THE UNIVERSITY OF BRITISH COLUMBIA

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RESEARCH
FOREST

KNIFE CREEK BLOCK

COMMERCIAL THINNING IN DRY-BELT DOUGLAS-FIR STANDS ON MULE DEER WINTER RANGE IN THE CARIBOO FOREST REGION

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Forward

Efforts at developing an integrated management approach for mule deer winter ranges have been ongoing since 1980. Extensive research has been conducted on mule deer habitat requirements and ecology. Based on this research, specialised partial cutting treatments for mature stands and juvenile spacing treatments for non-merchantable stand components have been developed and carefully tested. These treatments are now beginning to be operationally applied. They are part of a management approach that is described in a handbook (MOF Land Management Handbook #13) designed for managers with follow-up material tailored to operators.

The handbook identified the value of thinning treatments for stands with a dense pole layer, but did not provide specific recommendations on how to design thinning treatments to integrate habitat, timber, and silviculture values. Since publishing of the handbook, awareness of the large extent of these dense pole layer stands has increased, sparking interest in managing them to improve long-term habitat and silviculture values while providing a short-term timber source. The Cariboo-Chilcotin Land Use Plan - Integration Report has put a high priority on this stand treatment within mule deer winter ranges. This priority is reflected in winter range management plans that are now being developed to guide short and long-term integrated management in these areas. The management plans recommend an integrated approach to thinning these dense pole layers on winter ranges.

Experience with commercial thinning is limited in the interior Douglas-fir zone of the Cariboo Region and it has not been tried on mule deer winter ranges. This project was commissioned to help in the implementation phase of commercial thinning as it applies to winter range. It is designed to address the issues that need to be resolved for successful implementation of an operational commercial thinning program. The fact that thinning represents a key harvest opportunity identified in the Cariboo-Chilcotin Land Use Plan, makes the report timely.

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Abstract

Integration of mule deer winter range and timber management has been a topic of research and development in the Cariboo Forest Region for several decades. Mule deer ecology, silvics of Douglas-fir, and disturbance ecology are intimately linked in those forests where mule deer winter. The single tree selection silvicultural system is being employed to manage winter ranges in the Interior Douglas-fir biogeoclimatic zone. Mule deer winter range plans, being written under integration of the Cariboo-Chilcotin Land Use Plan, will direct a significant harvesting program towards stands with low mean diameter and high density. This report discusses two such stands on the Knife Creek Block of the UBC/Alex Fraser Research Forest, and provides a rationale for harvesting in each stand. Draft Silviculture Prescriptions are included for the two stands discussed. The treatment described is intended to increase the average diameter of the stand, retain the most vigorous trees, and improve mule deer habitat in the medium term while minimising the impact on deer in the short term. Recommendations for implementation include access and boundary layout, selection of leave trees, and harvesting methods. Costs of the treatment and value of the timber produced are a significant concern, and additional funding will be required to complete the treatment of the unmerchantable component of the stand.

Keywords: mule deer winter range, Interior Douglas-fir, selection silvicultural system, uneven-aged management,Silviculture Prescription, faller's selection, timber marking

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Introduction

Mule deer winter ranges cover approximately 275,000 ha in the Cariboo Forest Region, much of it in the interior Douglas-fir (IDF) biogeoclimatic zone. As a result of their disturbance history and ecology, many of the Douglas-fir stands on winter ranges have accumulated very high densities of small trees and lack large trees.

Since mule deer are reliant on the cover and forage provided by large Douglas-fir trees (Armleder *et al*. 1994), it is important for managers to ensure that a continuous supply of these trees is available throughout each winter range. Selection management, whereby all sizes of trees are managed on each harvest entry, logically achieves this. Repeated entries ensure that: residual trees have sufficient space to grow and develop the desired attributes for mule deer; and a portion of the stand is regenerated to ensure a sustainable stand. Most managers follow the BDq[1] method of selection management.

Management plans for mule deer winter ranges are currently being formulated, as directed under the integration of the Cariboo Chilcotin Land Use Plan (CCLUP Implementation Committee 1996). Those winter range plans will direct a significant harvesting program towards stands with a small average diameter. Such a program, described as "commercial thinning", is important because it will provide enhanced mule deer habitat in the future, and because it allows access to some commercial timber. Without such a program, mortality will continue, but very high densities of small trees will not allow for release of residual stems, and new large trees will not be recruited into the stands in a timely way. However, entertaining such a program could have negative impacts on mule deer populations, since harvested stands will have lower habitat value for some period of years after disturbance.

This report documents a project undertaken to create models of "commercial thinning" in two different stands located in two IDF subzones at the Knife Creek Block of the UBC/Alex Fraser Research Forest. The project was conceived by members of the Mule Deer Winter Range Committee, to address issues necessary to the successful implementation of commercial thinning on mule deer winter range.

Selected Stands

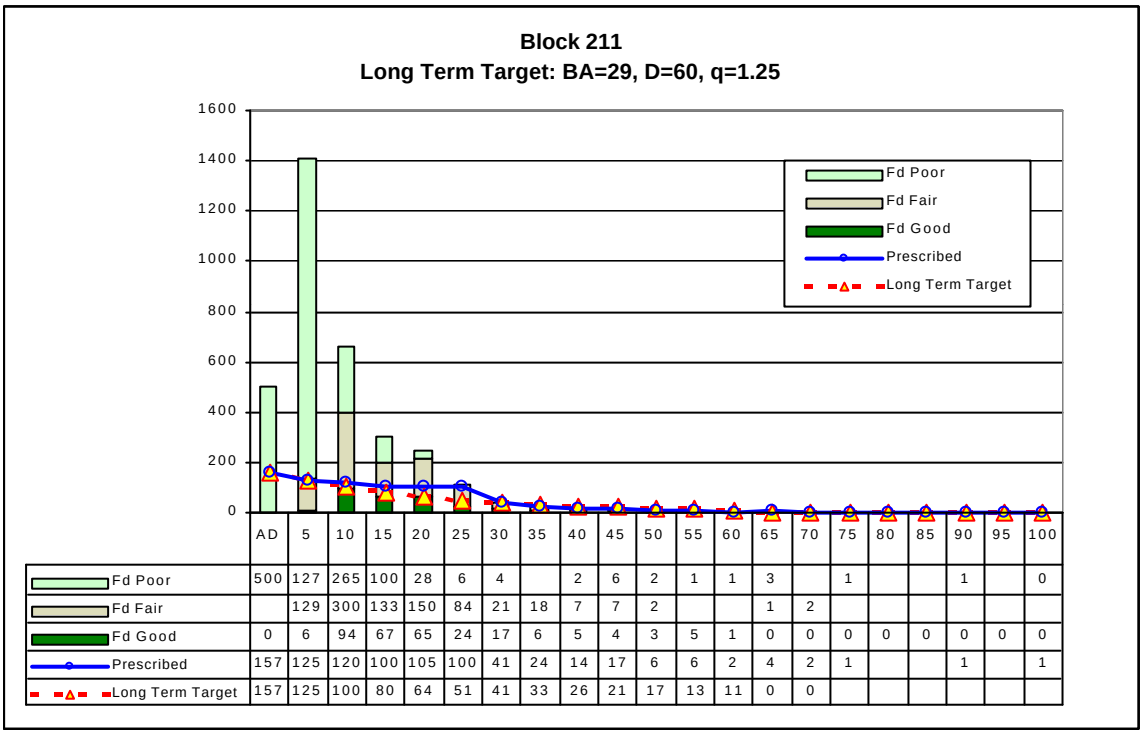
Block 211

Block 211 is located at the junction of the Big Meadow Road and the Jones Creek Road, in the xeric mild interior Douglas-fir subzone (IDFxm). It is a stand that has not been disturbed by any harvesting, and probably had its last fire between 90 and 100 years ago. The average stand diameter[2] is 18 cm and, on average the stand is carrying 39.7 m^2/ha of

[1] BDq management refers to the selection method, where stand structure is described by the residual basal area (B), maximum diameter (D), and quotient (q) of number of stems in one diameter class to the number in the next larger class.

[2] Quadratic Mean Diameter – the diameter of the tree of average basal area.
QMD = SQRT(Basal area/ha÷stems/ha÷π) x 2 x100

basal area, on trees 7.5 cm DBH and greater. The average total volume of the stand is estimated to be 169 m^3/ha for trees 17.5 cm DBH and greater. As shown in the stand table (**Figure 1**) this stand is extremely overstocked in DBH classes from 5 cm to 20 cm, and understocked in larger trees. Based upon research from the US (Larsson *et al*. 1983, Dolph *et al*. 1995) and current knowledge of Douglas-fir bark beetles (Humphreys 1995), we speculate that without disturbance, this stand is unlikely to replace large trees in a timely way when they eventually succumb to bark beetles. It is also suspected that this stand is susceptible to spruce budworm, which has been observed in the general area (Leo Rankin, personal communications, 2000).



AD	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Fd Poor	500	127	265	100	28	6	4		2	6	2	1	1	3		1			1		0
Fd Fair		129	300	133	150	84	21	18	7	7	2			1	2						
Fd Good	0	6	94	67	65	24	17	6	5	4	3	5	1	0	0	0	0	0	0	0	0
Prescribed	157	125	120	100	105	100	41	24	14	17	6	6	2	4	2	1			1		1
Long Term Target	157	125	100	80	64	51	41	33	26	21	17	13	11	0	0						

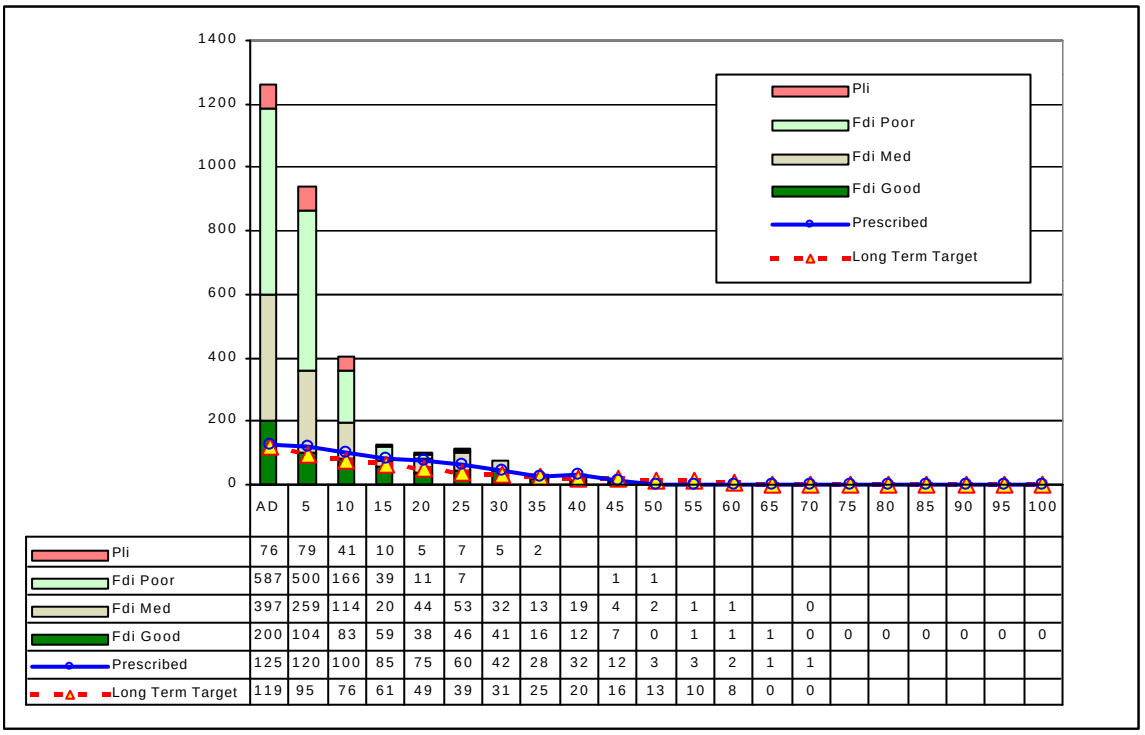
Figure 1: Stand table graph of Block 211, showing high overstocking in small diameter classes, and lack of stocking in large diameter classes. High densities in small DBH classes, causes poor or fair quality in those layers.

Block 212

Block 212 is located on the West Road, near the junction with the Big Meadow Road, in the dry cool interior Douglas-fir subzone (IDFdk3). It is a stand that was disturbed by harvesting in the late 1950's or early 1960's for which no historical information is available. Judging by the appearance of the stand, the area was cut according to a diameter limit, leaving smaller trees standing. The harvest was relatively patchy, yielding a mosaic of 30-40 year old trees and uneven-aged residual trees of relatively poor quality and small size. Since lodgepole pine was not merchantable at the time of harvest, it is present in the stand as a

mature component left at harvest time, and as a young component that regenerated after the harvest disturbance.

The average stand diameter is 21 cm and on average the stand is carrying 30.6 m^2/ha of basal area on trees 7.5 cm DBH and greater. The average gross total volume of the stand is estimated to be 158 m^3/ha for trees 17.5 cm DBH and greater. As shown in the stand table (**Figure 2**) this stand is also overstocked in trees from 5 cm to 30 cm DBH classes, and understocked with larger trees. Without disturbance, regeneration that was established after the last harvest will continue to grow, but the matrix of residual stems will not grow as quickly. As with block 211, we expect losses from spruce budworm, and barkbeetles and slow recruitment of larger trees in the stand.



