We're harvesting timber and maintaining caribou habitat: What about silviculture and other concerns?

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INTRODUCTION

The importance of maintaining mountain caribou habitat in the Quesnel Highland portion of the Cariboo Forest Region was widely recognized by the early 1980s. At that time, a 20-year timber harvesting deferral was established over much of this area. When the Cariboo-Chilcotin Land Use Plan (CCLUP) Implementation Process Final Report (Province of British Columbia 1995) was released, the area under the timber harvesting deferral for caribou habitat was designated as 35% modified harvest and 65% no harvest. The CCLUP allows operational timber harvesting within the modified harvest zone to begin as early as year 2000.

Winter habitat for mountain caribou in the Cariboo Forest Region is found primarily at elevations above 1400 m in mature and old Engelmann Spruce–Subalpine (ESSF) forests that have abundant arboreal lichens. Arboreal lichen is the major food source for caribou during winter months. Most of the winter range habitat in the Cariboo Forest Region falls within the ESSFwc biogeoclimatic subzone variant, with a smaller portion at high elevation in the ESSFwk variant. Caribou prefer slopes that are less than 45%, but occasionally use steeper terrain. They require large tracks of land with adequate food resources so that populations can widely disperse over the landscape and thereby limit predation. Clearcutting has been the most common silvicultural system used in these ecosystems. However, it removes the entire arboreal lichen source and more than 100 years will be required for a clearcut patch to provide adequate lichen forage for caribou. Consequently, a harvested area managed under normal rotations may never provide suitable caribou habitat. Therefore, a group-selection silvicultural system has been recommended by the Cariboo-Chilcotin Land Use Plan Caribou Strategy as a means to continuously retain suitable lichen-producing habitat throughout the winter range area.

Research was initiated as early as 1989 in the Cariboo Forest Region to study silvicultural systems that would maintain mountain caribou habitat. Based on initial studies, researchers recommended a group-selection silvicultural system in which 33% of the timber is removed every 80 years. Recommended opening sizes can vary, but should not exceed 1.0 ha. Although initial indications are that this silvicultural system would likely provide suitable habitat for caribou, concerns were expressed about other aspects of forest management. Can the regeneration on these sites meet all the silviculture obligations as outlined in the Forest Practices Code? Will windthrow be a problem? Is this method of harvesting operationally feasible? Although answers to these questions are still under investigation, results from 7 years of research are providing some guidance.

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Research began with a pilot trial in 1990. A group-selection system with two opening sizes (0.03 and 0.008 ha) and an uncut control was established. Concerns regarding harvesting feasibility and seedling growth on the smallest opening size led to a change in the next stage of the research when a larger replicated trial (EP 1104.02) was logged in the winter of 1992/93. In this trial, three opening sizes (1.0, 0.13, and 0.03 ha) and an uncut control were tested on three sites. One site was located at Blackbear Creek with an elevation range of 1370–1550 m. The other two sites were located in the Grain Creek drainage. The Upper Grain Creek site had an elevation range of 1460–1680 m; the Lower Grain Creek site had a range of 1525–1740 m. A third stage of this research includes an adaptive management trial in which approximately 1000 ha will be partially cut over a period of 3–4 years using a group-selection system. An adjacent area, which is over 2000 ha, will be left as an untreated control. This stage will provide information on the use of large, partially logged areas by caribou and will allow a better assessment of operational concerns. The first block is scheduled for logging in March and April 2000. Because of concerns regarding seedling growth and financial feasibility, the smallest opening size (0.03 ha) was dropped. Openings on the adaptive management trial range in size from 0.1–1.0 ha, with various sizes in between.

METHODS

Research efforts have concentrated on the replicated trial (EP 1104.02), where numerous studies have been completed. Here, we discuss the regeneration, microclimate, and windthrow results. This trial also includes studies of stand structure, lichen abundance and distribution, lichen growth, breeding bird communities, small mammal communities, and snow distribution and melt.

Most studies were replicated over all three sites but, because of costs, microclimate was extensively studied only at the Blackbear Creek site. One climate station was established at each of the Grain Creek sites in a 1-ha opening. At Blackbear Creek, microclimate was monitored in one opening of each size. A climate station was established in the centre and a grid of temperature probes recorded air, soil surface, and soil temperature at designated intervals across the opening. Microclimate was also recorded in the uncut control and an adjacent clearcut, and was monitored for 6 years in all locations. Windthrow has been monitored regularly along systematically established transects.

