamics, some portion of the landscapes that are currently north of boreal mixedwoods could be allocated to practices inspired by boreal mixedwood stand dynamics. In the end this should increase the region's resilience to global climate change by increasing the stand and species diversity.

What can managers and policy makers do?

Our current state of knowledge predicts that present forest management policy poses some risk by: 1) not allowing stands to age and change composition and structure according to natural stand dynamics; and 2) by failing to seriously consider past and future global climate change. A more precautionary

approach to forest management in the boreal mixedwoods should be based on:

1) the development of flexible standards that allow stands to change composition between and during rotations;
2) the development of a broader suite of alternative yield curves and targets within forest management plans, and adoption of a broader range of silvicultural practices (e.g., partial cutting, understory protection, underplanting of conifers in broadleaf-dominated stands) that 'artificially age' stands in terms of both composition and structure. These may be effective for conservation of biodiversity and ecosystem function in managed mixedwoods; and,
3) in the face of climate change, the re-thinking of concepts of local gene pool and seed tree zones to allow for innovative forest management and planning for future climate change by:
   a. increasing regional genetic diversity by using tree seed sources from southern seed zones in at least some of our regeneration efforts;
   b. increasing regional species diversity by establishing, on favourable sites within the eastern boreal mixedwoods (e.g., well-drained south-facing slopes), species and stand dynamics that resemble those of areas south of the current mixedwood zone;
   c. in the southern part of the western boreal mixedwoods, seriously examining the costs and benefits of silvicultural investments in the context of whether they are likely to survive to the end of rotation given climate change predictions; and
   d. increasing regional species diversity in areas north of the boreal mixedwood zone by establishing, on favourable sites, species and stand dynamics that currently occur in the mixedwood zone.

Research needs

There is an urgent need to better understand the potential risks of policies that lead to a change in the composition and/or age-structure of stands within mixedwood landscapes. To do this, we need studies that compare biodiversity and habitat features in managed versus unmanaged stands while controlling for mixedwood composition and age.

The time is ripe to undertake and study assisted migration of mixedwood species. These studies should explore management approaches for mixedwood stand dynamics in areas further north than they occur today, and investigate assisted migration of southern species, and their stand dynamics, into areas currently occupied by mixedwood forests.

Management Implications

- To maintain mixed forest composition and to more quickly develop the structural and compositional properties of older mixedwood forests, managers could utilize silvicultural approaches (e.g., variable-retention harvesting and understory protection) that 'artificially age' stands by accelerating the establishment and growth of some conifers while retaining some broadleaf trees. Alternatively, managers could allow a portion of the landscape to have extended rotations.
- Given likely scenarios for future climatic regimes, it is critical to undertake assisted migration and to develop management approaches for a future of uncertain climate and disturbance regimes.

Further reading

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