	AD	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Pli	76	79	41	10	5	7	5	2													
Fdi Poor	587	500	166	39	11	7				1	1										
Fdi Med	397	259	114	20	44	53	32	13	19	4	2	1	1		0						
Fdi Good	200	104	83	59	38	46	41	16	12	7	0	1	1	1	0	0	0	0	0	0	0
Prescribed	125	120	100	85	75	60	42	28	32	12	3	3	2	1	1						
Long Term Target	119	95	76	61	49	39	31	25	20	16	13	10	8	0	0						

Figure 2: Stand table graph of Block 212, showing overstocking in small diameter classes, and lack of stocking in large diameter classes. High densities in small DBH classes, causes poor or fair quality in those layers.

Cruising

At present, cruising on crown land in B.C. is primarily focussed on valuation of the timber to be cut and estimation of the cost of harvesting operations. Typically cruising only measures six to ten trees per plot by point sampling. Plots are located and compiled on the

basis of forest cover types. In order for a cruise to provide the information required to assess stand structure, more trees should be sampled, and the sample should include trees from all diameter classes. The cruise should be compiled by standards unit rather than timber types.

Issue:	**Problem Statement:**	**Solutions and Rationale:**
Cruising Methods	• Standard Cruising for appraisal purposes does not adequately describe the stand for the purposes of developing an uneven-aged prescription • Sample size (number of trees) is too small • Small diameter classes are generally not sampled. • Cruise intensity doesn't sufficiently sample the spatial variability. •	• Increased cruising requirement costs could be offset if appraisals were not required and stumpage was fixed for commercial thinning. • Cruise entire diameter distribution by 5 cm classes. • Include all diameter classes by using nested plots and combining prism and fixed area sampling. • Note the vigour and quality of each tree. • Compile stand tables by standards units. • Cruising should include classification of tree vigour and quality (Good-Fair-Poor).

Cruising Specifications:

To accurately describe stand structure, a combination of prism plots and fixed radius plots were used.

- P1 – Prism Plots, BAF=5

Collecting data by vigour class (**Table 3**) for all the trees with 12.5 cm DBH and greater.

- P2 - Fixed Radius Plot, R= 5.64 m (100 square meters)

Collecting data by vigour class (see **Table 3**) for trees taller than 1.3 m in height and smaller than 12.5 cm DBH
(the centre of plot P2 will be the same as for the plot P1)

AD (advanced reg.): trees with height > 1.3 m and DBH < 2.5 cm
DBH class 5: trees with DBH between 2.5 cm and 7.4 cm
DBH class 10: trees with DBH between 7.5 cm and 12.4 cm
And so on….

Cruise results were entered into a spreadsheet application, which compares the existing stand table to the target stand condition, and allows analysis of prescriptions. This

spreadsheet application (Uneven95, written by John Przeczek, RPF[3]) is quite sophisticated. A simpler spreadsheet can be used to examine stand structure, and help to set the marking guide for the stand.

Issue:	Problem Statement:	Solutions and Rationale:
Spatially variable stands	• Cruising investigates the structure and volume of stand. In the dry-belt, these stands may be very heterogeneous, but at a scale that cannot be reflected in the design of standards units. Providing an average stand table may not be very relevant to any of the various "types" sampled in the stand, and in fact the average condition may not exist anywhere in the unit.	• This requires careful consideration when instructing the markers/fallers and when communicating results to others. • Consider development of inventory methods to describe the spatial variability better. One method worth considering is the Step Point Transect approach, whereby the surveyor tallies the conditions encountered at each of a hundred or more points. The results are expressed in percentages, and help to guide decision rules.

Silviculture Prescription Rationale

Silviculture Prescriptions for blocks 211 and 212 are included at Appendix 1. Detailed rationales for the prescriptions follow in this section. These prescriptions are intended to be models only, and should not be used as a template. The intent is to demonstrate the contents of a commercial thinning prescription for the IDF, complete with sufficient rationale so that the reader may understand the changes that might be required to render the prescription for another site in similar conditions.

Setting Prescribed Stand Structure

Developing the prescription for the structure of the stand immediately after cutting is a matter of balancing the current stand deficits and surpluses in stems per hectare. The logic in setting the prescribed stand structure follows:

- Since we are embarking on commercial thinning in these stands, it is logical to expect that there will be a lack of large stems. For that reason, stems 37.5 cm DBH and larger are reserved from cutting.
- Because there is a very high density of small stems, cutting will concentrate in the diameter classes from 0 to 25 cm.

[3] Interior Reforestation Co. Ltd., Cranbrook, B.C.

- Juvenile spacing will be an important part of the treatment to reduce the density of small trees and remove any stems damaged during the thinning operation.
- The vigour and quality of small trees is generally poorer than larger trees. It is therefore important to retain a reserve of the largest trees available in surplus.

In order to balance current habitat condition with future habitat and timber value, a target of 75% residual basal area has been established for this treatment.[4] This target may result in residual density lower than residual basal area targets for the high, medium or low habitat classes (Dawson and Armleder 1999). This can be approached as a matter of estimating the cumulative surplus or deficits in stems by diameter class, and employing the target stand q-factor to equate trees in different diameter classes. Table 1 following shows how the prescribed residual stand for block 211 is calculated, by using surplus stems > 60 cm DBH and surplus stems <30 cm DBH to fill in the deficit in stems between 30 and 60 cm DBH. Note that, employing this technique, the deficit in number of stems was nearly balanced in the 25 cm class. The surplus trees in the 15 and 20 cm class are retained to meet the basal area target of 75% of the initial stand density.

Table 1: Developing the prescribed residual stand requires balancing cumulative surplus and deficit in density.

Knife Creek Block
Cutblock 211 **Commercial Thinning**

DBH class	Present Stand		Target		Prescribed Leave		Cumulative Surplus
	trees	BA	trees	BA	trees	BA	stems/ha
AR	500		157		157		149.70
5	1407		125	0.25	125	0.25	119.76
10	659	5.18	100	0.79	120	0.94	95.81
15	300	5.30	80	1.41	100	1.77	60.65
20	243	7.64	64	2.01	105	3.30	32.52
25	114	5.60	51	2.50	100	4.91	-6.79
30	41	2.93	41	2.90	41	2.90	-44.63
35	24	2.35	33	3.17	24	2.31	-35.70
40	14	1.77	26	3.27	14	1.76	-21.36
45	17	2.65	21	3.34	17	2.70	-7.49
50	6	1.18	17	3.34	6	1.18	-2.79
55	6	1.47	13	3.09	6	1.43	6.57
60	2	0.58	11	3.11	2	0.57	10.85
65	4	1.17		0.00	4	1.17	15.88
70	2	0.59		0.00	2	0.59	9.51
75	1	0.30		0.00	1	0.30	6.00
80	0	0.00		0.00		0.00	4.00
85	0	0.00		0.00		0.00	3.20
90	1	0.60		0.00	1	0.60	2.56
95	0	0.00		0.00		0.00	1.25
100	0	0.30		0.00	1	0.30	1.00
TOTAL	775	34.43	357	28.14	429	25.77	

Stems/ha balanced

Draft Williams Lake – Chimney Mule Deer Winter Range Management Plan. Under review.

This prescribed residual stand balances deficit in the 30-60 cm DBH range with surplus in trees > 60 cm and <30 cm DBH. Balance in numbers is achieved in the 25 cm DBH class. Surplus trees in the 20 cm DBH class are retained to achieve the residual density goal.

This approach of balancing deficits maximises post harvest habitat quality and also growth response to the harvesting by retaining a surplus of density in the largest diameter classes available. If the 25 cm class were cut more heavily, and greater density were retained in the 20 and 15 cm classes, the growth response of the residual stand would be lower. Such an approach would reduce both habitat recovery and timber production, and would have a more negative impact on the post-harvest habitat quality.

Block 211

Current Situation

This stand is currently overstocked in relation to target basal area, with a basal area of 34.4 m^2/ha in stems 12.5 cm DBH class and greater. If stems smaller than 12.5 cm DBH are considered, the stand has nearly 40 m^2/ha of basal area. This stocking is distributed on stems/ha in the following manner:

- A scattered distribution of stems greater than 27.5 cm DBH with approximately 3.5% of the total stems, or 15% of stems greater than 12.5 cm DBH occurring in this range.
- More than 30% of total stand basal area occurs with very densely stocked stems in the 2.5 to 17.5 cm diameter range (average close to 3000 stems/ha).

The concentration of basal area in the smaller diameter classes of this stand is reflected in the general vigour of the stand, which is dominated by poor to fair vigour classes right up to 50 cm DBH. The size, density and general health of the live tree crown generally define vigour. Generally, crown indicators are correlated with growth indicators such as length of the last ten-year increment, and height to diameter ratio. Trees of poor vigour cannot be relied upon to respond to harvesting and a more open canopy, growing into subsequent diameter classes in an orderly fashion. Fair vigour trees will likely respond slowly over a given time period and good trees will likely respond immediately to any opening, which increases available moisture since their photosynthetic capacity is already high.

Gingrich stocking charts are simple tools that describe density of a stand both in stems per hectare and basal area, allowing a manager to picture how many trees the basal area is distributed on. The Gingrich stocking chart for Knife Creek (Day 1998b) (**Figure 3**) indicates that this stand is well beyond the upper limit of stocking in its current untreated condition.

Mule Deer Winter Range Habitat:

Large old Douglas-fir is a prominent component of winter range in the Cariboo Forest Region because of their ability to intercept snow with their wide deep crowns. A clumpy arrangement of these large trees further increases their ability to intercept snow, and

improves litter fall forage production. With a high percentage of the stocking in this stand in small diameter classes, it is currently not optimal for deer winter range requirements, although the smaller diameter classes are important for thermal (wind) and visual cover.

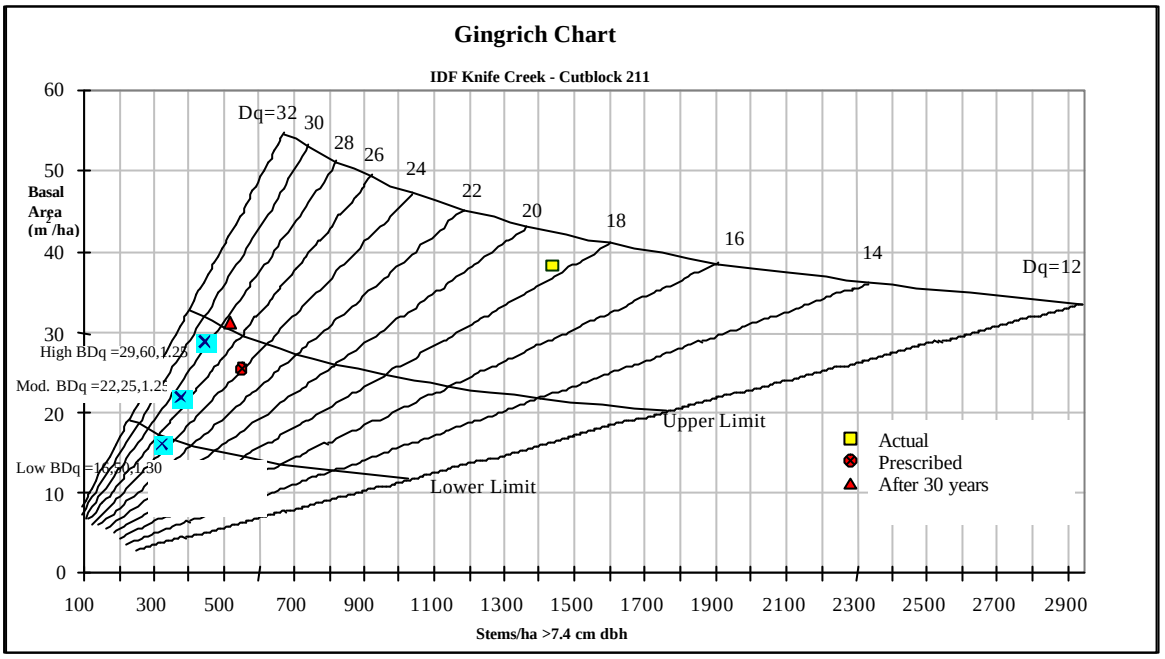


Figure 3: Cutblock 211-Gingrich Stocking Chart for depicting current, prescribed (after harvesting) and projected (30 years after cutting) stand density for the average stand conditions.

Volume Growth

The upper stocking limit generally defines the onset of competition-induced mortality. Since mortality in such overstocked Douglas-fir stands is slow to occur, stands found well over the upper stocking limit are characterised by a general non-vigorous condition with stagnated growth. Because much of the competition is for moisture, reduced growth usually occurs in trees of all sizes to a certain degree.

The low vigour and growth in this stand has two key implications for management. Firstly, without density control in the small to mid-sized diameter classes future volume production (mean annual increment or m.a.i.) will be constrained and significantly lower that the potential. Secondly, the ability of the stand to grow to produce a sustainable supply of merchantable timber volume and large trees for mule deer habitat is severely constrained.

Bark Beetles

High densities of small trees can increase competition for moisture with larger trees to the point that the resulting drought stress lowers resistance to bark beetles. Beetles may increasingly attack the larger trees, further reducing the stand's value for winter range habitat.

Spruce Budworm

Although it is not currently present in the area, the spruce budworm may be gradually moving toward the Knife Creek area from the South. A budworm epidemic in this stand would cause excessive mortality in the lower to middle diameter classes, potentially resulting in an understocked stand with limited growing stock capable of moving into larger diameter classes. Excessive mortality could dramatically increase dry fuel loading in these stands (see the next point).

