Title: Group selection silvicultural systems to maintain caribou habitat in high elevation forests (ESSFwc3) in central BC

Project purpose and management implications
This is a long-term research project that supports current policy (Cariboo-Chilcotin Land-Use Plan (CCLUP) (Prov.B.C. 1995), and CCLUP - Mountain Caribou Strategy (Youds et al. 2000)) and provides an integrated approach to resource management. Mountain caribou are on the provincial ‘threatened’ list and in the CCLUP, they are considered a key management species. Under the federal Species at Risk Act (SARA) mountain caribou are designated as threatened within Southern Mountains National Ecological Area (SMNEA) and recovery planning is underway provincially through the Species at Risk Co-ordination Office (SaRCO). The recovery strategy currently being developed for the Quesnel Highland has ‘modified harvesting ’ designated for 1,000’s ha of critical caribou winter range in the upper elevations of the Engelmann spruce – subalpine fire zone (ESSFwc3). The Quesnel Highland project was developed to test group selection silvicultural systems that retain caribou habitat (forage lichens associated with old-growth forests) while extracting timber, achieving regeneration, conserving biodiversity and understanding the effects of partial cutting on peak streamflow. This project fits well with the management recommendations proposed by Stevenson et al. (2001).

Specific objectives are to determine the impact of alternative silvicultural systems on:
- the abundance of arboreal forage lichens, and their relationship with old growth forest characteristics,
- the potential for natural regeneration,
- the performance of planted seedlings,
- peak snow accumulation, melt rate, and snow-free dates,
- wildlife diversity, particularly breeding birds and small mammals,
- stand stability through windthrow studies, and
- as required - forest health, particularly the incidence of balsam bark beetle, spruce bark beetle and two cycle spruce budworm.

Project History: initiated in 1990, this is a Ministry of Forests and Range Experimental Project (EP1104.02) and has been funded through FRDA II, the Ministry of Forests Silvicultural Systems program, FRBC, FII and FIA-FSP.

Methodology Overview
The study was conducted on four sites located 12 - 28 km east of Likely, B.C. in the Southern Interior Forest Region. Two of the sites, Upper and Lower Grain Creek, (52°41′29″N, 121°12′02″W and 52°40′45″N, 121°10′52″W, respectively) are located within the Grain Creek watershed. The two other sites, (52°36′37″N, 121°24′30″W) are located in the Blackbear Creek watershed. All study sites are submesic to mesic within the Engelmann spruce–subalpine fir wet, cold biogeoclimatic subzone variant (ESSFwc3).

The replicated trial is a randomized complete block design. Each 40 ha block was divided into four approximately equal-sized treatment units; three silvicultural systems treatments and a no-harvest treatment were randomly assigned to the experimental units. The group selection treatments are based on 30% area removal, and an 80-year cutting cycle. The treatments vary with opening size: 0.03 ha (20 m diameter), 0.13 ha (40 m diameter) and 1.0 ha (113 m diameter).
Plot size and density per treatment unit vary by component. Various components have been analysed with mixed model analysis of variance.

**Project Scope and Regional Applicability**

Southern and Northern Interior Forest Regions in ESSF forests in and out of Mountain Caribou habitat

**Interim Information**

**Lichen**

This is the abstract for the paper published in Rangifer, July 2007.

