Natural Resources Canada
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# Commercial Thinning of Mature Lodgepole Pine

## Results of "Beetle Proofing" Research in the East Kootenays

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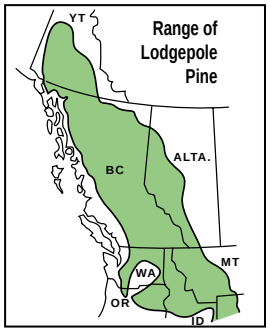
# Background



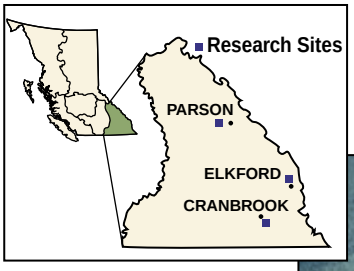

*Large, uniform stands of lodgepole pine provide 25% of annual timber harvests in western Canada and often dominate landscape units important to many user groups.*

Susceptibility of lodgepole pine stands to epidemic attack by mountain pine beetle increases sharply after about 80 years of age. During an epidemic outbreak, mature pines may be killed on thousands of hectares disrupting timber supply, habitat, recreation, aesthetics and watershed values. This concerns resource managers wherever maintenance of susceptible pine stands as mature forest cover is required.

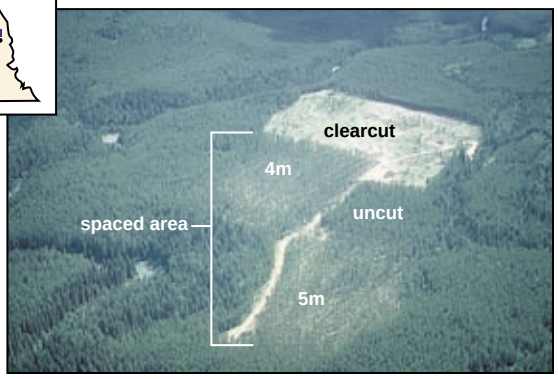
*Epidemic outbreak of mountain pine beetle in the Flathead River valley of southeastern British Columbia – 1982*

## The Research

Past research suggests that thinning or fertilization may reduce susceptibility of maturing stands (70 – 110 years old). The Canadian Forest Service, in partnership with FERIC, industry and the British Columbia Forest Service is testing this hypothesis in three mature lodgepole pine stands in southeastern British Columbia.




*Thinning to 4m and 5m inter-tree spacing is being compared to unthinned and clearcut blocks at 3 sites*



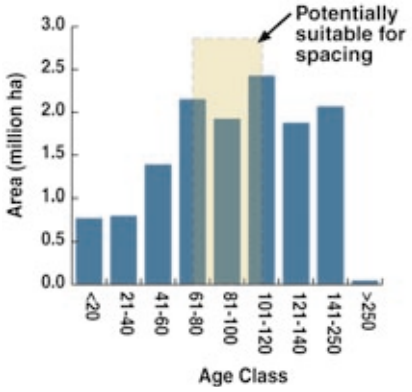

The prescription being tested is a 2 pass shelterwood or clearcut with reserves –

**1st pass:** Thin from below to 4m or 5m inter-tree spacing;

**2nd pass:** Overstory removal to release / initiate regeneration.

For research purposes, fertilizer (200 kg N / ha) was applied to part of each treatment three growing seasons after harvest.

**Age-class distribution of pine-dominated stands in British Columbia**



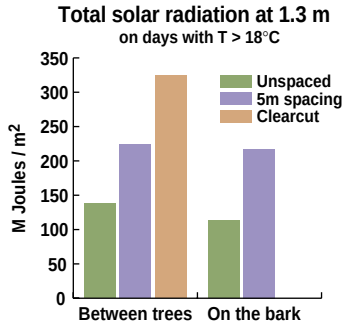

*Spacing mature pine stands may allow some timber harvest within policy constraints for adjacency, biodiversity, Equivalent Clearcut Area or habitat connectivity.*