Fire

Currently this stand is much denser than it was in the distant past. With its multiple layers and resulting ladder-fuels, this stand is highly susceptible to a stand replacing fire, which would eliminate mule deer habitat and threaten local properties. Such stands would be difficult to replace silviculturally after an intensive fire and therefore such an event could significantly impact volume production and the contribution to the allowable cut in the area.

Block 211 - Treatment Description

Objective

To improve timber volume production and enhance growth of larger trees to improve mule deer winter range habitat.

Target Stand Structure

- Long Term Target-29 m^2/ha residual basal area (B), Post Harvest-26.6m^2/ha residual basal area (75% of current stand basal area)
- 60 cm maximum diameter (D)
- 1.25 as a diameter diminution quotient (q)

Commercial Thinning Cutting Specifications:

This treatment will remove trees of poor to fair vigour in the 15 to 30 cm DBH classes throughout the stand. The prescribed stand will retain 75% of the current stand basal area, and will not be constrained to 29 m^2/ha. Care will be taken to maintain or create a clumpy structure in the stand. The best-formed and most vigorous trees will dictate clump location.

Harvesting will target poor and fair trees following this rule:

- DBH class 15 cut 1/3
- DBH class 20 cut 1/2
- DBH class 25 cut 1/9

Trees in DBH classes larger than 25 cm will not be cut.

Juvenile Spacing Specifications:

A clumpy structure has to be shaped in the stand at this entry, even in low diameter trees. Clumps will be comprised of the best-formed and most vigorous trees. The diameter class of the clump after spacing will be the diameter of the best-formed and most vigorous trees in the clump before spacing. Shorter poorly formed trees and trees of low vigour will be removed.

Spacing of trees **0 - 7.5 cm DBH** shall be as follows:

- Trees within a clump shall be spaced to an optimum distance of 2.7 m with an allowable variation from 1.5 metres to 3.2 metres. This will yield an average of 1000 trees/hectare, but will allow the selection of trees with the best form and vigour.
- Trees located on the outside of individual clumps may be closer than the optimum inter-tree distance as they have more room to grow. Trees located in the interior portion of the clump must be spaced close to the ideal inter-tree distance to allow for enough growing space.
- Inter clump distance may vary with the size of the dominant trees in the clump.

Spacing of trees **7.6 - 12.5 cm DBH** shall be as follows:

- Where two clumps meet, the clump of smaller trees will be spaced away from the larger clump at the inter-tree distance and latitude applying to the smaller trees.
- Deciduous trees in layer 1 (>12.5 cm DBH) must be felled if the conifer trees are suffering crown competition with the deciduous tree, but will otherwise be left uncut. Crown competition is defined as occurring when the top of the conifer is experiencing mechanical damage from the branches of the deciduous tree. All other deciduous shall be left uncut unless within the prescribed inter-tree distance of a conifer.
- Up to 12 mature aspen, cottonwood or birch will be left uncut on each hectare, even if they compete with crop trees. These trees will not be marked but shall be left by the stand-tending worker. A mature tree is defined as >12.5 cm DBH.

Benefits:

- Moderate snow interception cover will be maintained over the short term, with significantly improved habitat over much of the 30-year cutting cycle.
- Feasible harvests of small sawlogs and pulpwood will be realised today.
- Volume growth (m.a.i.) and merchantable size classes of timber will be significantly improved over the 30-year cutting cycle.

- Improvement in overall stand vigour will reduce the risk of catastrophic mortality in this stand from forest health factors.
- The resulting open stand with less ladder fuels will reduce the risk of catastrophic fire.
- Volume and basal area removal is concentrated in the 17.5 to 27.5 cm DBH classes for sawlogs and the 12.5 to 17.5 cm class for pulpwood (at 24 m^3/ha gross volume - depending on pulpwood markets).

After Thinning and spacing, the stand will have 544 residual stems/ha and 26.6 m^2/ha residual basal area over 7.5 cm DBH, indicating that stocking is comfortably between the upper and lower limits on the Knife Creek Gingrich stocking chart. When this residual stand structure is projected for 30 years to 2030, using the Knife Creek Stand Table Projection Model (Day 1998a), stocking will surpass the upper stocking limits. Such stocking should retain good vigour on most stems in the stand over this period, with higher growth rates evident for a significant portion of the cutting cycle. The improved vigour of trees in all diameter classes will allow stems to progressively move through the diameter classes over time in a predictable fashion according to the principles of uneven-aged management.

Block 212

Current Situation

This stand is currently overstocked in small diameter classes. If stems smaller than 12.5 DBH are considered, the stand has more than 30 m^2/ha of basal area. This stocking is distributed on stems/ha in the following manner:

- A highly clumped distribution of stems greater than 12.5 cm DBH with approximately 16% of the total stems, and 90% of the basal area occurring in this range.
- Within the clumps of timber, >12.5 cm DBH, 89% of the stems and 70% of the basal area are between 12.5 cm and 37.5 cm DBH. Also 11% of the stems and 30% of the basal area are in diameters between 37.5 and 72.5 cm.
- A high density of stems exist in openings (formerly skid trails) between the more mature clumps. Most of these juvenile stems range from less than 1.3 m in height up to 7.5 cm DBH, with some scattered trees between 7.5 and 12.5 cm DBH. While the average density of these stems is between 2500 to 3000 stem/ha, actual densities within the openings likely range from 3000 to 7000 stems/ha.

The clumpy nature of this stand reflects a significant number of openings created in the last entry. The prevalence of these openings, now filled with small trees and regeneration, precludes extremely high basal area stocking in the whole stand at this time. However, the current basal area is high enough that the stand is considered overstocked with lower than optimum vigour and growth. The Knife Creek Gingrich stocking chart (Day 1998b) that shows this stand above the upper limit of stocking reflects this situation (**Figure 4**). Gingrich stocking charts are simple tools that describe density of a stand both in stems per hectare and basal area, allowing a manager to picture how many trees the basal area is distributed on. It describes the stocking limits as starting points in a gradient rather than as hard limits.

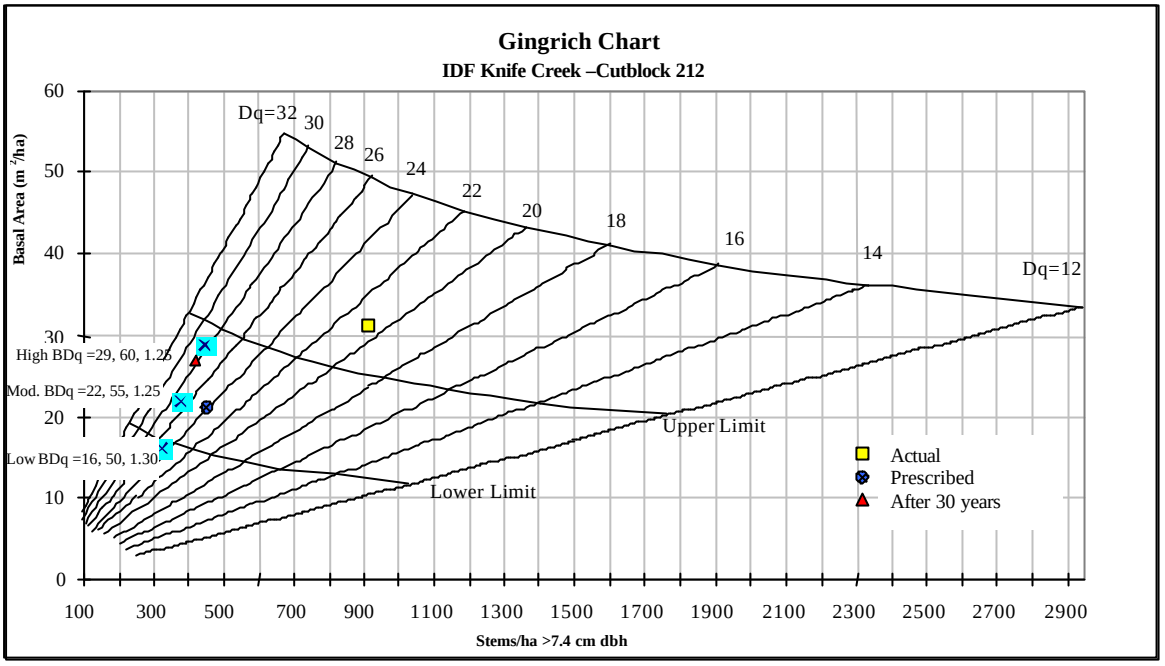


Figure 4: Cutblock 212-Gingrich Stocking Chart for depicting current, prescribed (after harvesting) and projected (30 years after cutting) stand density for the average stand conditions.

Implications:

Mule Deer Winter Range Habitat:

Large old Douglas-fir trees are a prominent component of winter range in the Cariboo Forest Region because of their ability to intercept snow with their wide deep crowns. A clumpy arrangement of these large trees, such as that found in the existing stand, further increases their ability to intercept snow, to produce more foliage than individual trees and to improve litter fall forage. Clumps of smaller diameter classes are also important for thermal (wind) and visual cover. The objective here, for any form of cutting, will be to maintain or create this clumpy structure while reducing competition.

Volume Growth:

The upper stocking limit generally estimates the onset of competition-induced mortality. Since mortality in overstocked Douglas-fir stands is slow to occur, stands found well over the upper stocking limit are characterised by a general non-vigorous condition with stagnated growth. Because much of the competition is for moisture, trees of all sizes are usually influenced with growth reductions to a certain degree. This situation can be found in some portions of this stand, which has quite a variable structure as a result of the last harvesting entry.

The lower vigour and growth in this stand has two key implications for management. Firstly, without thinning in the merchantable clumps of timber, future volume production (mean annual increment or m.a.i.) will be constrained and significantly lower that the

potential. Secondly, without juvenile spacing in the regeneration and small trees found in the openings, the ability of the stand to grow to produce a sustainable supply of merchantable timber volume over time is constrained. Also, the ability of the stand to produce large trees for mule deer habitat could be constrained over time, especially if competition-induced mortality occurs in the larger stems.

Bark Beetles

High stocking of small trees can increase competition for moisture with larger trees to a point where the resulting drought stress lowers tree resistance to bark beetles. Increased beetle-caused mortality in larger trees will further reduce the stand's value for winter range habitat.

Spruce Budworm

Although it is not currently present at Knife Creek, the spruce budworm may be gradually moving toward this area from the South. A budworm epidemic in this stand would cause excessive mortality in the lower to middle diameter classes, potentially resulting in an understocked stand with limited growing stock capable of moving into larger diameter classes. The excessive mortality could also dramatically increase dry fuel loading in these stands (See the next point).

Fire

Currently this stand is much denser than it was in the distant past. As it develops without treatment the resulting ladder-fuels makes this stand highly susceptible to a stand replacing fire, which would eliminate mule deer habitat and threaten local properties. Such stands would be difficult to replace silviculturally after an intensive fire and therefore such an event could significantly impact volume production and the contribution to the allowable cut in the area.

Block 212 Prescribed Treatment

Objective:

To improve timber volume production while not exceeding the minimum crown closure target for mule deer winter range.

Target Stand Structure

- Long Term Target-22 m^2/ha residual basal area (B), Post Harvest-20.5m^2/ha residual basal area (75% of current stand basal area)
- 60 cm maximum diameter (D)
- 1.25 as a diameter diminution quotient (q)

Commercial Thinning Cutting Specifications:

This treatment will remove trees of poor to fair vigour in the 15 to 35 cm DBH classes throughout the stand. The prescribed stand will retain 20.5 m^2/ha, (75% of the current stand basal area), close to long term target of 22 m^2/ha. Care will be taken to maintain or create a clumpy structure in the stand. The best-formed and most vigorous trees will dictate clump location.

Harvesting will target poor and fair trees following these rules:

- DBH class 15 cut 1/3
- DBH class 20 cut 1/4
- DBH class 25 cut 1/2
- DBH class 30 cut 1/2
- DBH class 35 cut 1/15

Trees in DBH classes larger than 35 cm will not be cut.

Juvenile Spacing Specifications:

The same as for Cutblock 211 (page 10).

Benefits:

- Moderate snow interception cover will be maintained over the short term, with significantly improved habitat over much of the 30 year cutting cycle.
- Feasible harvests of small sawlogs and pulpwood will be realised today.
- Volume growth (m.a.i.) and merchantable size classes of timber will be significantly improved over the 30-year cutting cycle.
- Improvement in overall stand vigour will reduce the risk of catastrophic mortality in this stand from forest health factors.
- The resulting open stand with less ladder fuels will reduce the risk of catastrophic fire.

Volume and basal area removal is concentrated in the 17.5 to 32.5 cm DBH classes for sawlogs and the 12.5 to 17.5 cm class for pulpwood (at 33 m^3/ha gross volume - depending on pulpwood markets).

After Thinning and spacing the stand will have 433 residual stems/ha and 21.3 m^2/ha residual basal area over 7.5 cm DBH, indicating a stocking comfortably between the upper and lower limits on the Knife Creek Gingrich stocking chart. When this residual stand structure is projected for 30 years to 2030 using the Knife Creek Stand Table Projection Model (Day, 1998a), Gingrich stocking remains within the upper and lower stocking limits.

Such a stocking should retain good vigour on most stems in the stand over this period, with higher growth rates evident for a portion of the cutting cycle. The improved vigour of trees in all diameter classes will allow stems to progressively move through the diameter classes over time in a predictable and orderly fashion according to the principles of uneven-aged management.