Group selection silvicultural systems have been recommended for managing mountain caribou (*Rangifer tarandus caribou*) habitat in high elevation Engelmann spruce – subalpine fir forests in east-central British Columbia. We measured the response of arboreal lichen (a key winter forage) to harvesting of 30% of the forested area using three partial cutting treatments, which created small (0.03 ha), medium (0.13 ha), and large (1.0 ha) openings, and a no-harvest treatment. Treatments were replicated on four sites, and monitored over a ten year post-harvest period. The short-term loss of lichen associated with removal of approximately one third of the trees was partially offset by a significant (p=0.01) increase in lichen abundance on trees in the caribou feeding zone (up to 4.5 m) in the three partial cutting treatments relative to trees in the uncut forest. Differences among treatments in the change in lichen composition, as measured by the percentage of *Alectoria sarmentosa* and *Bryoria spp.*, were marginally significant (p=0.10). The partial cutting treatments showing a greater likelihood of shifting towards more *Bryoria spp.* than no-harvest treatment (p=0.04). In the year of harvest (1993), larger trees were found to hold more lichen than smaller trees (p=0.04), and live trees supported more lichen than dead trees (p=0.01), but lichen loading was similar among tree species (p=0.51). Tree fall rates were similar among treatments, based on the ten year average (0.6–0.8% of sample trees per year). The results indicate that caribou foraging habitat is maintained in the residual forest when group selection systems that remove only 30% of the trees are applied. Information on the distribution of lichen is useful for developing stand level prescriptions. Providing lichen bearing habitat meets just one of the needs of caribou. A comprehensive approach that considers all factors and their interactions is essential to maintain and recover the threatened mountain caribou.


**Stand structure**

This study component describes the composition, size and age structures, and development of old Engelmann spruce – subalpine fir stands on the trial blocks. A comparison of the three stands in this study suggests that naturally established high elevation forests of the ESSFwc3 may not achieve some old-growth attributes, such as large dead trees and large, well-decomposed woody debris, until 350 or more years following initiation. Planted stands may achieve some ESSFwc3 old-growth features several decades sooner than natural stands, due to a shorter stand initiation period. The silvicultural system that has been proposed for maintaining suitable mountain caribou habitat following harvesting in this area (group selection system with 240 year rotation) will likely result in stands with many old-growth features including abundant arboreal lichens. Some features that may not be present in these stands include a uniform inverse-J age
distribution, many large (>60 cm dbh) live and standing dead trees, and large diameter, well decayed woody debris. Published in MOFR Research Report 26.

Planted stock

Little work has been done on tree regeneration in uneven-aged silviculture systems within high latitude forests despite a past history of regeneration failure. A journal article, on the ten year results from the Quesnel Highland trial, is in progress. This paper summarizes the performance of Engelmann spruce, subalpine fir and lodgepole pine after 10 growing seasons in three opening sizes, 0.03 ha, 0.13 ha and 1.0 ha and five microsite types. There are 4 sites, all in the ESSFwc3, but with, two at ~1500 m and two at ~1620 m. Ten years after planting: seedling survival averaged 45%, was greatest for fir, and varied by opening size and elevation; planted spruce and fir seedlings increased in height and diameter with increasing opening size and decreasing elevation; pine seedlings followed the same trend but with a statistically significant interaction between opening size and elevation. Pine seedlings at the high elevation sites were 30 to 48% smaller than those at low elevation, and at the high elevation the pine seedlings did not respond to the different opening sizes. Pine and fir seedling growth was independent of microsite; spruce seedlings seemed to benefit from planting on protected or raised microsites. Partial cutting can be an acceptable method of harvest in high elevation areas as long as there is a good understanding of the response of the system and expectations for regeneration. Tree growth may be slower in the smaller openings, however, these areas can be adequately reforested.

Lajzerowicz et al. (2006) compared fifth year seedling growth data across three high elevation trials (Quesnel Highland, Sicamous, Northern Rockies Wetbelt) testing a variety of opening sizes in group selection silvicultural systems in B.C. Similar results were found across all trial sites with opening size being one of the critical factors affecting seedling performance. Conditions in openings less than 0.1 ha were not favourable for seedling growth.

Natural regeneration

This is the abstract from the MOFR Research Report, March 2008

This study examines factors affecting natural restocking of small (≤ 1 ha) openings created by partial harvesting of high elevation (>1500 m) Engelmann spruce (\textit{Picea engelmannii} Parry ex Engelm.)–subalpine fir (\textit{Abies lasiocarpa} [Hook.] Nutt.) stands in east-central British Columbia, Canada. We examined the effects of opening size (0.03, 0.13, and 1.0 ha), seedbed, and seed supply on density of post-logging regeneration for 10 years post-harvest. The effect of opening size on growth release of advance regeneration was also examined. Both seed production and seedbed limited densities of post-logging seedlings. Densities of subalpine fir and Engelmann spruce post-logging regeneration remained low at two sites where seedfall was low. Seedbed scarification significantly increased seedling densities where seed rain was high. In the absence of scarification, abundant seed production had little effect on post-logging seedling densities. Increased height and basal diameter growth of advance regeneration following logging was greater on 1.0-ha than 0.13-ha and 0.03-ha openings. This study demonstrates that post-logging natural regeneration in combination with advance regeneration can restock small openings in partially harvested stands where there is an adequate distribution of mineral soil seedbed and logging or site preparation coincide with or shortly precede a year of abundant seed production.