### Objectives of the research are to determine if:

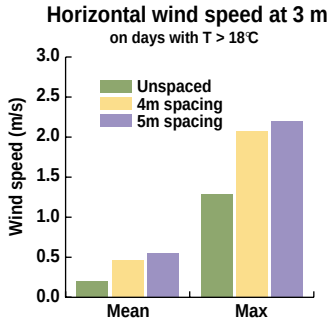
- susceptibility to mountain pine beetle is lowered
- commercial thinning is economically feasible
- stand growth response will increase volume or value yield this rotation
- a shelterwood regeneration system can be initiated for the next rotation
- wildlife habitat values and visual quality can be maintained

## Microclimate

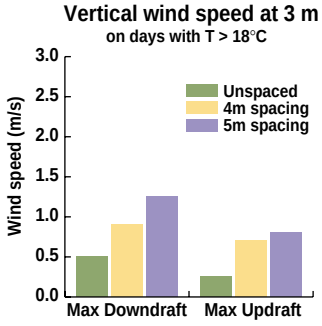
Stand and tree-level microclimate affects mountain pine beetle dispersal, host selection and attack. Higher winds, temperatures and light levels in open stands are less favourable. Wind turbulence may also disperse pheromones, which concentrate attacks on individual trees.




*Light levels during the typical beetle flight period were increased by spacing (both between trees and on the boles). Similar results were observed for temperature.*



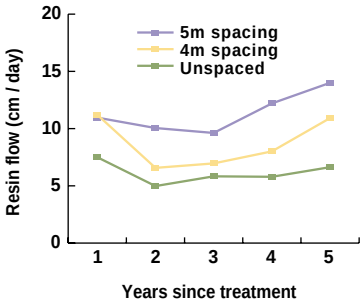

*Winds above about 2 m/s make host selection during the beetle flight difficult. This threshold was only exceeded in spaced stands.*




*Increased turbulence in spaced stands during the flight period may disrupt pheromone communications.*

## Tree Vigour

When attacked, vigourous trees produce resin to "pitch out" beetles. Resin production was higher in spaced stands following spacing for the full 5 years of measurement.



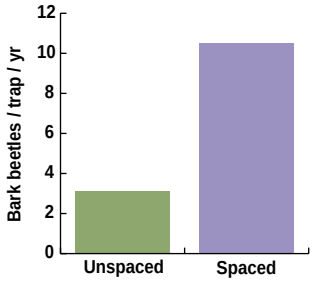

*Resin production in response to wounding, (5 year average of 10 codominant trees/treatment at three sites)*

*Large pitch tubes on a resistant lodgepole pine indicate unsuccessful attacks by mountain pine beetle*

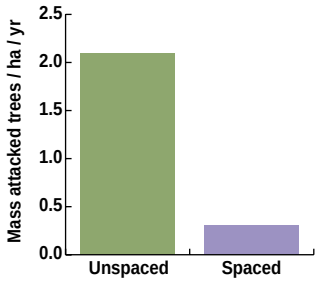
## Bark Beetles

Thirty-five species of bark beetles were captured in flight barrier traps. Almost all are secondary species attracted to fresh stumps and injured trees. Most were caught in spaced stands and 70% were caught in the first 2 years. The most common species were striped ambrosia beetle (*Trypodendron lineatum*), *Pityogenes knechteli* and *Hylastes* spp.).

Mass attacks by secondary bark beetles were more common in the unspaced stands. Mountain pine beetles attacked only three trees during the first 5 years.




*Average number of flying bark beetles caught per trap per year during the first 5 years after spacing.*




*Average number of trees/ha/yr mass attacked by secondary bark beetles in the first 5 years after spacing.*

# Harvest and Stand Dynamics

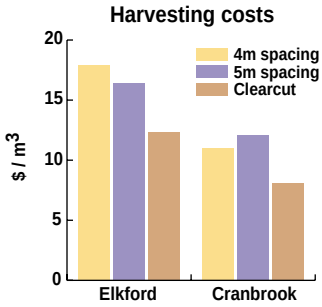
## Economic Feasibility

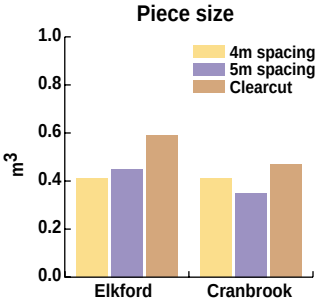
FERIC studied harvest operations at Cranbrook (feller-buncher / grapple skidder) and Elkford (hand falling / line skidder). Spacing these stands yielded 125 – 150 $m^3$ / ha, but cost per $m^3$ (stump to truck) was $1\,^1/_3$ to $1\,^1/_2$ times higher than the clearcut. Piece size removed had a major influence on cost. In general, wider spacing will yield larger average piece size.