Recommendations for Implementation

Layout

Designing boundaries, skid trails, and landing locations is a critical component of successful logging, particularly in partial-cutting prescriptions. Boundaries must be located so that timber is not isolated. Landings, roads and skid trails are permanent features in selection management, so they must be placed to minimise environmental impact and future maintenance requirements. Access must occupy as little ground as possible, since it is a permanent withdrawal from the productive landbase.

Uneven-aged management requires repeated entry into each stand. A permanent network of trails will therefore be developed in each cut block. Soils of the Knife Creek block are typically fine textured (Silt Loam to Silt Clay) and have high or very high hazard for soil compaction. Further, the soils have shallow forest floors, and are therefore sensitive to forest floor displacement. Site degradation by compaction is therefore expected if logging plans do not recognise the sensitive nature of the soil. Harvesting can be planned in such a way as to reduce the negative impact of trail development on productivity:

- Designate trails. Laying out and marking trails for logging contractors significantly reduces trail density (Nyland 1996).
- Minimise trail density. Current harvesting methods and practises require inter-trail spacing of not more than 40 m. As local contractors become more familiar with this prescription, and as logging equipment continues to develop, trail density can be reduced.
- Minimise trail width. Ensure loggers stay on one track, keep the trails as straight as possible, and employ skidding equipment that is as narrow as is practical.
- Protect the soil. Harvesting in winter when the soil is frozen greatly reduces compaction and displacement. Similarly, using slash from limbing and topping to provide a carpet for machinery on trails also protects the soils.

Trail layout also has a significant impact on damage to residual trees. Any time logs being skidded must be turned, they rub or bump against residual stems and cause wounds. Trail junctions must meet at a narrow angle, preferably less than 35° (Przeczek 1995). More than one trail should not join the main trail at a common junction, since such junctions create large voids in the stand. Trails should not curve except over very long distances, since trees on the inside of curves will always be rubbed.

Selecting Trees for Cutting

Selecting the trees to cut is the critical part of translating the stand prescription into the actual result on the ground. The choice of which trees to cut and which are to remain is based on the quality, density and spatial arrangement of the current stand of trees and on the specific objectives for the objectives for the residual stand. Selection of trees to cut and trees to leave is based on three criteria applied simultaneously:

- quantitative guidance - this guides the decisions on the density to be maintained after harvest;
- qualitative selection guides - this summarises the priority for maintaining residual trees based on tree quality and vigour and as well as two factors specifically related to mule deer habitat - clumpiness and microhabitat; and
- clumpiness recommendations.

The first criteria tells how many trees to leave, the second tells which type of trees should be left, and the third describes the spatial arrangement for the leave trees. Either the faller can do this selection process at the time of harvest or markers can mark trees prior to harvest. Both approaches are discussed in this section.

Quantitative Guidance

Decisions on how many trees to leave in a given area are based on the average basal area to be retained after the thinning operation is completed. The target for this average residual basal area will be specified in the Silviculture Prescription. The residual stand will contain stocking voids, skids trails and other areas that currently have less than the target basal area. Therefore, parts of the stand will have to be maintained above the target density to meet the desired average basal area. Since prism sweeps are not taken randomly (the marker or faller will not perform a sweep where there are not enough trees to allow cutting), the target density at each sweep must be adjusted upwards. This is best accomplished by increasing the basal area target for making cut/leave decisions, to compensate for the voids and planned skid trail network. Depending upon the particular stand conditions, allowing 10-20% on each prism sweep should allow for voids and provide for damaged trees to be cut in a final cleanup pass.

Quantitative guidance can also include a reserve on certain tree sizes or types. In the case of commercial thinning on mule deer winter ranges, the prescription calls for leaving all Douglas-fir stems >37.5 cm DBH. A small component of these trees may need to be harvested for skid trail development, but skid trails should be designed, where possible, to minimise harvest of these non-target stems. Large stumps on skid trails are problematical, since they are generally tall and skidding equipment travels beside them anyway.

Quantitative guidance should be applied in the field using a prism or other suitable angle gauge. Prisms (3-5 BAF) are recommended.

Qualitative Guidance -- Selection Guides and Tree Classification

Selection guides provide tree classification systems that use qualitative decisions (Anderson and Rice 1993), and quantitative methods to guide and assist with tree selection decisions (Marquis 1976, Guldin 1991). Tree classification interprets management objectives, the silvics of the species, and the ecology of the site. A tree classification for Knife Creek is shown below in Table 2. Trees in higher classification should be retained in preference to trees in lower classifications.

Table 2: Tree classification for timber marking on mule deer winter range. Each tree considered for cutting or retention should be classified, and class A should be left in preference to class B. Class C trees should be cut unless retained for biodiversity considerations.

Class		**Species**	**Values**	**Future**
Habitat	**A1**	Douglas-fir.	Currently or potentially providing good cover and forage. Located on important topographic features.[5]	Poor to Good vigour and low risk[6].
	A2	Douglas-fir.	Currently providing good cover and forage. Crown forms component of a clump of 3 or more trees.	Good vigour and low risk.
	A3	Douglas-fir.	Potentially providing good cover and forage. Has potential to join crowns with adjacent trees to form a clump.	Good vigour and low risk.
	A4	Douglas-fir.	Currently providing cover and forage. Crown is still a component of a clump, but may be small or leaning away from the main clump.	Poor vigour and low risk.
Timber	**B1**	Any species (including Douglas-fir).	Neither currently nor potentially providing good cover and forage but with good timber potential.	Good vigour and low risk.
	B2	Any species (including Douglas-fir).	Neither currently nor potentially providing good cover and forage but with good timber potential.	Poor vigour and low risk.
Risk	**C**	Any species (including Douglas-fir).		Poor vigour and high risk.

Tree vigour and diameter are used as a surrogate for tree age when selecting for cutting. Classification of trees by their vigour is relatively simple, given some experience. Qualitative criteria for identifying vigorous Douglas-fir have been modified slightly from Schmidt *et al*. (1976), to localise the system to Knife Creek (Table 3).

[5] Ridges, terrain breaks, south or west facing slopes have high value to mule deer.

[6] Risk is defined as the likelihood of the tree dying before the next entry (30 years from present).

Table 3: Vigour classification by qualitative descriptions for interior Douglas-fir (after Schmidt *et al.* 1976).

Characteristic	Good Vigour	Fair Vigour	Poor Vigour
Crown Class	Dominant or Codominant.	Codominant or Intermediate.	Intermediate or Suppressed.
Live Crown Ratio	> 40%	20 - 40%	< 20%
Crown Shape	Pointed to rounded.	Rounded to flat.	Flat or spike-topped.
Crown and Foliage	Dead branches rare. Foliage moderately dense or better.	Occasional dead branches. Foliage moderately dense.	Dead branches frequent. Foliage thinning to sparse.
Bark	Dark bark plates at base are broad with well exposed new bark between. Upper bole -- ¼ or more of tree height light grey and smooth.	Less exposed new bark between plates. Upper bole -- less than ¼ of tree height light grey and smooth.	No new bark exposed between plates. Upper bole -- dark grey rough bark for entire stem.
Insects or Disease	Free of damage.	Light damage.	Mod. to heavy damage.

Clumpiness Recommendations

A clumpy arrangement of large Douglas-fir trees is important to mule deer, since the interlocking crowns of adjacent trees in a clump are more effective at intercepting snow (Armleder *et al.* 1986) and providing forage from litterfall (Waterhouse *et al.* 1991). This approach to harvesting ensures that density is within the target range of basal area, but the stand is comprised of clumps and gaps. In practise, this means that inter-tree spacing will be highly variable, allowing for the retention of the best-formed and most vigorous trees as a primary objective. For a further discussion of creating clumpy stand structure, refer to Armleder (1999).

Clumps are described as groups of trees with approximately equal height. The diameter class of the clump is the diameter class of the best-formed and most vigorous trees. When a clump has been identified, it should be thinned from below to remove the poorly formed and low-vigour stems, leaving the trees at the spacing indicated in Table 4 in each clump. The wide latitude in inter-tree distance promotes a clumpy structure and allows the retention of the best trees.

The residual basal area target, as discussed on page 16, should control the density of the stand. The inter-tree distances indicated in Table 4 should help to guide the arrangement of leave trees in a clumpy fashion.

Table 4: Recommended inter-tree distances for each diameter class within the range of classes considered for commercial thinning. The wide range allows a faller to leave trees very close together, or up to 1.5 times the average inter-tree distance, to permit selection of the best trees and creation of clumpy structure.

DBH (cm)	Inter-tree Distance (m)	
	Average	Range
5	2.84	1.0 - 4.26
10	3.18	1.0 – 4.77
15	3.55	1.0 – 5.33
20	3.97	1.0 – 5.95
25	4.44	1.0 – 6.66
30	4.96	0.5 – 7.44
35	5.55	0.5 - 8.33

Decision-Making

Presently in the Cariboo Forest Region most selection management is carried out by faller's selection, whereby fallers determine which trees to cut under the guidance of the Silviculture Prescription. This approach is economically attractive, and generally provides results satisfactory to licensees and the Ministry of Forests. However, very few other jurisdictions use faller's selection.

It is the authors' opinion that a trained marking crew will generally provide better results than faller's selection, in terms of the residual stand. Logging contractors operate in a competitive environment, which dictates that they find the most efficient way to complete the task at hand. In selection management the issues of tree selection and protection of the residual stand are very important silviculturally, but are costly in terms of a logging operation. The logger's interests will frequently be at odds with the prescription (Day 1998).

However, in the case of commercial thinning where the timber quality is poor, trees are small, and density is high, the effectiveness of tree marking is open to debate. The two blocks described in this report will have a portion of their area marked to leave, and the remainder cut by faller's selection.

Issue:	Problem Statement:	Solutions and Rationale:
Faller's selection versus marking	• Marking may add \$1-2 /m^3, depending on harvested volume. • Faller's selection harvesting may substantially increase in cost compared to current experience. • Difficulty finding experienced staff to do the marking, or contractors to do the right harvesting under faller's selection.	• Marking the stand by specialised staff can increase the quality of operations; usually the marker takes a silvicultural approach to marking. • A critical comparison of the cost of each strategy is necessary, to allow evaluation of the two options.

Regardless of whether the decisions are made by the faller or by a marking crew, they will require a brief set of decision rules that covers each condition encountered in the stand. **Table 5** (following) shows the decision rules for Block 211 and 212, as an example of how the cutting might be implemented. These rules should be expressed clearly and simply.

Table 5: Decision rules for Blocks 211 and 212. Ratios of leave to total trees taken from stand table information, by comparing the prescribed stand (stems/ha) to present stand (stems/ha).

Block 211 – Specific Rules	General Rules
1) Leave 1 in 5 trees in the 10 cm class. 2) Leave 2 in 5 trees in the 15 and 20 cm classes. 3) Cut only risk trees (class C) in the 25-35 cm classes.	• Leave all Douglas-fir 40 cm class and larger. • Leave all class A1 trees. • Leave Douglas-fir, and cut other species. • Leave trees whose crowns are a part of a clump, and cut isolated trees. • Thin from below, leaving the most vigorous and best formed trees. • Leave up to 10 deciduous and class C trees per hectare.
Block 212 – Specific Rules	
1) Leave 1 in 4 trees in the 10 cm class. 2) Leave 3 in 5 trees in the 15 to 30 cm classes. 3) Cut only risk trees (class C) in the 35 cm class.	

Faller's Selection

Fallers will select trees for cutting by:

- Employing the tree classification system to determine which trees should be cut and which should be retained.
- Thinning from below – cutting the poorest vigour and quality, and leaving the best.
- Leaving trees in clumps with interlocking crowns, and allowing gaps to develop.
- Using a prism (5 BAF or smaller) to ensure adequate density is retained, allowing for some damage to be cut on a final clean-up pass.
- Leaving all trees > 37.5 cm DBH

Tree Marking

The residual stand should not be comprised of "left-overs" (Fiedler 1995), so marking should focus on the residual trees. Ideally leave-trees should be marked. However, efficiency and cost dictate that marking should be conducted in whichever manner is fastest. Stands can be marked by mark-to-leave, mark-to-cut, or a combination of the two. A consistent marking and colour system is critical for clear direction to loggers and successful implementation. The following protocol has been adopted at the Research Forest:

- Cut -- Orange paint in a ring at breast height;
- Leave -- Blue paint on four spots evenly spaced around the tree at breast height.[7]

Trees should also be marked at the stump to allow assessment of the marking status after the tree has been cut. The stump mark should be a short vertical stripe on the downhill side, starting below stump-height and extending up above the level of the falling cut.

Rub trees should be designated at any place where trails turn, with the intention of removing them at the end of the logging program. The rub trees are simply marked as leave trees (blue paint) and then re-marked for removal after the skidding is finished.

Marking is challenging work, and should be conducted by well-qualified staff. Staff should be conversant with cruising and silviculture, and should be familiar with logging operations, particularly falling and skidding. A discussion of the necessary steps for marking a stand follows.

Lay out and flag permanent skid trails to access 100% of the block. Trails should be at, or slightly below, the density specified in the prescription, straight, and parallel. Trail junctions should be angled less than 35° to allow logs to turn without undue damage to the residual stand.

[7] Trees marked-to-leave should be marked as inconspicuously as possible, since the resulting stand would have every tree marked.

A marking tally[8] is useful to guide the marking toward the target stand structure. Frequently, however, a first harvest will concentrate on other issues such as species composition or health. In these cases, a marking tally is not very useful because the markers approach residual basal area before marking for structure can be considered. Instead, a post marking re-cruise is more efficient and a simply matter of returning to the cruise plots and noting the marking status of each tree in the plot.

