Sustainability of Lodgepole Pine (*Pinus contorta latifolia*) Near Fraser Lake, British Columbia

Final Report

Submitted to:
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1. Introduction

In the early 1990s, a long term productivity trial was established by Fraser Lake Sawmills at CP 70-3 on the Holy Cross FSR in collaboration with FERIC (Forest Engineering Research Institute of Canada) and the BCFS (British Columbia Forest Service) (Figure 1.). This study was designed to record the productivity and cost of log processing completed at-the-stump to that at roadside. In addition, a trial was established to examine the effect of five site preparation treatments on long term site productivity. Harvesting economics and early regeneration results were prepared by FERIC (Mitchell & von der Gonna 1994) and BCFS (Heineman 1999), respectively. The study found that the combined cost ($/m^3) was lowest for roadside processing with natural regeneration ($6.12/m^3), and highest for at-the-stump processing followed by double-pass disc trenching and planting at approximately 3600 seedlings/ha ($9.86/m^3). One year after harvest, natural lodgepole pine germinates were found to be most abundant on forest floor material that had been compacted by repeated passes of heavy equipment, and least numerous in areas that had been processed at the stump and later chain-dragged.

Figure 1. Treatment sign for CP 70-3

In 1998, Fraser Lake Sawmills and members of the University of Northern British Columbia's faculty of forestry created a replicate (CP 100-1) to the long-term productivity trial on CP 70-3. In the spring of 1999, PSPs (Permanent Sample Plots) were established on the planted areas. Plot centers for monitoring natural regeneration were established at the same time. Heights of all trees in the PSPs were measured at the time of planting and in the fall of 1999. Natural regeneration was poor in the fall of 1999, most plots had no germanents. Preliminary analysis determined the heights on all treatments to be similar (Figure 2).

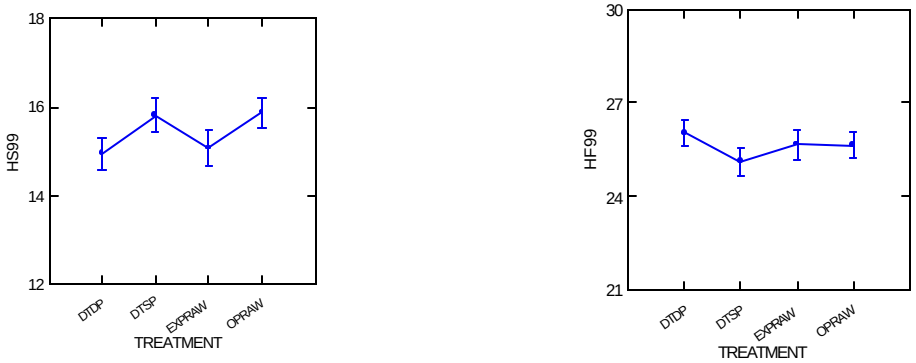

Figure 2. Displays the heights collected for trees on CP 100-1 in both the spring and fall of 1999 ($P > 0.05$).

2. Sites

2.1 CP 70-3

The Holy Cross study site is a 59 ha, west-facing block located in the Vanderhoof Forest District at 918 m elevation and 51 km south of Fraser Lake. The block is transitional between the SBSdk (Dry Cool Sub-Boreal Spruce) and SBSmc2 (Babine Moist Cold Sub-Boreal Spruce) biogeoclimatic subzones. Soils are moderately well-drained and composed of loam to sandy clay-loam, with some areas slightly higher in coarse fragments. Total bulk density and fine fraction bulk density were determined pre and post harvest. Harvesting took place between June 2 and July 24 of 1992. Seed bed and cone surveys were conducted on August 10, 1992. Five regeneration strategies were also established in 1992: 1) A control with natural regeneration, 2) No site preparation, planted at 1400 sph, 3) Chain drag with natural regeneration, 4) Single-pass disc trench, planted at 1400 sph, and 5) Double-pass disc trench, planted at 3600 sph.