*Typical piece size from spacing at Cranbrook*

Operational experiences since these trials indicate that economics of harvest improve:

- if more than 125 $m^3$ / ha are taken
- if a clearcut is included in the same sale
- as spacing and piece-size increase
- with crew experience, and
- with shorter log hauls

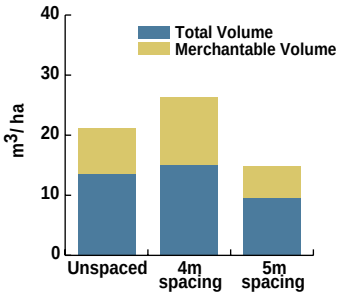


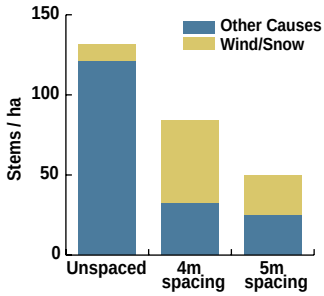




# Stand Dynamics

## Mortality

Mortality occurred in all treatments in the first 5 years. Most losses in the unspaced stands were suppressed trees in smaller diameter classes that would have been removed during spacing. Although fewer trees were lost in spaced stands, volume loss was similar due to larger piece size.



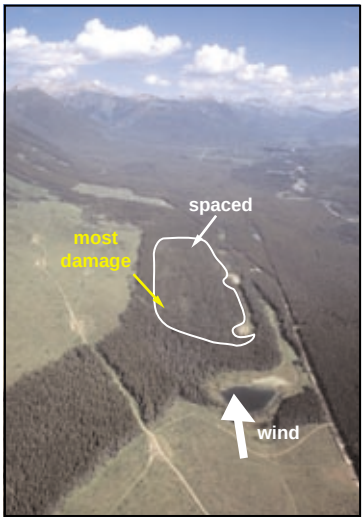

*Mortality in the first 5 years, averaged over all three sites.*

## Wind and Snow Damage

Risk of wind and snow damage increases when dense stands are thinned and the proportion of total losses caused by wind or snow was higher in spaced stands at all study sites. Careful attention to windthrow hazard rating during prescription is very important.

At both Cranbrook and Parson, damage was restricted to a single small patch (<1 ha) where prespacing stand density (and height:diameter ratio) was very high (>2000 stems / ha). Dense patches of small trees are poor habitat for mountain pine beetle and could be left unthinned or clearcut to reduce losses.

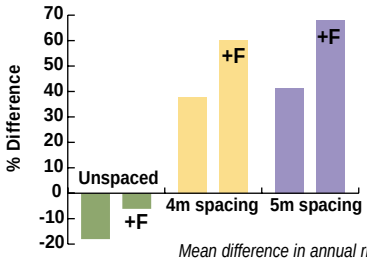
At Elkford, where exposure hazard was high and endemic windthrow evident before spacing, more extensive damage occurred. Six years after spacing, wet snow and high winds caused severe damage and spaced units were clearcut to salvage recoverable losses.




*Extensive wind damage occurred at Elkford where exposure hazard was high*

## Overstory Growth

In the first 5 years after harvest, radial growth rate increased in spaced stands but declined in unspaced stands. Fertilization enhanced radial growth in all treatments. With growth now concentrated on larger stems in spaced units, larger piece size at the final cut should result in higher log values and lower logging costs.