Two or three markers should work together as a team to mark the space between each pair of trails. They assess each tree for vigour, form, quality, ability to withstand the post-harvest environment, contribution towards the target stand, and falling difficulty. Trees that need to be felled in a particular direction to avoid stand damage can be marked for directional falling. Such a tree is marked with a vertical arrow on the side to which the tree must be felled. Trees along the trails are assessed for probability of skidding damage, and rub trees are marked as necessary (particularly at trail junctions). Rub trees are marked as leave trees, with the intent that they will be cut on a final "clean-up" pass. Farrar (1996) recommends that 3-5% of the cut be allocated for marking damaged trees after logging is nearly complete (refer to page 23 for further discussion of damage to residual trees). Periodically the markers must pause to ensure that the target residual basal area is being met. This is generally done with a prism relascope (3 to 5 BAF metric). It is important to remember that the prism will tend to homogenise the stand and markers should allow significant latitude for clumpiness. Unstocked voids should be included in the residual basal area of the stand.

Logging

Logging Contractors

Selection of a logging contractor is the most critical decision (Province of BC 1997). Production should not be more than two or three truckloads (80 to 120 m^3) per day. Careful training of the contractor is important to ensure that the objectives and marking are understood. This approach to harvesting is sufficiently different from standard Faller's Selection logging and all members of the logging crew will require training. The critical concepts for each member of the crew are:

- Contractor -- willing attitude and low-production and high-quality orientation,
- Fallers -- ensure directional falling in lead to trail, protection of regeneration, recognition of damage, topping and limbing in the bush, bucking as necessary to overcome falling mistakes, stop falling in high wind, willingness to cut difficult trees;
- Skidder operators -- stay on trail, no backing over regeneration, no unauthorised trails, no bunching logs with the blade, pull cable to the trees, keep tires and blade off of trees, always winch in lead to the tree.

Research Forest staff have discussed the potential of implementing a system of quality-based payment for logging contractors, as has been adopted for other silvicultural

[8] Traditionally two markers are accompanied by a tally person, who notes the marking status, species and diameter class of each tree in the stand. This allows the markers to compare their progress towards the prescribed stand, and continuously adjust their marking.

contractors in British Columbia. Such a system would reward high quality and penalise low-quality work. Currently payment is based entirely upon production levels, and higher production equates to higher pay rates despite accompanying quality problems.

It is clear that a lot of training is required for fallers, skidder operators, and contractors before there is a sufficient pool of contractors willing and qualified to do this type of logging work. Training for loggers is a high priority.

Damage to Residual Trees

Logging damage is a feature of selection cutting, but the levels of damage are controllable. Nyland (1996) suggests that work practices substantially influence the extent of damage. Crew training, use of special practices, proper supervision, and choice of equipment are key components to minimising damage. The logging crew is the critical element in reducing damage, and careful work habits must be promoted (Nyland 1996).

Three types of damage must be recognised:

Top Damage -- falling trees break out the top or shear the branches from a leave-tree. Top damage is worse in cold winter weather when branches are frozen. This type of damage can be reduced by careful directional falling, and falling in multiple passes so that new holes open up for difficult trees.

Basal Scarring -- skidding equipment or moving logs bump or rub against the lowest log and remove bark and sometimes wood from the tree. Broken wood weakens the tree, and damaged bark allows stem-rotting pathogens to enter the tree and cause decay. Basal scarring is worse during the spring and summer, when the sap is up, and lessens during the winter. Careful falling to put trees in lead to the trail is critical, careful skidding, however is most important.

Root Damage -- repeated traffic either compacts the soil around roots or mechanically damages roots by breakage or abrasion. This type of damage is minimised on frozen soils and the worst when soils are wet. Logging in winter on snow or frozen soil, logging on dry ground, or using a mat of limbs and tops can all reduce the level of damage. Restricting machinery to designated skid trails will also reduce the amount of unnecessary damage. Root damage will cause a loss of tree vigour, and may create points of entry for decay-causing pathogens. It is our opinion that root damage is a primary cause in unexplained mortality of spruce after partial cutting.

Work Habits to Reduce Damage

The training and attitude of the logging crew can have a very significant effect upon the amount of damage that is created to the residual stand. Figure 5 depicts some of the critical activities that reduce damage and more methods are discussed in Table 6.

Damage and Decay

Despite the best efforts of all to reduce logging damage, not all can be avoided. It is important to consider the damage that does occur and to develop a strategy for dealing with it.

Basal scarring is of less concern than top damage, since Douglas-fir are quite resistant to decay after injuries (Craig 1970). Craig (1970) found that over 60% of the scars sampled in the central Cariboo were infected, but that level of decay resulting from those infections amounted to only 1-5% of the gross volume of scarred Douglas-fir. Craig (1970) sampled decayed volumes and scar ages from a wide area. Drier regions had significantly lower rates of volume loss than moister regions. The central Cariboo was the moistest region studied. Decay and resin-soaked wood caused by wounds result in loss of volume and quality in the most valuable portion of the tree and therefore losses in value are greater than the decay volume alone would indicate.

Trees that are small diameter at the time of logging will have only a small volume of rot. Decay resulting from basal scars only affects the wood that exists at the time of injury (Craig 1970, Allen and White 1997, Zeglen 1997) and does not expand into new heartwood over time.

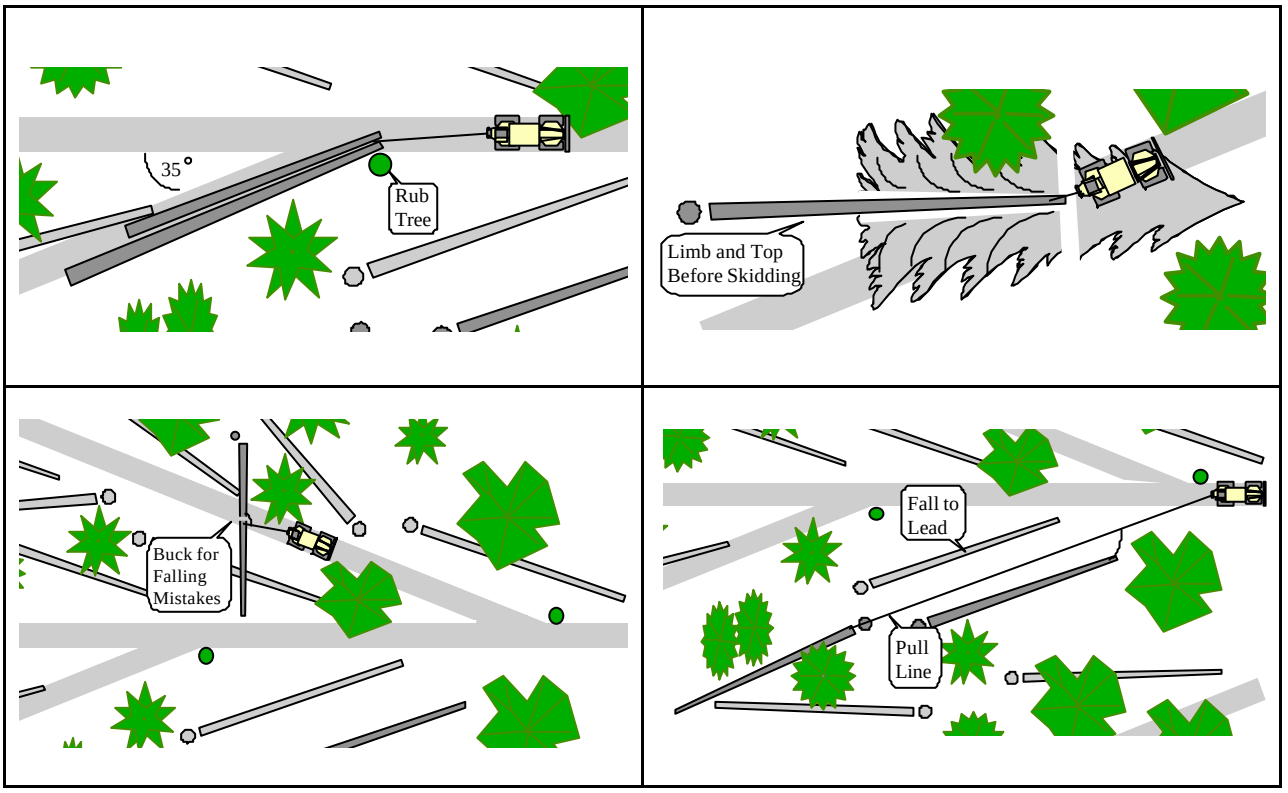


Figure 5: Work practices to reduce damage to the residual stand (After Przeczek 1995).

Table 6: Work habits which will reduce residual-stand damage during logging

Falling	Skidding
• Fall to lead for the skidder -- trees should be felled at an angle of about 35° or less to the trail; • Allow that not all trees will reach the trail, and the skidder operator will have to pull cable; • Stop falling when wind velocity makes it uncertain that you can put your tree where you want it; • Top and limb every felled tree; • Buck those trees which do not fall in lead with the trail; • Protect the residual stand according to the following priorities - marked trees - well formed poles and saplings - regeneration • Fall in multiple passes to improve the falling opportunities and reduce hang-ups and breakage • Work co-operatively with the skidder operator to ensure safety and efficient logging with minimum damage; • Get assistance from the skidder to winch or push dangerous trees -- do not leave hang-ups; • Consider using a block and tackle, pry-bars or other felling aids to fall problem trees in one pass at the end of the falling; • Discuss concerns or ideas with the contractor and the supervisor to improve the results.	• Use small to medium size skidding equipment; • Prefer crawler tractors to rubber-tired skidders; • Keep the skidder on the trails and follow the same track every trip; • Place debris or cull logs on inside of corners; • Work co-operatively with the faller to ensure safety and efficient production with minimal damage; • Watch the corners of the blade and wheels on trail-side trees; • Be prepared to pull mainline up to 30 m; • Fly a maximum of three chokers; • Do not skid whole trees -- skidding should always be done by tree-length (limbs and tops removed); • Trees which have not been felled to lead should be bucked to shorter lengths to reduce skidding damage; • Drive in the trail backwards, or turn around at trail junctions -- do not back over regeneration; • Do not bunch butts together to facilitate skidding; • Pass the mainline on the correct side of all trees between the skidder and the log -- stop winching if the cable is rubbing on a leave tree; • Use a snatch block at an intermediate tree to angle the mainline for particularly difficult skidding problems; • Discuss concerns or ideas with the contractor and the supervisor to improve the results.

Craig (1970) does not distinguish between the incidence of infection and the incidence of decay. This is an important consideration, since a scar may be infected but the tree resists decay. Allen and White (1997) report that 88% of wounds on western larch result in decay, while only 7.8% of scars on lodgepole pine result in decay. Aho *et al*. (1983) suggest that trees with resinous wood (including lodgepole pine and Douglas-fir) are less readily infected by decay fungi than trees with non-resinous wood (true firs and hemlock). The author's experience suggests that the incidence of decay associated with scars on Douglas-fir is relatively low, based upon observations of fire-scarred trees after cutting. This supposition requires verification -- it is important to find out the incidence of decay associated with logging scars on Douglas-fir, since the management implications are significant. Aho *et al*. (1983) report that spruces are very susceptible to infection by decay fungi when injured.

Douglas-fir which have basal scars should preferably be cut, but based upon our informal observations, can be left with little risk of attracting bark beetles, even with up to half of their circumference scarred. Until further information is available, the following guidelines are offered based upon local experience, and three pertinent reports (Craig 1970, Aho *et al*. 1983, Allen and White 1997):

- large scars are more likely to cause decay than small scars;
- scars that gouge the wood are more likely to cause decay than scars which do not;
- a scar on a large tree will cause much greater volume loss to decay than a similar scar on a small tree;
- wounds in contact with the ground are more likely to result in decay than higher wounds, and the decay progresses very rapidly;
- decay is established relatively quickly, and 5% losses can occur in just 10 years;
- scarred Douglas-fir may be left;
- scarred pine may be left;
- scarred spruce should be cut.

Addressing Damage During Harvesting

Residual trees should be protected by the use of rub trees, or by the strategic placement of logging slash, cull logs, or stumps (Przeczek 1995, Zeglen 1997). Not all trees can be protected in this way, however. Damaged trees should be addressed by re-marking the stand for a final clean-up pass before logging is complete. Farrar (1996) recommends that 3 to 5% of the harvest be retained unmarked until this final cleanup pass, to hedge against overcutting the prescription at the end of the logging. Any trees that have significant top damage should be cut, since such damage is apparently very attractive to Douglas-fir bark beetles. In addition, Craig (1970) found scars in the upper bole had a higher incidence of infection by decay fungi. Spruce with basal scars or root damage should be cut. Lodgepole pine or Douglas-fir that have large or gouged basal scars should be removed if the stand density will allow their removal.

Since damage to residuals can be attractive to bark beetles, monitoring of selection cutting is important for several years after logging. Routine bark beetle detection and management activities as described by Day (1997) are sufficient to manage outbreaks resulting from selection harvesting.

Issue:	Problem Statement:	Solutions and Rationale:
Choice of logging methods to implement the prescription in the best way	• Low volume removal • Low productivity in harvesting • Need to minimise residual damage • Need to minimise area taken up in skid trails	• For large cutblocks, single grip harvester and forwarder will have high productivity and efficiency. • For smaller cutblocks, small tractor/forwarder methods will increase productivity, minimising residual damage and skid trail area. • Low value and volume of timber harvest may not support mechanical logging systems. Hand falling and small line skidders may provide the best solution.