2.2 CP 100-1

The replicate study site is located 3 km east of the 35 km sign on the Holy Cross FSR. It is on a 60.2 ha block with variable aspect, at 925 m elevation, and situated in the SBSmc2 (Sub-Boreal Spruce Moist Cold) biogeoclimatic subzone. The soils range from silt to sandy-loam textures. This block was summer logged in 1998 and site prepped using the same treatments as CP 70-3. A fall cone survey indicated 3 strata containing 19488, 5104, and 2600 naturally regenerated seedlings. It is estimated that there will be 4872, 1276 and 650 well spaced seedlings in these strata. After this survey, small sections (approximately 5 ha) of the block were: i) disc trenched, ii) double disc trenched, iii) chain dragged in the fall of 1998, and iv) left for natural regeneration (ie no site preparation/control). The majority of the block was left for raw planting. The block and treatments were planted, except for the chain drag and control areas, in May 1999.

3. Purpose and Objectives

Common linkages between CP 70-3 and CP 100-1 as well as new research areas to pursue have been identified but are not limited to, sowing of legumes on double disc trenched and raw planted areas, monitoring of natural regeneration in all planted areas in addition to the chain drag and control treatments and fertilization trials. The project's objectives have been identified as the following:

a) establish realistic lodgepole pine stand management scenarios,
b) document natural regeneration on these sites series,
c) document early biological and economic long term sustainability on CP 70-3, and
d) monitor results with respect to harvesting and site preparation (biological and economical), over a minimum of one rotation.
e) establish nutrients and nutrient levels necessary to optimize pine growth in the study area.

Natural regeneration is being monitored to determine rate and intensity of growth and establishment, to possibly verify that its emergence occurs over a relatively short period, and to address forest health concerns related to genetic potential.

In general, nitrogen deficiencies are common in BC. The use of legumes can restore and bolster soil nitrogen on harvested forest sites. Previous studies conducted in the Fraser Lake area have indicated that there are other possible nutritional limitations to pine growth. It is proposed that individual trees be given supplemental nutrient treatments in the form of fertilizers to further assess limitations for pine in the study area.

The objective of most fertilization in western forests is to increase the growth of the current crop over the short term. Intensive silvicultural practices such as forest fertilization have been identified as one way to increase the productivity of our forests, and perhaps also reduce the age-class distribution problem or uneven amounts of timber in certain age classes. The age-class distribution gaps may be narrowed through fertilization because rotation lengths are shortened through increased forest productivity. It is therefore important to understand how forest nutrients cycle and how intensive management activities influence the productivity and sustainability of our forests. Fertilization screening trials will allow foresters to predict potential or possible tree volume growth and extra yield per hectare, describe tree growth responses to nitrogen, phosphorous, potassium and trace elements such as boron, and magnesium additions, and identify significant positive and negative effects of forest fertilization on height, basal area, and volume responses, pest damage, and wood quality.

Tree nutrient status is generally determined by analyzing the foliage. In this case, foliar analysis in conjunction with information on site quality and stand growth performance will be used to evaluate forest stand nutrient status on an annual basis so that optimal nutrient levels may be maintained. Depending on the results of the annual monitoring of foliar nutrient status, fertilizer may be adjusted annually to achieve the desired foliar concentration. Statistical analysis and graphical interpretation techniques will be used to analyze the foliage collected each fall. Stand growth will be monitored over repeated applications of fertilizer.