Performance of advanced regeneration is also being followed. Trees were tagged at 3 of the sites in all treatments immediately after harvesting and they have been assessed periodically. The last assessment was in 2007 which captured the 15 year results. Reporting on these findings will be completed in upcoming years.

**Small mammals and breeding birds**

The composition and structure of the small mammal and breeding bird communities were similar among the group selection and no-harvest treatments in the early post-harvest years. A few species of birds associated with old forest declined in abundance while some generalist species increased, and a couple of new species were recorded. Within the group selection treatments, there was less use of the openings than the residual forest by red-backed voles and some bird species. The bird community was re-sampled in 2004 and 2005 but results were similar to the earlier immediate post-harvest study.

The small mammal community was re-examined in 2006 and the responses of forest floor small mammals to 1.0-ha group-selection cuts, uncut forests and large clearcuts, were compared. Results support the growing body of knowledge that group-selection silvicultural systems when conducted in subalpine forests, may maintain important ecological processes and diversity better than large clearcuts. A paper has been prepared and submitted for publication in 2008.

**Vegetation**

In 1994 (two years post-harvest), within the openings, the shrub and bryophyte layers had declined by more than half while the herb layer had increased by 10 – 20% cover. This pattern was still apparent 10 years later in 2004, though the shrub layer (B1 and B2) has increased since the 1994 measurement. The B2 layer (low shrub) was not significantly different among treatments by 2004 (33 – 49%) but lower than pre-harvest levels (54 - 57%). *Rhododendron albiflorum and Abies lasiocarpa* were more abundant in the no harvest treatment but this is offset by other species such as *Ribes lacustre, and Sambucus racemosa* being more common in the harvested openings. The herb layer still remains at greater abundance in the openings in 2004 (47-66%) than the pre-harvest amounts (33-46%) while the moss/liverwort layer remains substantially lower (currently at 10-26%) than the pre-harvest abundance of 36-48%. No data on the vegetation component of this trial was collected in 2007-08.

**Snow melt (ablation)**

Snow research plots were established in the Quesnel Highland research trial after logging and snow surveys were done during the spring of each year from 1995 through 1999. This provided very useful information of the relation between forest structure and snow but it lacked power because there was no pre-logging data. Subsequently, a snow research project was established at the Mt. Tom Adaptive Management trial and snow surveys were done for 5 pre-logging years (2001-2005). Post-logging snow surveys started at Mt. Tom in the spring of 2007 and in order to allow the Black Bear results to be better-compared with the more powerful (pre- and post-) Mt. Tom data, the need for at least one year of overlapping data between the two sites was identified. Since 2007 was the first post-logging year at Mt. Tom, this year was selected for snow surveys on the Quesnel Highland project. Snow surveys starting in March 2007 consisted of repeated measurements of snow water equivalent at each of 40 points in each of 7 plots, representing two small, two medium, and two large openings and a Control.
Contacts:
Ministry of Forests and Range Forest Science Staff, Southern Interior Region
Michaela.Waterhouse@gov.bc.ca – Silvicultural systems
Harold.Armleder@gov.bc.ca – Wildlife habitat
Teresa.Newsome@gov.bc.ca – Silviculture
Pat.Teti@gov.bc.ca - Hydrology

Project Website:
Publications can be downloaded from Canadian Forest Service Forest Ecosystem Research Network of Sites (FERNS)
http://cfs.nrcan.gc.ca/subsite/ferns/quesnel

Citations


http://srmwww.gov.bc.ca/car/planning/cclup/cari_strategy/reports/cari_2000_rpt/cari_main.html