Hotchkiss River Mixedwood Timber Harvesting Study
by D.A. Maclsaac¹, S. Lux¹, D. Sidders¹ and I. Edwards¹

The Hotchkiss River Mixedwood Timber Harvesting Study is a cooperative project involving Canadian Forest Service, Daishowa-Marubeni International Ltd., Manning Diversified Forest Products Ltd., the Forest Engineering Research Institute of Canada and Alberta Land and Forest Service aimed at developing new approaches to natural regeneration and harvesting systems for western Canada's boreal mixedwood forests, at a site near the Hotchkiss River in northwestern Alberta. The study used conventional harvesting equipment to test eleven harvesting and silvicultural systems designed to protect and minimize wind damage to immature white spruce residuals and encourage vigorous hardwood regeneration following harvest of the aspen overstory. Research areas include wind damage, wind firmness and growth response of the immature white spruce, effects of harvesting disturbance and timing on soil properties, confier and hardwood regeneration after harvest, efficiency of equipment and harvesting costs, modelling of wind flow and long-term growth and yield. Already in its sixth year, the project has a planned 20-year series of harvests and surveys. Technology transfer is an important component of this study for delivery and promotion of research results on behalf of the proponents and all related research collaborators. Products include demonstration maps and field guides, self-guided tour trails with interpretive signage and field tours (including active operations) as required. Hotchkiss River has also been designated a Forest Ecosystem Research Network (FERN) site.

Key words: silviculture systems, white spruce, Picea glauca, aspen, Populus tremuloides, understory protection, harvesting, Alberta, boreal mixedwoods, technology transfer

Introduction
Boreal mixedwoods occupy about one-third of the productive land base of the prairie provinces and northeastern British Columbia and are an extremely valuable economic resource (Brace and Bella 1988). Increases in hardwood utilization on these lands, coupled with public demand to maintain mixedwoods for a variety of nontimber purposes, are challenging the traditional confier bias in mixedwood management. Within the next 60 to 80 years, however, white spruce that have developed to commercial size through natural succession under the protection of hardwood species will be a significant source of spruce timber in boreal mixedwoods (Brace and Bella 1988). There is a need for a mixedwood approach to both management planning and operations.

Although a previous Canadian Forest Service (CFS) study had shown that silvicultural and harvesting systems utilizing conventional equipment could be used to protect up to 50–60% of the immature residual white spruce during harvest of overstory hardwood trees on mesic sites (Navratil et al. 1994), it did not address the need for layout and harvesting strategies to mitigate blowdown, especially on moist to wet sites. As a result, windthrow (blowdown) risk was a major concern requiring further research. The Hotchkiss River Project was established to design and implement silvicultural systems that provide various levels of wind protection on an operational scale.

The project area was known to have high windthrow risk for residual spruce prior to first-pass treatments (Navratil et al. 1994). Risk of wind damage after harvest to individual white spruce trees is influenced by many factors, such as local wind regimes, topography, tree morphology (e.g., slenderness coefficient (SC)), spruce density, amount of root damage during harvest, effective screening by adjacent stands or windbreaks and support from residual aspen within harvested strips (Ruel 1995, Coutts and Grace 1995, Mitchell 1995).

Partners and Funding
The project was initiated by a partnership of the Canadian Forest Service, Daishowa-Marubeni International Ltd., Forest

¹Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, 5320 - 122 Street, Edmonton, AB T6H 3S5.
Engineering Research Institute of Canada and Alberta Land and Forest Service with the more recent inclusion of Manning Diversified Forest Products Ltd. The University of Alberta, and the Western Boreal Growth and Yield Cooperative have also become participants.

To date, the project has been funded in two phases: Phase 1 (1992–1995) Canada-Alberta Partnership Agreement in Forestry; Phase 2 (1997–2000) Alberta Forest Resource Improvement Program. In both phases, there has been considerable in-kind support from all partners.

Objectives

The objectives of the Hotchkiss River project are to:

1. Test the effectiveness of designated silvicultural and harvesting prescriptions for reducing wind damage to immature residual white spruce and encouraging new aspen regeneration;
2. Assess post-harvest white spruce composition, density, and stock distribution, and subsequent periodic growth in order to develop and refine mixedwood regeneration and stocking standards and growth and yield methodologies;
3. Assess harvesting productivity and costs for each prescribed treatment; and
4. Provide an operational-scale demonstration of alternative harvesting systems in a boreal mixedwood landscape that will facilitate integrated use and contribute to maintaining biodiversity and long-term boreal ecosystem sustainability.

Research Methods and Design

The Hotchkiss River Project is located near Manning in northwestern Alberta within the Lower Foothills Natural Subregion (Anonymous 1994) on a mixedwood site typical for the region (Navratil et al. 1994). Trembling aspen (Populus tremuloides Michx.) forms the 86 to 91-year-old overstory, with a 60-year-old white spruce (Picea glauca (Moench) Voss) understory. Immature white spruce had an average density of 774 stems ha\(^{-1}\) with a mean height of 10.6 m and mean DBH of 11.6 cm. The dominant ecosite is GL1 (glaciolacustrine, moderately well drained) on mid-to-upper slopes, grading to GL2 (glaciolacustrine, imperfectly drained) and OGL2 (organic over glaciolacustrine, very poorly drained).