*Mean difference in annual ring width 4 to 5 years after spacing as a percentage of the mean of the 5 years before treatment. (+F indicates fertilization)*

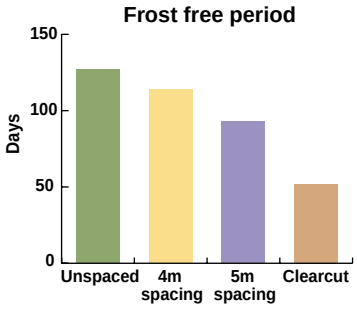
# Regeneration

*Spruce advance regeneration in the 4m spacing at the Elkford site 5 years after release.*

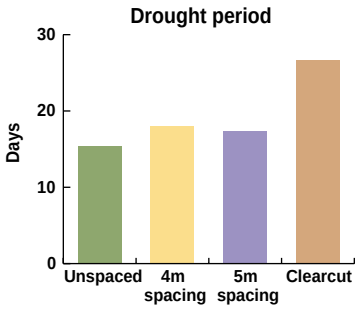
Shade-tolerant advance regeneration, augmented by ingress and under-planting if necessary, might be grown under a spaced stand in a shelterwood management system. Establishing a mixed species regeneration layer could accelerate "green-up" after the final cut and help to mitigate concerns for visual quality, wildlife cover, and protection of watershed values.

## Microclimate

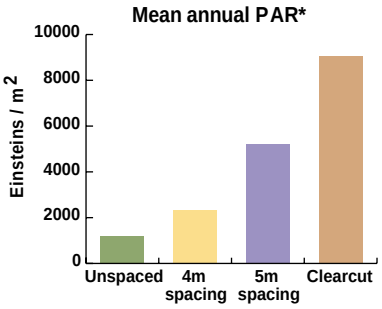
Moderation of forest floor microclimate by retention of canopy cover can have both positive and negative effects on regeneration. The frost-free period is longer, and drought period is shorter in spaced stands than in adjacent clearcuts. However, light available for photosynthesis is also lower in spaced stands than in adjacent clearcuts.




*Frost-free period (4-year average for three sites) was much longer in spaced stands than in adjacent clearcuts.*



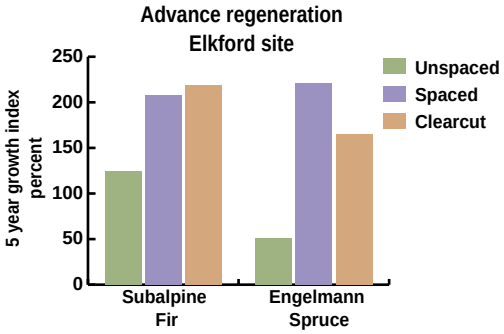

*The number of days with severe drought stress (soil moisture tension > 20 bars) is lower in spaced stands than in adjacent clearcuts.*

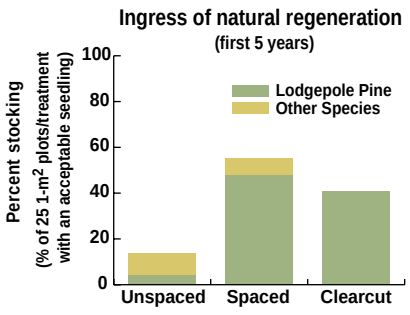


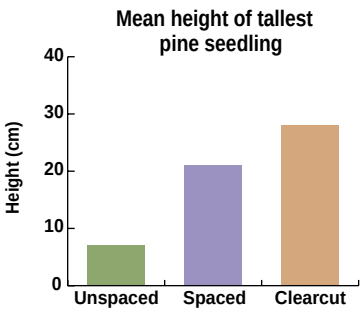

*The amount of light available for photosynthesis is lower when canopy cover is retained.*
** Photosynthetically Active Radiation — 4 year mean (1994-1997 at Cranbrook)*

## Natural Regeneration

Advance regeneration was patchy and suffered up to 60% mortality during the thinning operation. Spacing provides enough light for undamaged seedlings to release, and for lodgepole pine to naturally regenerate. Most natural regeneration over the first 5 years was lodgepole pine.