Natural regeneration is being assessed in the openings to determine whether it is a viable regeneration option. Natural regeneration ingress densities are being monitored on 1164 plots of 1 ha^2, equally distributed among the three opening sizes (0.03, 0.13, and 1.0 ha) and randomly located within selected openings in each opening size. On one-half of the plots, scarification removed all vegetation and soil organic layers to create a mineral soil seedbed. The remaining one-half of the plots were not scarified. One-half of the scarified plots and one-half of the non-scarified plots were artificially seeded with spruce and subalpine fir seed to determine whether the amount of seed limits natural regeneration success. Seed traps were placed on selected openings to assess the abundance of natural seed rain.

Artificial regeneration is also being tested. Three species (subalpine fir, Engelmann spruce, and lodgepole pine), which were present before harvesting, were planted on five different planting treatments within all opening sizes. The five planting treatments included: three microsite locations, a large mineral screef (50 × 50 cm) created by a hand-held Hawke scarifier, and a control, where the seedlings were planted in a grid with no emphasis on microsite. Microsite planting treatments included:

- raised sites, which promoted better drainage and increased soil warming;
- protected sites, which were behind obstacles to avoid mechanical damage from snow creep; and
- planting spots, which were composed of rotten wood.

RESULTS AND DISCUSSION

Microclimate

These ESSFwc3 sites are cold and wet. Principal factors limiting seedling growth are short growing seasons, cool growing season temperatures, and in some situations, excess moisture. Growing season frosts are uncommon on the steep slopes. The group-selection method limits soil warming compared to a clearcut because the adjacent forest canopy shades a high proportion of the logged area. This shading can have two detrimental effects: it can reduce the growing season by delaying the snow melt, and it can cause lower air and soil temperatures during the growing season on northern and eastern aspects of the openings (Table 1). The accumulated degree-days in the large opening (1.0 ha) are lower than those in a clearcut located below the Blackbear Creek installation. The degree-days in the large openings at Upper Grain Creek and Lower Grain Creek were lower that those recorded at the Blackbear site (555, 605, and 639, respectively) in 1998 indicating a lower growth potential.

TABLE 1 *Effects of opening size and location (distance from centre) within an opening on accumulated 5°C growing degree-days between May 1 and September 30, 1994 in the 0.03, 0.13, and 1.0 ha partial-cut treatments at Blackbear Creek*

	0.03 ha			0.13 ha			1.0 ha			
Aspect	0 m Centre	7 m	10 m Edge	0 m Centre	14 m	20 m Edge	0 m Centre	32 m	40 m	56 m Edge
S	478	410	423	523	515	435	570	572	560	548
W	478	377	373	523	507	419	570	553	439	390
N	478	371	370	523	505	440	570	458	514	389
E	478	421	451	523	502	420	570	518	342	334

Natural Regeneration

Cone and seed production in these high-elevation forests is highly variable, both in time and in space. At the Blackbear Creek site, the number of seeds collected in traps was high in 1993 (167 filled seed per m^2), but much lower (< 10 per m^2) during each of the following 3 years. At the two Grain Creek sites, the 1993 peak in seed numbers was very reduced (4 seeds per m^2), and numbers of seeds in other years were less than 1 seed per m^2 Mean numbers of subalpine fir seed followed similar trends, but were generally smaller than mean numbers of spruce.

Five years after logging at the Blackbear Creek, site mean densities of spruce and subalpine fir seedlings were higher on scarified sites (3.3 and 10.1 seedlings per m^2) than on non-scarified sites (0.3 and 2.0 seedlings per m^2). Artificially applied seed had no significant effect on seedling densities, indicating that seed supply on this site was not limiting. Seedling densities were generally highest in the first year of measurement—the year following the peak seed rain—and declined steadily throughout the period of measurement. Subalpine fir seedling densities were smaller on large openings rather than on either medium or small openings, but spruce seedling densities showed no relationship to harvested opening size.

Natural regeneration densities were much smaller at the two Grain Creek sites than at the Blackbear Creek site. This was probably due to the much smaller natural seed rain at these sites. Five years after logging, spruce seedling densities averaged only 0.2 seedlings per m^2 on scarified and 0.3 seedlings

per m^2 on non-scarified sites. In contrast to the Blackbear Creek site, seedling densities were consistently higher on artificially seeded sites than on unseeded sites.

