EXTENSION NOTE

forest sciences
NELSON FOREST REGION

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CASE STUDY: Using Partial Cutting to Reduce Susceptibility of Mature Lodgepole Pine Stands to Mountain Pine Beetle Attack—Beetle Proofing

- **Many factors contribute to successful implementation of partial cutting techniques for beetle proofing:**
  - **Clearly defined objectives and criteria.**
  - **Proper layout.**
  - **Well-trained, experienced, and motivated logging contractors.**
  - **Suitable equipment.**
  - **On-going co-operation between all parties.**
  - **Commitment.**

INTRODUCTION

Since the early 1990s, Crestbrook Forest Industries Ltd. (CFI) has been involved in partial cutting of mature lodgepole pine stands in the East Kootenays of British Columbia (Whitehead 1997). The objective of these trials is to increase stand resistance to mountain pine beetle attack. This is known as beetle proofing.

Beetle proofing harvesting trials were carried out in several of CFI's license areas, including TFL #14 at Parson in the Invermere Forest District. CFI has applied the beetle proofing operationally and refined the system at all phases from planning to reforestation. This Extension Note describes beetle proofing in general, and the specific activities at TFL #14 (Figure 1).

BEETLE PROOFING

Beetle proofing is an intermediate harvest entry that targets the removal of a portion of the basal area and reduces stocking levels to create a more open and uniformly spaced stand structure. The objective is to create post-harvest micro-climatic stand conditions with higher temperatures, greater wind flow, and greater light attenuation, which, combined with the improved vigour of the residual stems, promotes stand resistance to mountain pine beetle infestation and mortality.

The *Forest Practices Code of BC Act* introduced various legislated operational harvesting restrictions—such as riparian management, green-up, and adjacency and cutblock size—that make it challenging for a forest manager to meet the landscape-level objectives while faced with large-scale mountain pine beetle epidemics and timber supply constraints. Beetle proofing creates stand conditions that meet the adjacency and resource management objectives, and reduce the stand's susceptibility to mountain pine beetle attack. Mature pine stands can be economically harvested or "beetle proofed" and held in the scheduling queue for 10-20 years to accrue modest volume gains and incur minimal losses to mortality because many of the competitors and poorer stems would have been removed. During this time it is possible for adjacent clearcuts to green-up or to establish regeneration layers under the canopy. These benefits are now becoming apparent, and beetle proofing is coming of age in the Kootenays.

AREA DESCRIPTION

TFL 14 is located south of Golden, BC and includes the entire Spillimacheen River drainage basin, including the benchlands adjacent to the Columbia River wetlands, west to the Glacier National Park boundary. The 151 000-ha landbase, is comprised of approximately 85 000 ha of productive forest land of which 52 000 ha is net operable forest land with an AAC set recently by the Chief Forester at 165 000 m^3. Of this landbase approximately 63% is pine leading or pure pine, much of which is age class 5 or better and therefore considered highly susceptible to mountain pine beetle attack.

MANAGEMENT OBJECTIVES AND PLANNING

In addition to the usual Management Plan and Forest Development Plan, higher level planning on TFL #14 also includes Resource Management Plans (RMP) for the 22 planning cells that define the various landscapes on the TFL. RMPs consist of a textual description of the management objectives and tables describing resources found within each planning cell, along with qualitative and quantitative data and a mapping folio consisting of a forest cover base map and a series of overlays that provide spatial representation of all the identified resource values.

Landscape Level

The RMP for the Bench North planning cell, where much of the beetle proofing has been carried out, includes the following management objectives:

- Manage highly productive stands to produce high-quality timber and to explore opportunities for minor wood products and pulp fibre.
- Schedule harvesting to maintain accessible winter operating areas so as to minimize harvesting costs. This will also provide stability in the contracting community by ensuring year-round employment for the contractor force.
- Manage high-value winter ranges for ungulates within the planning cell and within the adjacent Columbia Wetlands.
- Manage for biodiversity by providing a variety of timber types, habitat types, and seral stages that complement the Columbia Wetlands and its many resource values.
- Manage for Partial Retention visual quality objectives for established viewpoints along Highway #95.
- Manage for water quality and quantity along streams that provide domestic and agricultural water supply.
- Diversify stands across the landscape that are currently dominated by mature pine to address mountain pine beetle management concerns.