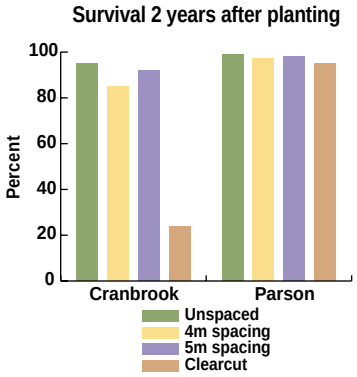


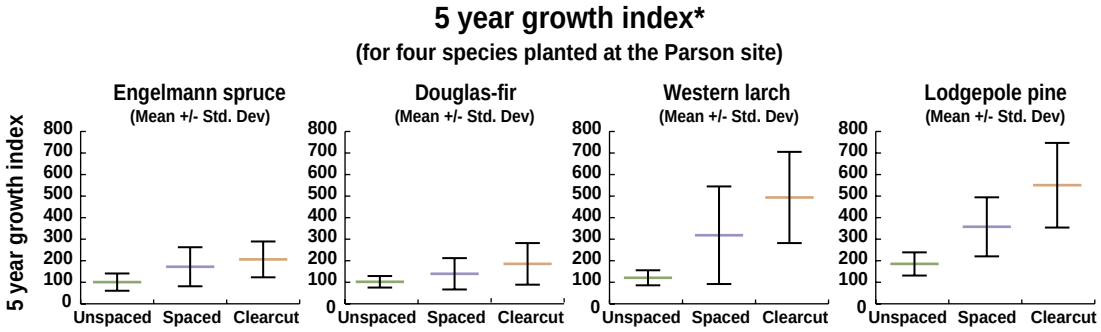
## Planted Seedling Survival

Moderation of extremes in the forest floor microclimate under retained canopy may be very important to regeneration on very harsh sites or in very harsh years.




## Planted Seedling Growth

Four conifer species with a range of shade tolerance were planted into each spacing level studied. Relative growth performance over the first 5 years varied considerably with species and treatment.




*Differences in 5-year relative growth index* for 4 species planted on the Parson site are related to shade tolerance and light availablility.*
** Growth index = (% Basal Diameter Increase + % Height Increase)/2 - Trees with browsing damage not included.*

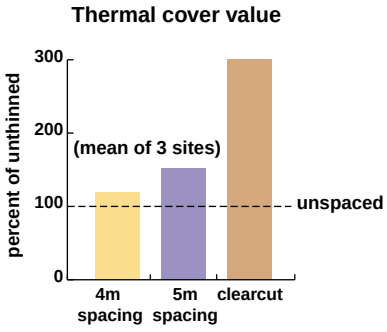
*Although western larch planted at Parson in a moderately moist year survived well in all treatments, they did not tolerate the more extreme conditions in the clearcut at the Cranbrook site, which was planted in a very hot and dry year.*

# Wildlife Habitat

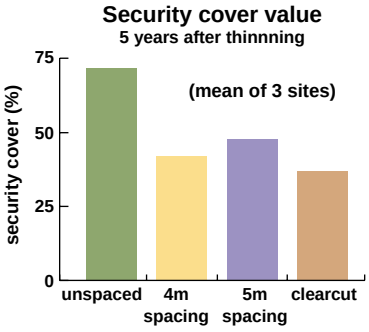
Mid-elevation (MSdk) habitats in the Rocky Mountains are characterized by stands dominated by maturing lodgepole pine, and most of these are zoned for integrated resource use. Winters are often very cold, but have a slight snowfall. Utilization of harvested openings is heavy by deer, elk and moose until snow depth exceeds 50 cm, particularly in areas interspersed with good quality thermal and hiding cover. If thinned stands can provide these values, they could fill an important need in landscape-level habitat management plans.

## Thermal Cover

A "windchill" formula was used to examine relative differences in thermal regimes experienced by animals during winter. Daily maximum theoretical rates of heat loss in winter were calculated from daily minimum temperatures and daily maximum windspeeds.




*Daily maximum windchill is expressed as % of windchill in unthinned stands. On average, rate of heat loss is 3 times higher in the clearcut than in the unthinned stand, but only 1 1/4 to 1 1/2 times higher in thinned stands.*




*Hiding cover was evaluated using sight boards in fall 5 years after harvest was complete. Security cover is lower in all treatments, but rapid shrub growth or conifer regeneration is beginning to replace cover value supplied by dense overstory stems in the unthinned stand.*