4. Work Completed in 2000

- The eleven natural regeneration plots on the chain-dragged treatment were examined for the presence of germinants on the 25th of August (Nicole Wilder, Patience Byman, Marcyn Partyka, and Anne Cole). 1999 germinants were marked with spiral nails, and 2000 germinants were marked with straight nails, 41 and 27 germinants were found respectively.
- Legumes were sown on top of the trench in the double disc trenched treatment in April. The seed mixture used consisted of 40% birds foot (*Lotus denticulatus*), 30% alsike (*Trifolium hybridum*) and 30% short white Dutch (*Trifolium repens*). (Facilitated by Brian Walker of Fraser Lake Sawmills).
- Fertilizer trial was implemented on an operational portion of the block (see attached map). Fertilizer was applied in accordance with Table 1. The trees were measured and retagged (Patience Byman and Marcyn Partyka) on July 25. The area was stem mapped (Patience Byman, Marcyn Partyka, Nicole Wilder, and Anne Cole) on the 8th of August.

Table 1. Five proposed fertilization treatments for CP 100-1.

Treatment	Label	N	P	K	S (%)	Trace Elements (%) (Mg, B, Mn, Cu, and Fe)
Control	unfertilized	0	0	0	0	None
F1	Partial fertilization	14	16	10	0	None
F2	Partial fertilization	14	16	10	12	None
F3	Partial fertilization	14	16	10	0	Yes
F4	Complete fertilization	14	16	10	12	Yes
F5	Trace	0	0	0	0	Yes
F6	Complete fertilization*	14	16	10	12	Yes

*Fertilization will occur only once in 2000.

- Treatment boundaries were staked in August (Brian Walker).
- Fall 2000 heights and health assessments were collected (Patience Byman and Kirstin Campbell) on September 18th. Basic statistical analysis was completed (Patience Byman) and the results show that a significant difference in tree heights is beginning to take place across treatments (Figure 3 and 4a &b).

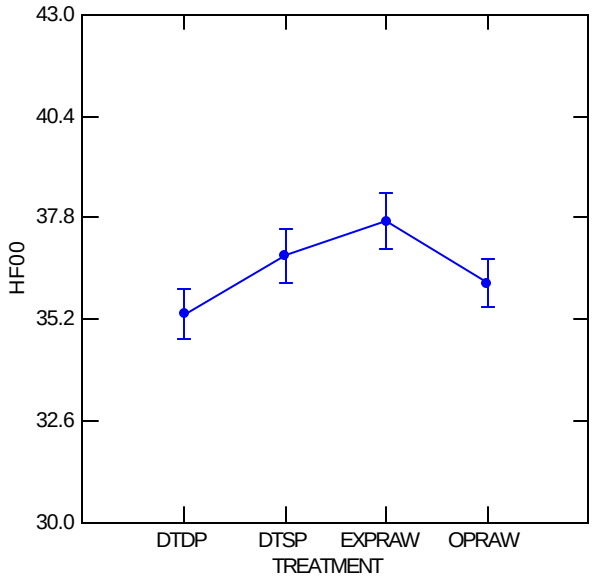

Figure 3. Displays the differences in height across all treatments in the fall of 2000 on CP 100-1 (p-value < 0.0001).

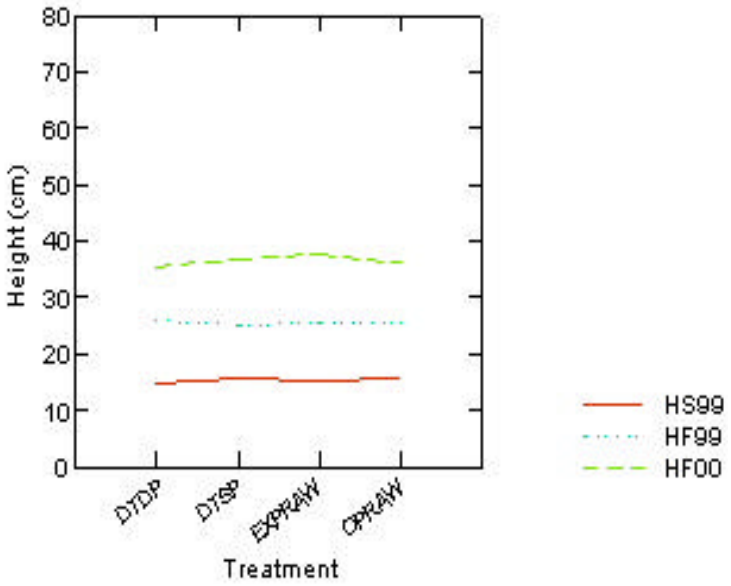

Figure 4a. Shows change in height growth from the spring of 1999 to the fall of 2000 for seedlings on CP 100-1.