Stand Level

Stand-level objectives defined in the beetle proofing silviculture prescriptions include the diversification of stand attributes while maintaining harvesting options within and adjacent to the stand. Final overstory removal is planned to occur within 10 to 20 years.

Silviculture System

The prescribed silviculture system for most beetle proofing situations is best described as the preparation cut or an intermediate cut. In some cases, there may be regeneration objectives for this cut where openings exist or are created by harvesting. However, it is becoming evident that regeneration, either natural or planted, under a 5x5-m spaced canopy cannot be relied upon to produce a well stocked stand in a reasonable time frame. In all but a very few cases it is obvious that an additional harvest entry will be required to either open the stand further or create openings throughout the stand to favour regeneration.

Stand Selection Criteria

Detailed stand selection criteria have already been developed (van Mol 1976). Basically, these criteria define stand and stem characteristics that will form a stable and windfirm residual stand.

The beetle proofing prescription for TFL #14 uses the following cut-and-leave specifications; these have evolved over the past 4-5 years and are vital to achieving the desired results:

- Beetle-infested pine trees must be harvested.
- Pine will be the first choice for removal, followed by other species, as available.
- The target spacing of leave trees is approximately 5x5 m.
- Preference for leave trees will be those exhibiting good form, vigour, and windfirmness. In terms of species, they will be: (1) dominant Fd>Sx>Bl, (2) co-dominant Fd>Sx>Bl, (3) dominant Pl, (4) intermediate Fd>Sx>Bl, and (5) co-dominant Pl.
- Due to the potential for wind and snow damage, small pine (12.5-17.5 cm dbh; 15.0-20.0 dsh) may be removed to create larger openings in the canopy.
- The objective is to retain approximately 400 stems/ha and reserve approximately 50% of the pre-harvest basal area.

These selection criteria are used by the logging supervisors and the logging contractor (faller). They have been refined to be reasonably understandable, to provide enough flexibility for allowing natural inter and intra stand variations, and to address worker safety and harvesting efficiency while eliminating costly tree marking.