Cost of Treatment versus Revenue Generated

Some stands identified for commercial thinning may have marginal economic return from the harvest and others may be quite economically viable. Many of these stands would benefit from juvenile spacing combined with commercial thinning. For stands with marginal economic returns from commercial thinning, combined spacing and thinning with additional funding for the spacing would result in improved economics.

Issue:	Problem Statement:	Solutions and Rationale:
Pulp-sized Douglas-fir	• This type of stands has a high percentage of pulp-sized wood due to a high number of trees in 10-15 cm DBH classes. • At this time Douglas-fir pulp wood seems to be less desirable on the market	• We intend to set up a research project with PAPRICAN, to test quality of pulp resulted from small diameter Douglas-fir.

Table 7 (following) examines the economic operability of commercial thinning in mule deer winter range, based upon experience and assumptions from the Knife Creek Block

of the UBC/Alex Fraser Research Forest. The results indicate, given a stumpage rate of $0.25/m^3 and assuming that pre-commercial thinning is paid externally, that the sawlog volume must be at least 14 m^3/ha. If the value of the logs to be cut must bear the cost of additional thinning then the volume must be at least 40 m^3/ha. The assumed values and costs are included in Table 7, so that the reader may examine the sensitivity of these estimates to varying assumptions.

Volume production from the two test blocks is estimated earlier in this report:

- block 211 (24 m^3/ha gross total, 20.4 m^3/ha net merch.); and
- block 212 (33 m^3/ha gross total, 28 m^3/ha net merch.)

According to Table 7 both blocks will pay their way for logging, but neither block will pay its way for post-harvest treatment. It is therefore necessary to identify external funding for the post-harvest slashing and spacing. It is appropriate that this cost be borne by the province, since the work is in support of a wildlife habitat objective.

Table 7: Calculation of minimum operable volume for commercial thinning, assuming minimum stumpage ($0.25/m^3) and using assumptions from Knife Creek.

Cost/ha			
A. Pre-harvest Expences			
Operation	**Cost/ha**		
Layout	$	10.00	
Cruising*	$	60.00	
Traversing	$	30.00	
Skidtr. Layout	$	20.00	
Silv. Prescr.	$	40.00	
TOTAL+5%	**$**	**160.00**	A
B. Post-harvest Expences			
Slashing & Spacing	**$**	**300.00**	
TOTAL	**$**	**460.00**	B

Cost/m3			
Harvesting**	$	35.00	
Marking	$	2.00	
Stumpage	$	0.25	
TOTAL	**$**	**37.25**	C

*Cruising was done to assess the stand structure, using fixed radius plots for small trees and prism plots for large trees

**Cost of harvesting in similar contracts Knife Creek/UBC Research Forest

Selling Price, $/m^3	**$**	**50.00**	D
Net Revenue ($/m^3) (D - C = E)	**$**	**12.75**	E
Correct Gross Total to Net Merch Volume (sawlogs)		**0.85**	F
Allowance for Profit		**5%**	G
Corrected Estimated net value ($/m^3) ((E x F) - G = H)	**$**	**10.30**	H

A. Estimated minimum volume (m^3/ha) required for harvesting to be feasible without Slashing and Spacing
(A / H = I) **15.5** I

B. Estimated minimum volume (m^3/ha) required for harvesting to be feasible with Slashing and Spacing
(B / H = J) **44.7** J

Summary

Commercial thinning will feature prominently in timber harvesting opportunities in mule deer winter ranges over the next 30 years. It is a treatment that will provide a low volume of small logs, and will have marginal economics. Never the less, it is a critical activity to ensure that high-density stands with a small mean diameter will contribute both habitat values and timber production. Without commercial thinning, these stands will have suppressed volume growth and reduced mule deer habitat value as compared to their potential.

Thinning must be applied to all stems, including unmerchantable diameter classes. The economics of this harvesting opportunity are marginal in some stands. Since the timber produced will not support the cost of post-harvest slashing and spacing in some stands, external funding will be required in spite of minimum stumpage.

Laying out the operation with a minimum of trails is critical to ensure that the thinning can occur between trails, since the residual basal area targets apply to the whole hectare, and the density between the trails must account for all the voids in the stand.

Deciding which trees to leave and which to cut is the most important activity in selection management. The residual stand must not be comprised to left-overs that the mill doesn't want, so fallers or markers should be deciding which trees to leave and cutting the rest. Always leave the best-formed and most vigorous trees, and work to develop a clumpy arrangement of leave trees.

The logging work force is responsible for ensuring that the prescription is accomplished. Loggers must be well trained and fully informed of the objectives of the work. They should work to minimise the damage to the residual stand, and aim to improve the stand through their logging.

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Appendix 1: Model Silviculture Prescriptions Blocks 211 and 212

THE UNIVERSITY OF BRITISH COLUMBIA

ALEX FRASER RESEARCH FOREST

Silviculture Prescription

For

Block 211, Knife Creek

February 12, 2002

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RPF Initials

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SILVICULTURE PRESCRIPTION

Silviculture Prescription

TENURE IDENTIFICATION

Williams Lake Forest District

LICENCE NO.: SUP 15382 LTC L42641	CUTTING PERMIT:	BLOCK NO: 211	LOCATION: Knife Creek Block Jones Creek Rd.
AREA UNDER TENURE (HA): 21.7	OPENING NUMBER:		LICENSEE NAME: UBC/Alex Fraser Research Forest
All assessments required under section 37 or section 39 (3) (a) of the Operational Planning Regulation (B.C. Reg. 107/98) have been conducted according to the procedures outlined in that regulation. This silviculture prescription is consistent with the results or recommendations of any assessment required under section 37, and complies with the Timber Harvesting Practices Regulation.			

Prescription Overview	COMMERCIAL THINNING in an overstocked stand of Douglas-fir, removing a moderate amount of poor to fair vigor stems from the mid to lower canopy layers, followed by a juvenile spacing to solve high density in advanced regeneration and 5 cm DBH class.

AREA SUMMARY

AREA OF NO PLANNED REFORESTATION (ha) (NPR)									
PERMANENT ACCESS	Rock	Water	Swamp	Other NP	NC>4HA	RESERVES WITH NO MODIFICATIONS: WTP	IMMATURE	OTHER (Specify)	TOTAL NPR AREA
						3.0			3.0

NET AREA TO BE REFORESTED INCLUDING RESERVES WITH MODIFICATIONS (HA)			
SU	STRATUM	SU AREA DESCRIPTION	NET AREA TO BE REFORESTED:
1	A	Mosaic of several different forest cover types: 1. Dense immature Fd layer 2, 3, 4 with some trees barely merchantable 2. Mature small to larger sawlog Fd and Fd vets (some Fd pole-sized trees) 3. Dense Fd - Mixed age-classes (all well represented).	Commercial Thinning No regeneration objective
		TOTAL NET AREA TO BE REFORESTED:	N/A
		TOTAL AREA UNDER PRESCRIPTION:	21.7

RPF Initials

OBJECTIVES

LONG TERM MANAGEMENT OBJECTIVES

FROM CCLUP	From Management and Working Plan #2	From Forest Development Plan
Enhanced resource development zone. The primary control on timber development will be mule deer winter range management.	Enhancing education, demonstration and research opportunities. Compartment 1: Priorities – deer, timber, range.	Priority 6.2: Uneven aged Fd – selection management for mule deer winter range. Improve the health and vigor of an overstocked stand, building a better stand structure for mule deer habitat.

CONDITIONS THAT MUST EXIST AFTER HARVEST OR TREATMENT TO ACCOMMODATE KNOWN RESOURCES

WILDLIFE	SENSITIVE AREAS
Mule deer winter range Long term target stand structure – high crown closure. Transitional stand structure after harvesting – moderate crown closure. In areas with clumps of large Fdi, the clumpy structure will be preserved. The abundant Fdi advanced regeneration and pole layer will be protected, assuming that some advanced and natural regeneration will be lost due to logging access	N/A
	RECREATION
	Thinning will provide a better structure for recreational use.
	VISUAL LANDSCAPE
	Not visually sensitive.
BIOLOGICAL DIVERSITY	WATERSHEDS OTHER
3.0 ha (14% of the cutblock area) was designated as Wildlife Tree Patch. WTP represents the average conditions of the cutblock. Within the cutblock, deciduous will be left, excepting situations where they will be cut, if they are interfering with valuable Fdi. These aspen will be felled to waste.	N/A
	CULTURAL HERITAGE
	N/A
	FISHERIES
	N/A
RANGE	LAKESHORE MANAGEMENT
After thinning, the grass layer will be better developed.	N/A

ECOLOGICAL INFORMATION AND SITE CHARACTERISTICS

ECOLOGY AND CRITICAL SITE CONDITIONS

		BIOGEOCLIMATIC				
SU	STRATUM	ZONE	SUBZONE	VARIANT & PHASE	SITE SERIES	SITE TYPE

SU	STRATUM	OTHER CRITICAL SITE CONDITIONS THAT AFFECT THE TIMING OF OPERATIONS,AND HOW THEY AFFECT THE TIMING
		• For falling and skidding of wood around dispersed leave-trees or small clumps the "bark-peeling" stage of growth, when the bole is highly susceptible to damage in the spring, is a concern. This time period is between April and July.

MANAGEMENT STRATEGIES

RIPARIAN MANAGEMENT STRATGIES

RIPARIAN/ LAKE ID	RIPARIAN/ LAKE CLASS	Description of THE Purpose and Extent of REMOVAL OR MODIFICATION OF TREES AND ANY RELATED FOREST PRACTICES IN RIPARIAN RESERVE ZONE(S)
N/A		

RIPARIAN/ LAKE ID	RIPARIAN/ LAKE CLASS	MANAGEMENT STRATEGIES FOR RIPARIAN OR LAKESHORE MANAGEMENT AREAS INCLUDING: Protecting Stream Banks (IF THERE IS NO RRZ), Maintaining Shade, AND Debris Management. if Felling and/or Yarding Across Streams. INCLUDE EITHER THE RESIDUAL BASAL AREA OR DENSITY FOR RMZ(S) AND LMZ(S).	INCLUDE ONE OF:	
			RESIDUAL BA (M^2/HA)	RESIDUALDENSITY (SPH)
N/A				

FOREST HEALTH MANAGEMENT STRATEGIES

MANAGEMENT STRATEGIES TO REDUCE FOREST HEALTH RISKS

This harvesting entry will increase overall stand vigour which will make trees less susceptible to bark beetle attack.

COARSE WOODY DEBRIS MANAGEMENT STRATEGIES

MANAGEMENT STRATEGIES TO ACCOMMODATE CWD OBJECTIVES, INCLUDING VOLUME AND RANGE OF PIECE SIZES, IF ANY

Wildlife Tree Patches and residual stand in partial cutting will provide coarse woody debris over time. Five to eight large, fallen Fdi in different stage of decay will be retained on site. Aspen will be retained throughout the block, and where marked to cut will be felled to waste.

MANAGEMENT STRATEGIES FOR ARCHAEOLOGICAL SITES

MANAGEMENT STRATEGIES TO MANAGE AND CONSERVE ARCHAEOLOGICAL SITES

AOA: high-moderate potential in West and South part of the cutblock.

An archaeological impact assessment has been completed in accordance with the procedures of the *operational planning regulation* and the prescription is consistent with the results and recommendations of the assessment.

VEGETATION MANAGEMENT STRATEGIES

Herbicide	YES: ☐ NO: ☒	Manual/Motor Manual	YES: ☐ NO: ☒
Livestock:	YES: ☐ NO: ☒	Other	YES: ☐ NO: ☒

After harvesting, a juvenile spacing must be carried out to reduce snow damage in non-merchantable component.

SOIL CONSERVATION

SITE DISTURBANCE

	HAZARD RATINGS (IF LOGGING METHODS OTHER THAN CABLE OR AERIAL ARE PROPOSED)			**SOIL CHARACTERISTICS** (*IF TEMPORARY ACCESS STRUCTURES ARE PROPOSED)*		
SU	SOIL COMPACTION	SURFACE SOIL EROSION	SOIL DISPLACEMENT	DEPTH TO UNFAVORABLE SUBSOIL (CM)	TYPE OF UNFAVORABLE SUBSOIL	SEDIMENT DELIVERY RISK
1						

	SOIL DISTURBANCE LIMITS	
SU	MAXIMUM ALLOWABLE SOIL DISTURBANCE WITHIN THE NET AREA TO REFOREST (%)	MAXIMUM EXTENT SOIL DISTURBANCE LIMITS MAY BE TEMPORARILY EXCEEDED TO CONSTRUCT TEMPORARY ACCESS STRUCTURES (%)
1		

Maximum proportion of total area under the prescription allowed for permanent access: __%.

SLOPE INSTABILITY INDICATORS:

N/A

REHABILITATION TIME FOR TEMPORARY ACCESS STRUCTURES

N/A

MANAGEMENT STRATEGIES FOR TEMPORARY ACCESS STRUCTURES

NA

This prescription is not in conflict with the prohibition, under section 7 (4) or 8 (4) of the *Timber Harvesting Practices Regulation*, against constructing bladed or excavated trails.