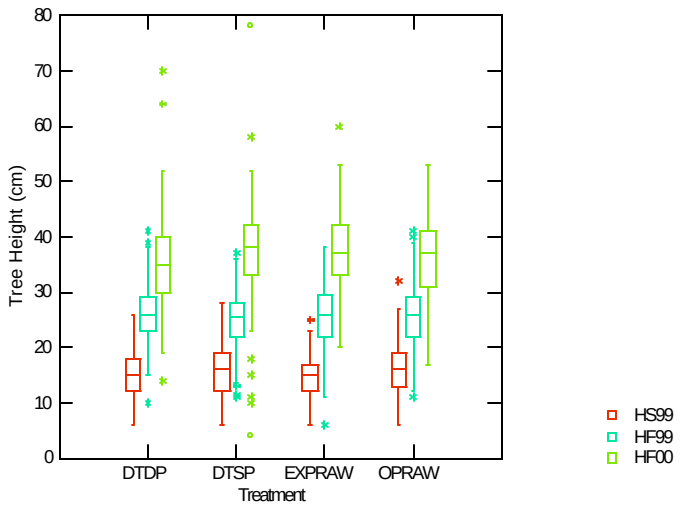

Figure 4b. Box plots are used to display height growth across all treatments on CP 100-1.

5. Work completed in 2001

- The remaining 47 natural regeneration plots on the control, raw plant, single and double disc trench treatment areas were examined for the presence of germinants on the 17th of May (Nicole Wilder and Tracy Murray). 1999 germinants were marked with spiral nails, and 2000 germinants were marked with straight nails (Table 2).

Table 2. Natural regeneration stocking by treatment on CP 100-1

	SPH		
TREATMENT	**1999**	**2000**	**Total**
Single Pass Disc Trench	3200	229	3429
Double Pass Disc Trench	5556	2667	8222
Operational Raw Plant	2222	1111	3333
Experimental Raw Plant	1556	889	2444
Chain Drag	5818	5673	11491
Control	3407	1333	4741

- Fertilizer was applied for a second time in accordance with Table 1 on June 13th and 15th (Nicole Wilder, Tracy Murray and Jennifer Lange).

6. Future Work

- A random selection of trees (by tag number) from all fertilizer treatments must be made in order to collect foliage in the fall.
- Foliage samples need to be taken from the predetermined trees in the fall of 2001. The leaves must then be analyzed to determine if fertilization should be adjusted the following spring.
- Heights should be taken in all treatments in the fall of 2001 in order to establish any early effects that the fertilizer may be having on the crop trees. Health factors should be recorded at the same time heights are taken.

7. References

Barclay, H.J. & H. Brix. (1985). Effects of high levels of fertilization with urea Of growth of thinned and unthinned Douglas-fir stands. Can. J. For. Res. 15: 730-733.

Heineman, J. (July 30, 1999). Natural regeneration of lodgepole pine on four types of seedbed: The effects of harvesting systems that process at the stump versus at roadside and chain-dragging. British Columbia MOF Forest site management section, Silviculture Note 20.

Mitchell, J. & von der Gonna, M. (July 1994). At the stump and roadside log processing: costs and impacts of harvesting and forest renewal. FERIC technical report SR-93.

Silvicultural History and Map for F.L. A18162 C.P. 100 BLK. 001
(Prepared by Fred Hankins, GIS technician for
West Fraser Mills, Fraser Lake, BC).
Location: Hallet Lake North, 3km east of the 35km sign on the Holy Cross FSR.
Size: Gross 60.2 ha.