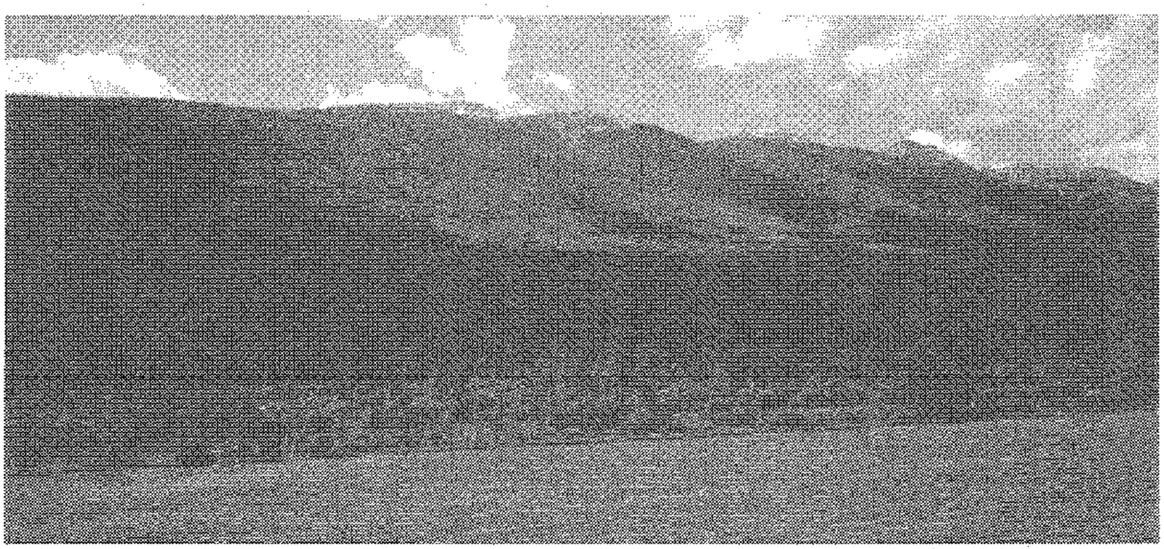

Figure 1. Panoramic view of TFL 14 after beetle proofing.

Layout

Block layout must be done with greater consideration for terrain and stand lean as well as for the differing requirements of the mechanized and the hand-falling systems described below.

Pre-locating skid trails is necessary to achieve the desired results with the minimum of disturbance and residual damage, and with reasonable tree-to-truck costs. Skid trails are laid out to meet the specific falling requirements of: thinning from below, block-specific terrain conditions, the height and size of the timber, the type of harvesting system being used, and the contractor's own preferences. This phase is best carried out by layout personnel with a harvesting (preferably falling) background, in conjunction with the logging contractor assigned to the block.

HARVESTING

Trails are constructed using a combination of a crawler-tractor (on even ground) and a smaller excavator hoe equipped with a hydraulic thumb to push over and bunch the timber along the pre-located trails and to construct any bladed or excavated trails as dictated by the terrain and slopes. Trail construction and related phases can cost between \$3.00 and 6.00/m^3, depending on the average volume/tree harvested, volume/ha removed, and terrain and soil conditions. This is within the range of trail construction costs for other partial cutting systems, and generally 40-50% higher than for clearcut blocks due to the lower volume/ha removed and somewhat higher trail densities. Figure 2 shows post-harvest results.

The harvesting phase is completed using one of two conventional ground-skidding systems:

1. Hand falling and line skidding with tracked and/or rubber-tired skidders—This is carried out in much the same way as any partial harvesting system. In this type of system, layout plays an important role in allowing falling and skidding to occur with the lean of the timber, particularly in the winter when snow in the crowns limits a faller's directional falling capabilities and increases risk. Skidding is responsible for much of the damage to the thin-barked residual pine; therefore, good trail layout, a good machine operator, and the use of rub trees are all critical. Some contractors have also utilized the small hoe with a thumb to "chuck" and pre-bunch timber to minimize residual damage and to allow the use of a grapple skidder if one is available. When comparing this system to fully mechanized systems it should be noted that although terrain is not as limiting and logging costs are similar, faller stress and fatigue can be considerable.
2. Mechanical falling and grapple skidding—Harvesters, or excavators with falling heads, access the block along the network of built trails. Working from the back of the block or trail system towards the landing, the feller-bunchers utilize "ghost" trails between the main trails and leave trees to reach and cut the timber. Cut timber is swung around and bunched, butts ahead, along the main trails if the machine is equipped with a suitable "single grip" style of harvesting head. If the machine is equipped only with a falling/processing head, timber is felled into a natural opening and "hoe chucked" into bunches along the main trails. Tracked or rubber-tired grapple skidders are used to forward the pre-bunched timber to the landings. A second pass is made to hand fall any missed snags, poorly spaced stems, and damaged or beetle-infested stems.

   One of the shortcomings of this system is that snow and debris can accumulate on the roof window of the machine. This obscures the operator's view of the tops and hampers the selection of leave trees. It may be advisable, depending on the stand and snow conditions, to have crews mark-to-cut stems with broken tops, i.e. that are unsuitable as leave trees.