SU	GENERAL LOCATION (ALSO REFER TO MAP):	MAX ALLOWABLE HEIGHT OF CUTBANKS (M)	AVERAGE HEIGHT OF CUTBANKS (M)	Equipment to be Used (if other than excavator)
N/A				

SILVICULTURAL SYSTEMS

SILVICULTURAL SYSTEMS

SU	SILVICULTURAL SYSTEM / VARIANT / PHASE
1	Commercial Thinning of the pole layer (trees 12.5 – 32.5 cm DBH) to enhance long term forest structure desirable for mule deer habitat.

ADDITIONAL DEFINING CRITERIA (size, distribution, other)

The existing stand composition is pure Fd with some At.
This stand is currently overstocked with a basal area of 34.4 m^2/ha in stems 12.5 cm or greater in diameter. If stems smaller than 12.5 DBH are considered, the stand has nearly 40 m^2/ha of basal area. This stocking is distributed on stems/ha in the following manner:

- A scattered distribution of stems greater than 27.5 cm DBH with approximately 3.5% of the total stems, or 15% of stems greater than 12.5 cm DBH occurring in this range.
- A high density of stems exist in the 2.5 to 17.5 cm diameter range. Densities average close to 3000/ha with more than 30% total stand basal area occurring within this range.

OBJECTIVE

To improve timber volume production while not exceeding the minimum crown closure target for mule deer winter range.

Long TermTargets for High Crown Closure stands for Mule Deer Winter Range:

B = 29 m^2/ha D= 60 cm DBH Q = 1.25 Cutting cycle = 30 years.

As a transitional stage after harvesting, the basal area of the stand will be lowered at 25.7 m^2/ha (75% of current stand basal area).

PRE-HARVEST STAND STRUCTURE AND SITE CONDITION:

The average stand structure for the cutblock is described in APPENDIX I - Stand structure tables and charts

POST-HARVEST STAND STRUCTURE TARGETS:

Commercial Thinning

This treatment will remove trees of poor to fair vigor in the 15 to 25 cm DBH classes throughout the stand, taking care to create and maintain a clumpy structure in the stand. Clump location will be decided by the best formed and most vigorous trees.

Harvesting will target poor and fair trees following this rule:

DBH class 15 cut 1/3
DBH class 20 cut 1/2
DBH class 25 cut 1/9

Trees in DBH classes larger than 25 cm will not be cut.

Juvenile Spacing Specifications:

A clumpy structure has to be shaped in the stand at this entry, even in low diameter trees.

Clumps will be comprised of the best formed and most vigorous trees.

The diameter class of the clump after spacing will be the diameter of the best formed and most vigorous trees in the clump before spacing. Shorter poorly formed trees and trees of low vigor will be removed.

Spacing of trees 0 - 7.5 cm DBH shall be as follows:

Trees within a clump shall be spaced to an optimum distance of 2.7 m with an allowable variation from 1.5 metres to 3.2 metres. This will yield an average of 1000 trees/hectare, but will allow the selection of trees with the best form and vigor.

Trees located on the outside of individual clumps may be closer than the optimum inter-tree distance as they have room to grow.

Trees located in the interior portion of the clump must be spaced close to the ideal inter-tree distance to allow enough growing space.

Inter clump distance may vary with the size of the dominant trees in the clump.

Spacing of trees 7.6 cm DBH and 12.5 cm DBH shall be as follows:

Where two clumps meet, the clump of smaller trees will be spaced away from the larger clump at the inter-tree distance and latitude applying to the smaller trees.

Deciduous trees in layer 1 (>12.5 cm DBH) must be felled if the conifer trees are suffering crown competition with the deciduous tree, but will otherwise be left uncut. Crown competition is defined as occurring when the top of the conifer is experiencing mechanical damage from the branches of the deciduous tree. All other deciduous shall be left uncut unless within the prescribed inter-tree distance of a conifer.

Up to 12 mature aspen, cottonwood or birch will be left uncut on each hectare, even if they compete with crop trees. These trees will not be marked but shall be left by the stand tending worker. A mature tree is defined as >12.5 cm DBH.

Volume and basal area removal is concentrated in the 17.5 to 27.5 cm DBH classes for sawlogs and the 12.5 to 17.5 cm class for pulpwood (at 24 m3/ha gross total volume - depending on pulpwood markets).

After Thinning and spacing the stand will have 424 residual stems/ha and 25.7 m2/ha residual basal area over 12.5 cm DBH. Such stocking should retain good vigor on most stems in the stand over this period, with higher growth rates evident for a significant portion of the cutting cycle. The improved vigor of trees in all diameter classes will allow stems to progressively move through the diameter classes over time in a predictable and orderly fashion according to the principles of uneven-aged management.

OPPORTUNITIES FOR FUTURE HARVESTING::
Next entry can be scheduled after 30 years.
HARVESTING:
Skid trails are marked in the field at a distance of 40 m between them. The width of skid trails will be no larger than 3 m. Skidding must be done only on marked skid trails, using small skidders, and preferably cable equipped machines to be able to pull out the wood between skid trails. Leave rub-trees at skid trail intersections and turnings. 5% is maximum allowable for damage and removal of non-target trees.

WINDTHROW MANAGEMENT STRATEGIES

Strategies to Address Expected Impacts from Windthrow:

S U	Stratum	STRATEGIES
1	A	**Windthrow risk is LOW**. In the stand with dense Fdi some windsnap and snow breakage may be expected, in suddenly exposed smaller pole-sized stems. To avoid this a juvenile spacing must be carried out after harvesting. Generally most trees have a high degree of taper and will not be susceptible to a more open stand condition.

STOCKING REQUIREMENTS –

ASSESSMENT DATES

SU	REGENERATION DATE (YEARS)	FREE GROWING ASSESSMENT PERIOD (YEARS)	
		EARLY	LATE

STOCKING REQUIREMENTS:

SU	LAYER	PREFERRED		ACCEPTABLE		MAX CONIFEROUS	POST SPACING DENSITY	
		SPECIES	MINIMUM HEIGHT (M)	SPECIES	MINIMUM HEIGHT (M)	STEMS/HA	MIN STEMS/HA	MAX STEMS/HA
1	MATURE 12.5 CM+	Fd						
	POLE 7.5-12.5 CM	Fd						
	SAPLING 1.3 M-7.5 CM	Fd				2500	282	1200
	REGEN 0-1.3 M	-	-		-			

SU	WELL SPACED TREES/HA				PLANNED RESIDUAL BASAL AREA (M^2/HA)	HEIGHT RELATIVE TO COMPETITION (%OR CM)
	LAYER	TARGET PREF & ACC	MINIMUM PREF & ACC	MIN PREF	MIN HORIZ DISTANCE PREF & ACC		
1	MATURE 12.5 CM+	-	-	-		26** (15-35)	
	POLE 7.5-12.5 CM	120	120	120	-		
	SAPLING 1.3 M-7.5 CM	282	282	282	-		-
	REGEN 0-1.3 M	-	-	-	-		-

OTHER REQUIRED INFORMATION AS PER S. 41(2) OF THE *FOREST PRACTICES CODE OF BC ACT*:

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ADMINISTRATION

PRESCRIPTION PREPARED BY (RPF SIGNATURE AND SEAL):

Mircea Rau, FIT

Ken Zielke, RPF

J. Kenneth Day

RPF NAME (PRINTED)

DATE: NO: 1542

Original Prescription Date (if Amended): _____

RPF SIGNATURE AND SEAL

PRESCRIPTION ATTACHMENTS:

- ☒ ADDITIONAL SP COMMENTS: APPENDIX I STAND STRUCTURE TABLES AND CHARTS
- ☒ SP MAP(S)
- ☐ FIELD DATA CARDS (E.G., SP PLOT CARDS, FOREST HEALTH EVALUATIONS, FUEL HAZARD ASSESSMENT CARDS, SITE SENSITIVITY FIELD CARDS, PLANTABILITY FIELD CARDS, ETC.)
- ☐ COPIES OF ADVERTISING
- ☐ COPIES OF REFERRALS
- ☐ COMMENTS FROM ADVERTISING/REFERRALS
- ☐ ASSESSMENTS ON ACTIONS RESULTING FROM COMMENTS
- ☐ TREE ACCEPTABILITY CRITERIA FOR SUBSEQUENT SURVEYS
- ☐ TERRAIN STABILITY FIELD ASSESSMENT
- ☐ ARCHAEOLOGICAL IMPACT ASSESSMENT
- ☐ VISUAL IMPACT ASSESSMENT
- GULLY ASSESSMENT
- ☐ RIPARIAN ASSESSMENT
- ☐ FOREST HEALTH / PEST INCIDENCE ASSESSMENT
- ☐ STAND AND STOCK TABLES
- ☐ PERMANENT ACCESS CALCULATION SHEET
- ☐ OTHER: SPECIFY

_____

LICENSEE SIGNING AUTHORITY:

Licence Holder Signing Authority:

Signature

J. Kenneth Day

Name (Printed)

Date:

Original Approval Date (if Amended):

PRESCRIPTION APPROVED BY:

District Manager's Signature

District Manager's Name (Printed)

Date: _____

Original Approval Date (if Amended): _____

THE UNIVERSITY OF BRITISH COLUMBIA

ALEX FRASER RESEARCH FOREST

Silviculture Prescription

For

Block 212, Knife Creek

February 12, 2002

RPF Initials

SILVICULTURE PRESCRIPTION

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THE UNIVERSITY OF BRITISH COLUMBIA

ALEX FRASER RESEARCH FOREST

SILVICULTURE PRESCRIPTION

Silviculture Prescription

TENURE IDENTIFICATION

Williams Lake Forest District

LICENCE NO.: SUP 15382 LTC L42641	CUTTING PERMIT:	BLOCK NO: 212	LOCATION: Knife Creek Block - West Rd.
AREA UNDER TENURE (HA): 33.3	OPENING NUMBER:		LICENSEE NAME: UBC/Alex Fraser Research Forest
All assessments required under section 37 or section 39 (3) (a) of the Operational Planning Regulation (B.C. Reg. 107/98) have been conducted according to the procedures outlined in that regulation. This silviculture prescription is consistent with the results or recommendations of any assessment required under section 37, and complies with the Timber Harvesting Practices Regulation.			

Prescription Overview	COMMERCIAL THINNING in an overstocked stand of Douglas-fir, removing a moderate amount of poor to fair vigor stems from the mid to lower canopy layers, followed by a juvenile spacing to solve high density in advanced regeneration and 5 cm DBH class.

AREA SUMMARY

AREA OF NO PLANNED REFORESTATION (ha) (NPR)									
PERMANENT ACCESS	Rock	Water	Swamp	Other NP	NC>4HA	RESERVES WITH NO MODIFICATIONS: WTP	IMMATURE	OTHER (Specify)	TOTAL NPR AREA
						4.0			4.0

NET AREA TO BE REFORESTED INCLUDING RESERVES WITH MODIFICATIONS (HA)			
SU	STRATUM	SU AREA DESCRIPTION	NET AREA TO BE REFORESTED:
1	A	Mosaic of several different forest cover types: **Dense immature Fd layer 2, 3, 4 with some trees barely merchantable** **Mature small to larger sawlog Fd and Fd vets (some Fd pole-sized trees) and some mature Pl** **Dense Fd - Mixed age-classes (all well represented).** **Openings with dense natural or advanced regeneration of Fd with some poor quality Pl**	Commercial Thinning No regeneration objective
		TOTAL NET AREA TO BE REFORESTED:	N/A
		TOTAL AREA UNDER PRESCRIPTION:	33.3

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OBJECTIVES

LONG TERM MANAGEMENT OBJECTIVES

FROM CCLUP	From Management and Working Plan #2	From Forest Development Plan
Enhanced resource development zone. The primary control on timber development will be mule deer winter range management.	Enhancing education, demonstration and research opportunities. Compartment 1: Priorities – deer, timber, range.	Priority 6.2: Uneven aged Fd – selection management for mule deer winter range. Improve the health and vigor of an overstocked stand, building a better stand structure for mule deer habitat.

CONDITIONS THAT MUST EXIST AFTER HARVEST OR TREATMENT TO ACCOMMODATE KNOWN RESOURCES

WILDLIFE	SENSITIVE AREAS
Mule deer winter range Target stand structure – moderate crown closure In areas with clumps of large Fdi, the clumpy structure will be preserved. The abundant Fdi advanced regeneration and pole layer will be protected, assuming that some advanced and natural regeneration will be lost due to logging access	N/A
	RECREATION
	Thinning will provide a better structure for recreational use.
	VISUAL LANDSCAPE
	Not visually sensitive.
BIOLOGICAL DIVERSITY	WATERSHEDS OTHER
4.0 ha (12% of the cutblock area) were designated as Wildlife Tree Patch. WTP represents the average conditions of the cutblock. Within the cutblock, deciduous will be left, excepting situations where they will be cut, if they are interfering with valuable Fdi. These aspen will be felled to waste.	N/A
	CULTURAL HERITAGE
	N/A
	FISHERIES
	N/A
RANGE	LAKESHORE MANAGEMENT
After thinning, the grass layer will be better developed.	N/A

ECOLOGICAL INFORMATION AND SITE CHARACTERISTICS

ECOLOGY AND CRITICAL SITE CONDITIONS

		BIOGEOCLIMATIC				
SU	STRATUM	ZONE	SUBZONE	VARIANT & PHASE	SITE SERIES	SITE TYPE

SU	STRATUM	OTHER CRITICAL SITE CONDITIONS THAT AFFECT THE TIMING OF OPERATIONS,AND HOW THEY AFFECT THE TIMING
		For falling and skidding of wood around dispersed leave-trees or small clumps the "bark-peeling" stage of growth, when the bole is highly susceptible to damage in the spring, is a concern. This time period is between April and July.