Eleven harvesting systems were designed for this study to provide varying degrees of wind protection to residual immature spruce following aspen harvest. These are silviculture systems as well because they are designed to test hardwood regeneration and growth of the immature white spruce, following the two-stage harvesting and tending model described by Brace and Bella (1988).

These options represented a range of harvesting difficulty using conventional fellerbuncher/grapple skidder technology, as originally designed:

- F-1-1 One-pass control with a modified uniform shelterwood in one portion
- F-1-2 One-pass control (white spruce avoidance with no wind protection)
- F-2 One-pass modified uniform shelterwood
- F-3 Two-pass modified uniform shelterwood
- F-4 Two-pass shelterwood/50 m strip
- F-5-1 Three-pass shelterwood/50 m strip
- F-5-2 Three-pass shelterwood/100 m strip
- F-6-1 Two-pass alternate 50 m strip
- F-6-2 Two-pass alternate 100 m strip
- F-6-3 Two-pass alternate 150 m strip
- F-7 Four-pass progressive 50 m strip

Four Uncut Controls

The project has a planned 20-year series of harvests and surveys. Eleven blocks (530 ha) were harvested in the fall and winter of 1993–94 (Fig. 1). The second-pass harvest was done in November 1998.

Second-Pass Harvest Design

The second-pass harvest was scheduled at least five years after the first pass to allow the residual spruce to become more windfirm. The second-pass harvest as originally designed would substantially increase windthrow risk for residuals in the first-pass areas as well as destabilise spruce residuals in some second-pass areas (Navratil et al. 1994). For this reason, second-pass recommendations for the project were reviewed and approved by a technical committee comprised of staff from the partner organizations following analysis and interpretation of fourth year post-harvest blowdown and white spruce morphological assessment by transect measurements, air photo interpretation and ground assessment. Factors used to rate blowdown risk included SC by height class, change in SC for standing and blowdown trees, blowdown risk rating by treatment, percentage blowdown by height class, number of trees, percent and total blowdown volume, and block size and configuration. A windthrow risk model developed on site was also used in this evaluation (Flesch 1998, Flesch et al. 1998).

Results indicated that immature white spruce with high risk to blowdown required additional protection in second-pass designs. For this reason, additional aspen was retained in treatments F-3, F-6-2 and F-6-3, as well as a 10 m buffer around landings. Prescriptions for other second pass treatments followed the original design.

Research Studies

The following studies are taking place at the Hotchkiss site:

1. Analysis of wind damage and windfirmness in immature residual white spruce;
2. Growth response of immature residual white spruce and residual hardwoods; conifer and hardwood regeneration response to harvesting/silviculture systems;
3. Effects of season of harvest on soil physical properties and aspen regeneration;
4. Effects of harvesting disturbance on soil temperature and aspen suckering density and growth on skid trails, landings and log decks;
5. Efficiency of equipment and harvesting costs;
6. Analysis of wind speed and direction; and modelling of wind flow; and
7. Modelling long-term growth and yield

Technology Transfer

Technology transfer activities include field tours with demonstration maps and field guides and self-guided tour trails with interpretive signage. Field guides and signage present harvesting prescriptions with technical specifications of each silviculture system with related graphics, maps, and tables summarizing activities to date. These materials have been prepared in such a manner as to allow progressive upgrading as research information is made available. Since project initiation, there
have been many formal and informal field tours, including operational demonstrations as well as on-site presentations of research findings. Clients have included delegates representing provincial, national and international organizations from industry, government and research.

Technology transfer is also accomplished through inclusion as part of the national CFS Forest Ecosystem Research Network of Sites, including utilization of its world-wide web page (http://www.pfc.cfs.nrcan.gc.ca/practices/ems/hotch kiss/hotch kiss.htm). In addition, a professional video has been produced. The Alberta Land and Forest Service has provided large photo mosaics to all partners. Publications include a comprehensive CFS Information Report as well as conference and workshop proceedings.

Results have been tailored to the target audience by adhering to the original objectives of the study, which were designed for the forest industry, and by keeping the forest managers in northwestern Alberta heavily involved in the project through inclusion of senior woodlands and harvesting staff in the project committee, activities of local advisory committees and impact on day-to-day work. This enhances understanding of the role that this study has in assisting in developing methods to maintain healthy mixedwoods and maintain conifer AAC.

Making the Link from Research to Practice

Several silvicultural and harvest prescriptions designed in this project are being tested by industry throughout the region. Specifically, the two-stage harvest and stand tending model has been adopted; the approach to pre-harvest planning, and methods for the designation and layout of machine corridors used in this study have gained widespread use.

Understory protection methods from the Hotchkiss River Project have been used at a number of research and field demonstration sites, including: Manitoba Model Forest in Pine Falls, Alcott Creek Demonstration Area in Saskatchewan, Slo can Forest Products Forest Renewal Demonstration Site in Fort Nelson B.C., Cameron Hills NWT, and the Ecosystem Management to Emulate Natural Disturbance (EMEND) project in Alberta.

Conclusions

Through research results and technology transfer, the Hotchkiss River Project provides operational-level recommendations on the most effective harvest and silviculture systems to protect immature conifer from windthrow as well as offer information on which systems provide the best stand-level growth response of both immature white spruce and regen-
erating hardwoods. The two-stage harvesting and stand-
tending model tested in this research can be used by compa-
ies to more efficiently coordinate harvesting and stand-
tending activities in order to improve growth and yield from
their boreal mixedwood sites.

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