   Although a significant amount of damage to the tops of residual stems may occur during the falling phase with a new operator, once operators are trained, this system has many advantages, including: higher productivity, less residual stem damage, lower winter harvest stump heights, increased worker safety, and less dependence on timber lean. However, the system is more limited by terrain, and contractors need longer term contract commitments because of their high capital investment.

Spacing has been carried out at three distances: 4 m, 5 m, and 6 m. Research results thus far suggest that the 5-m spacing is more effective than 4-m spacing, i.e. from a beetle management perspective. Operationally, the wider spacing is more efficient and economical to har-

Figure 2. Post-harvesting results of beetle proofing.

vest. The 4-m spacing is suitable in heavily stocked stands with smaller average diameters and poorer height:diameter ratios (i.e. where there is a higher risk to wind and snow damage). The 6-m spacing has been used where significant numbers of advanced regeneration (layers 2 and 3) are present and provide additional shading and wind flow resistance, i.e. reducing the effective beetle proofing attributes.

SUMMARY

CFI's planning and harvesting staff were encouraged by the initial success of the research trials; they saw the potential for the planned management of mountain pine beetle at the landscape level rather than undertaking reactive salvage and control harvesting of stands as driven by the unpredictable beetle cycles.

Over 600 ha of pine have been beetle proofed on TFL #14 over the past several years with varying degrees of success. Many factors contribute to successful beetle proofing:

1. Clearly defined management objectives and stand-selection criteria.
2. Proper layout of blocks, treatment units, and access (landings) including the pre-located (and pre-constructed) skid trails.
3. Well-trained and motivated logging contractors using harvesting equipment and systems suited to the block size and layout, terrain, stem size, and removed volume. Use of a logging contractor with partial cutting experience and a demonstrated commitment to achieving the desired results is essential.
4. Cooperation between planning, layout, harvesting, and silviculture staff; contractors; and government agencies to maintain an ongoing monitoring and feedback loop that includes field review before, during, and after harvesting.
5. The staff's uncompromising commitment to making it work; the result is a clear example of practical adaptive forest management.

Even with most of these elements in place, the beetle-proofing costs (using either harvesting system) are 15 to 40% higher than clearcutting in similar stands. The volume/ha removed, the average volume/stem removed, and the terrain are the most critical stand-limiting factors which affect logging costs. TFL #14 managers consider beetle proofing in stands where the volume removal is under 100 m^3/ha, or where the average volume of stem removed is 0.2 m^3 or less, to be either marginal or uneconomical (the high pulp markets experienced in the early 1990s not withstanding). Logging costs can be minimized and worker safety increased by decreasing the skid trail spacing, and increasing the road and landing densities (within acceptable site-disturbance levels). In addition, silviculture challenges include residual stem vigour and windfirmness, the viability of growing stock under partially shaded conditions, and the potential for damage to lower layers during overstory removal.

However, there are also many benefits of beetle proofing that are more difficult to factor into the decision-making process. These include:

1. The value of increased contractor efficiency and productivity through the stability of long-term scheduling of a steady flow of timber.
2. The positive impact on timber supply through reduced adjacency constraints, availability of timber to lessen falldown or fibre shortfalls, and the recovery of volumes normally lost to mortality.
3. The management of forest health risks as an interim measure reduces the risk or magnitude of catastrophic mountain pine beetle outbreaks and helps mitigate future downward pressures on fibre flow.
4. The value of developing stands that contain high quality mature timber with established regenerated layers and no adjacency restrictions.
5. The ability to manage for other resource management values that depend on the maintenance of mature canopy cover.
6. Provides access to timber that may otherwise be unavailable due to adjacency, riparian, fisheries, or watershed concerns.

While all timber on TFL #14 is hauled tree length on off-highway trucks to the log yard in Parson, beetle proofing is also well suited to cut-to-length systems utilizing harvesters/processors and forwarders. On the down side, with larger areas being harvested by partial cutting, there are increased obligations and risks associated with silviculture, forest health, windthrow, and road maintenance.

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