Seven years after logging, heights of spruce and subalpine fir natural regeneration were not sufficient to meet current height requirements contained in stocking standards for the area.

These results indicate that natural regeneration ingress may successfully regenerate openings of 1 ha or less, provided that a year of high seed production occurs shortly after logging. In addition, height requirements in stocking standards for the area would need to be adjusted. However, the unreliability of cone and seed production at these high elevations makes it very difficult to predict natural regeneration success after any given year of logging.

Artificial Regeneration

Five-year results indicate that planted seedling growth and survival generally decrease with increasing elevation and decreasing opening size (Tables 2 and 3). One exception is spruce on the Blackbear Creek site, where differences in growth were minimal between the medium and large openings.

Differences in seedling performance on the microsite treatments were minimal. Survival was lowest for all species on the control, where there was no site preparation or microsite consideration.

Will free-growing and stocking standards be met? Survival is a concern on some treatment combinations as is evident in Table 1. At the current growth rates, minimum heights contained in current free-growing and stocking standards may be difficult to achieve for pine (1.6 m) in the small openings on all sites, and the medium openings at Lower Grain Creek. Minimum height requirements may be difficult to achieve with subalpine fir (0.8 m) on the small and medium openings at Lower Grain Creek. Spruce would make the current minimum height (0.8 m) standards for free growing on all sites and opening sizes. These figures may underestimate the ability to meet height standards since height growth is expected to accelerate over the next few years.

TABLE 2 *Five-year percent seedling survival (values less than 50% are bolded)*

	Subalpine fir			Lodgepole pine			Engelmann spruce		
Site	**1.0 ha**	**0.13 ha**	**0.03 ha**	**1.0 ha**	**0.13 ha**	**0.03 ha**	**1.0 ha**	**0.13 ha**	**0.03 ha**
Blackbear	89.4	84.1	89.7	75.0	77.1	55.1	75.8	72.1	**47.6**
Upper Grain	73.5	66.1	65.2	75.0	56.5	52.6	74.1	64.3	55.2
Lower Grain	66.2	56.4	**37.5**	72.3	**39.6**	**13.7**	57.6	52.9	**37.3**
All sites	76.6	69.1	64.7	74.1	58.0	40.6	64.9	61.1	46.7

TABLE 3 *Five-year height growth (1999 height minus planting height in centimetres)*

	Subalpine fir			Lodgepole pine			Engelmann spruce		
Site	**1.0 ha**	**0.13 ha**	**0.03 ha**	**1.0 ha**	**0.13 ha**	**0.03 ha**	**1.0 ha**	**0.13 ha**	**0.03 ha**
Blackbear	29.9	28.0	22.6	53.2	39.8	30.0	29.1	29.0	22.3
Upper Grain	17.8	12.7	10.8	38.1	25.3	22.5	23.2	18.6	15.8
Lower Grain	16.1	11.0	9.3	41.3	18.7	15.7	19.7	14.3	12.4
All sites	22.2	18.7	16.1	42.2	30.3	25.3	24.1	21.5	17.1

Windthrow

A total of 43 trees have fallen over in the past 4.5 years, representing 3.4% of the total number of trees permanently marked on the windthrow transect lines. Of these trees, 81% were dead before falling (2 spruce and 33 subalpine fir), and the few live trees (2 spruce and 5 subalpine fir) were scattered over the treatment units. The least windthrow occurred in the uncut control areas (2.6%) compared to the small (3.2%), medium (4.1%), and large (4.2%) treatment units. The data indicate that the weaker dead trees are falling at a slightly higher rate in the harvested treatment units than found in uncut forest.

SUMMARY

The replicated trial provided encouraging information and indicated some areas of concern. Very small openings and very high-elevation sites may be especially challenging to regenerate artificially, but larger openings (over 0.1 ha), especially at the lower elevations, are currently regenerating adequately. Natural regeneration may be a suitable option in years of abundant cone and seed production, but not in other years. Overall, this group-selection silvicultural system seems a viable option for both timber management and maintaining caribou habitat. Further testing of this system during the adaptive management phase will help to refine management techniques.

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