MANAGEMENT STRATEGIES

RIPARIAN MANAGEMENT STRATGIES

RIPARIAN/ LAKE ID	RIPARIAN/ LAKE CLASS	Description of THE Purpose and Extent of REMOVAL OR MODIFICATION OF TREES AND ANY RELATED FOREST PRACTICES IN RIPARIAN RESERVE ZONE(S)
N/A		

RIPARIAN/ LAKE ID	RIPARIAN/ LAKE CLASS	MANAGEMENT STRATEGIES FOR RIPARIAN OR LAKESHORE MANAGEMENT AREAS INCLUDING: Protecting Stream Banks (IF THERE IS NO RRZ), Maintaining Shade, AND Debris Management. if Felling and/or Yarding Across Streams. INCLUDE EITHER THE RESIDUAL BASAL AREA OR DENSITY FOR RMZ(S) AND LMZ(S).	INCLUDE ONE OF:	
			RESIDUAL BA (M^2/HA)	RESIDUALDENSITY (SPH)
N/A				

FOREST HEALTH MANAGEMENT STRATEGIES

MANAGEMENT STRATEGIES TO REDUCE FOREST HEALTH RISKS

This harvesting entry will increase overall stand vigour which will make trees less susceptible to bark beetle attack.

COARSE WOODY DEBRIS MANAGEMENT STRATEGIES

MANAGEMENT STRATEGIES TO ACCOMMODATE CWD OBJECTIVES, INCLUDING VOLUME AND RANGE OF PIECE SIZES, IF ANY

Wildlife Tree Patches and residual stand in partial cutting will provide coarse woody debris over time. Five to eight large, fallen Fdi in different stage of decay will be retained on site. Aspen will be retained throughout the block, and where marked to cut will be felled to waste.

MANAGEMENT STRATEGIES FOR ARCHAEOLOGICAL SITES

MANAGEMENT STRATEGIES TO MANAGE AND CONSERVE ARCHAEOLOGICAL SITES

AOA: low potential for archaeological sites. No AIA necessary.

VEGETATION MANAGEMENT STRATEGIES

Herbicide	YES: ☐ NO: ☒	Manual/Motor Manual	YES: ☐ NO: ☒
Livestock:	YES: ☐ NO: ☒	Other	YES: ☐ NO: ☒

After harvesting, a juvenile spacing must be carried out to reduce snow damage in non-merchantable component.

SOIL CONSERVATION

SITE DISTURBANCE

	HAZARD RATINGS (IF LOGGING METHODS OTHER THAN CABLE OR AERIAL ARE PROPOSED)			**SOIL CHARACTERISTICS** (*IF TEMPORARY ACCESS STRUCTURES ARE PROPOSED)*		
SU	SOIL COMPACTION	SURFACE SOIL EROSION	SOIL DISPLACEMENT	DEPTH TO UNFAVORABLE SUBSOIL (CM)	TYPE OF UNFAVORABLE SUBSOIL	SEDIMENT DELIVERY RISK

	SOIL DISTURBANCE LIMITS	
SU	MAXIMUM ALLOWABLE SOIL DISTURBANCE WITHIN THE NET AREA TO REFOREST (%)	MAXIMUM EXTENT SOIL DISTURBANCE LIMITS MAY BE TEMPORARILY EXCEEDED TO CONSTRUCT TEMPORARY ACCESS STRUCTURES (%)

Maximum proportion of total area under the prescription allowed for permanent access: __%.

SLOPE INSTABILITY INDICATORS:

N/A

REHABILITATION TIME FOR TEMPORARY ACCESS STRUCTURES

N/A

MANAGEMENT STRATEGIES FOR TEMPORARY ACCESS STRUCTURES

NA

This prescription is not in conflict with the prohibition, under section 7 (4) or 8 (4) of the *Timber Harvesting Practices Regulation*, against constructing bladed or excavated trails.

SU	GENERAL LOCATION (ALSO REFER TO MAP):	MAX ALLOWABLE HEIGHT OF CUTBANKS (M)	AVERAGE HEIGHT OF CUTBANKS (M)	Equipment to be Used (if other than excavator)
N/A				

SILVICULTURAL SYSTEMS

SILVICULTURAL SYSTEMS

SU	SILVICULTURAL SYSTEM / VARIANT / PHASE
1	Commercial Thinning of the pole layer (trees 12.5 – 37.5 cm DBH) to enhance long term forest structure desirable for mule deer habitat.

ADDITIONAL DEFINING CRITERIA (size, distribution, other)

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The existing stand composition is 95% Fd and 5% Pl with some At.
This stand is currently overstocked in small diameter classes. If stems smaller than 12.5 DBH are considered, the stand has more than 30 m2/ha of basal area. . This stocking is distributed on stems/ha in the following manner:

- A highly clumped distribution of stems greater than 12.5 cm DBH with approximately 16% of the total stems, and 90% of the basal area occurring in this range.
- Within the clumps of timber, >12.5 cm DBH, 89% of the stems and 70% of the basal area are between 12.5 cm and 37.5 cm DBH. Also, 11% of the stems and 30% of the basal area are in diameters between 37.5 and 72.5 cm.
- A high density of stems exist in openings (formerly skid trails) between the more mature clumps. Most of these juvenile stems are less than 1.3 m in height up to 7.5 cm DBH, with some scattered trees between 7.5 and 12.5 cm DBH. While the average density of these stems is between 2500 to 3000 stem/ha, actual densities within the openings likely range from 3000 to 7000 stems/ha.

The clumpy nature of this stand reflects a significant number of openings created in the last entry. The prevalence of these openings, now filled with small trees and regeneration, precludes extremely high basal area stocking in the whole stand. However, the current basal area is high enough that the stand is considered overstocked with lower than optimum vigor and growth.

OBJECTIVE

To improve timber volume production while not exceeding 25% removal of existing basal area.
Long Term Targets for Moderate Crown Closure stands for Mule Deer Winter Range:
B = 22 m^2/ha D= 60 cm DBH Q = 1.25 Cutting cycle = 30 years.
Post-harvest target basal area is 20.5 m^2/ha (75% of current basal area).

PRE-HARVEST STAND STRUCTURE AND SITE CONDITION:

The average stand structure for the cutblock is described in APPENDIX I - Stand structure tables and charts

POST-HARVEST STAND STRUCTURE TARGETS:

Commercial Thinning
This treatment will remove trees of poor to fair vigor in the 15 to 35 cm DBH classes throughout the stand, taking care to create and maintain a clumpy structure in the stand. Clump location will be dictated by the best formed and most vigorous trees.
Harvesting will target poor and fair trees following this rule:
DBH class 15 cut 1/3
DBH class 20 cut 1/4
DBH class 25 cut 1/2
DBH class 30 cut 1/2
DBH class 35 cut 1/15
Trees in DBH classes larger than 35 cm will not be.

Juvenile Spacing Specifications:
A clumpy structure has to be shaped in the stand at this entry, even in low diameter trees.
Clumps will be comprised of the best formed and most vigorous trees.
The diameter class of the clump after spacing will be the diameter of the best formed and most vigorous trees in the clump before spacing. Shorter poorly formed trees and trees of low vigor will be removed.
Spacing of trees 0 - 7.5 cm DBH shall be as follows:
Trees within a clump shall be spaced to an optimum distance of 2.7 m with an allowable variation from 1.5 metres to 3.2 metres. This will yield an average of 1000 trees/hectare, but will allow the selection of trees with the best form and vigor.
Trees located on the outside of individual clumps may be closer than the optimum inter-tree distance as they have room to grow.
Trees located in the interior portion of the clump must be spaced close to the ideal inter-tree distance to allow enough growing space.
Inter clump distance may vary with the size of the dominant trees in the clump

Spacing of trees 7.6 - 12.5 cm DBH shall be as follows:
Where two clumps meet, the clump of smaller trees will be spaced away from the larger clump at the inter-tree distance and latitude applying to the smaller trees.
Deciduous trees in layer 1 (>12.5 cm DBH) must be felled if the conifer trees are suffering crown competition with the deciduous tree, but will otherwise be left uncut. Crown competition is defined as occurring when the top of the conifer is experiencing mechanical damage from the branches of the deciduous tree. All other deciduous shall be left uncut unless within the prescribed inter-tree distance of a conifer.
Up to 12 mature aspen, cottonwood or birch will be left uncut on each hectare, even if they compete with crop trees. These trees will not be marked but shall be left by the stand tending worker. A mature tree is defined as >12.5 cm DBH.

Volume and basal area removal is concentrated in the 20 to 35 cm DBH classes for sawlogs and the 15 cm class for pulpwood (at 33 m^3/ha gross volume - depending on pulpwood markets).
After Thinning and spacing the stand will have 333 residual stems/ha and 20.5 m^2/ha residual basal area over 12.5 cm DBH.

OPPORTUNITIES FOR FUTURE HARVESTING::

Next entry can be scheduled after 30 years from now, due to low a lower value of residual basal area .

HARVESTING:

Skid trails are marked in the field at a distance of 40 m between them. The width of skid trails will be no larger than 3 m. Skidding must be done only on marked skid trails, using small skidders, and preferably cable equipped machines to be able to pull out the wood between skid trails. Leave rub-trees at skid trail intersections and turnings.
5% is maximum allowable for damage and removal of non-target trees.

WINDTHROW MANAGEMENT STRATEGIES

Strategies to Address Expected Impacts from Windthrow:

SU	Stratum	STRATEGIES
1	A	**Windthrow risk is LOW**. In the stand with dense Fdi some windsnap and snow breakage may be expected, in suddenly exposed smaller pole-sized stems. To avoid this, a juvenile spacing must be carried out after harvesting. Generally most of the trees have a high degree of taper and will not be susceptible to a more open stand condition.

STOCKING REQUIREMENTS –

ASSESSMENT DATES

SU	REGENERATION DATE (YEARS)	FREE GROWING ASSESSMENT PERIOD (YEARS)	
		EARLY	LATE

STOCKING REQUIREMENTS:

SU	LAYER	PREFERRED		ACCEPTABLE		MAX CONIFEROUS	POST SPACING DENSITY	
		SPECIES	MINIMUM HEIGHT (M)	SPECIES	MINIMUM HEIGHT (M)	STEMS/HA	MIN STEMS/HA	MAX STEMS/HA
1	MATURE 12.5 CM+	Fd						
	POLE 7.5-12.5 CM	Fd						
	SAPLING 1.3 M-7.5 CM	Fd		Pli		2500	245	1200
	REGEN 0-1.3 M	-	-		-			

SU	WELL SPACED TREES/HA				PLANNED RESIDUAL BASAL AREA (M^2/HA)	HEIGHT RELATIVE TO COMPETITION (%OR CM)
	LAYER	TARGET PREF & ACC	MINIMUM PREF & ACC	MIN PREF	MIN HORIZ DISTANCE PREF & ACC		
1	MATURE 12.5 CM+	-	-	-		20.5(15-30)	
	POLE 7.5-12.5 CM	100	100	100	-		
	SAPLING 1.3 M-7.5 CM	245	245	220	-		-
	REGEN 0-1.3 M	-	-	-	-		-

OTHER REQUIRED INFORMATION AS PER S. 41(2) OF THE *FOREST PRACTICES CODE OF BC ACT*:

THE UNIVERSITY OF BRITISH COLUMBIA

ALEX FRASER RESEARCH FOREST

SILVICULTURE PRESCRIPTION

ADMINISTRATION

PRESCRIPTION PREPARED BY (RPF SIGNATURE AND SEAL):

Mircea Rau, FIT
Ken Zielke, RPF

J. Kenneth Day
RPF NAME (PRINTED)

RPF SIGNATURE AND SEAL

DATE: NO: 1542

Original Prescription Date (if Amended): _____

PRESCRIPTION ATTACHMENTS:

- ☒ ADDITIONAL SP COMMENTS: APPENDIX I STAND STRUCTURE TABLES AND CHARTS
- ☒ SP MAP(S)
- ☐ FIELD DATA CARDS (E.G., SP PLOT CARDS, FOREST HEALTH EVALUATIONS, FUEL HAZARD ASSESSMENT CARDS, SITE SENSITIVITY FIELD CARDS, PLANTABILITY FIELD CARDS, ETC.)
- ☐ COPIES OF ADVERTISING
- ☐ COPIES OF REFERRALS
- ☐ COMMENTS FROM ADVERTISING/REFERRALS
- ☐ ASSESSMENTS ON ACTIONS RESULTING FROM COMMENTS
- ☐ TREE ACCEPTABILITY CRITERIA FOR SUBSEQUENT SURVEYS
- ☐ TERRAIN STABILITY FIELD ASSESSMENT
- ☐ ARCHAEOLOGICAL IMPACT ASSESSMENT
- ☐ VISUAL IMPACT ASSESSMENT
  GULLY ASSESSMENT
- ☐ RIPARIAN ASSESSMENT
- ☐ FOREST HEALTH / PEST INCIDENCE ASSESSMENT
- ☐ STAND AND STOCK TABLES
- ☐ PERMANENT ACCESS CALCULATION SHEET
- ☐ OTHER: SPECIFY

  _____

LICENSEE SIGNING AUTHORITY:

Licence Holder Signing Authority:

Signature

J. Kenneth Day
Name (Printed)

Date:

Original Approval Date (if Amended):

PRESCRIPTION APPROVED BY:

District Manager's Signature

District Manager's Name (Printed)

Date: _____

Original Approval Date (if Amended): _____

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