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Effects of Site Preparation Treatments on Soil Disturbance and Microsite Distribution—Alternatives to Broadcast Burning in the North-Central Interior[AC1]

by

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1 INTRODUCTION

Broadcast burning for site preparation has been an effective tool in forest management, but has declined substantially in recent years compared to mechanical treatments[AC2] due to increasing costs, risks, and restrictions. Two of the more common alternatives to broadcast burning in the north-central interior of British Columbia have been disc trenching and windrow piling (with or without burning the piles). The costs and benefits of this shift away from broadcast burning to mechanical treatments, in terms of short- and long-term site productivity, are not fully known.

This memo will summarize the effects of site preparation on soil disturbance and the distribution of microsites. Another memo (Yole and Kranabetter 1996) compares soil properties of microsites created by site preparation treatments, and a future memo will examine seedling response.

2 STUDY SITE AND EXPERIMENTAL DESIGN

The study is located 50 km northeast of Smithers in the Bulkley Forest District, on a mesic site with a gently-sloping north aspect, transitional between the SBSmc and ESSFmc subzones (elevation 1000 m). The study site has well-drained to moderately well-drained soils of loam to silty clay loam texture, a variable coarse fragment content (0–60% volume), 3–8 cm of forest floor (hemimor), and a gentle slope gradient (0–5%). Initially, the site was winter logged on a 1-m deep snowpack that decreased as the work progressed.

A randomized study design was used, with three replicates of each of the four site preparation treatment types (broadcast burn, disc trenching, pile-and-burn, and no treatment). The 12 treatment units were approximately 30 x 50 m in size, and were planted to lodgepole pine (*Pinus contorta* Dougl. ex Loud) and hybrid white spruce (*Picea glauca* [Moench] Voss *x engelmannii* Parry ex Engelmann).

Site hazard ratings were determined based on site properties, according to the methods described in *Land Management Handbook #8*:

Hazard Rating	
Compaction Hazard:	High (assuming SiL predominant texture)
Mineral Soil Displacement Hazard:	Low
Forest Floor Displacement Hazard:	Moderate
Surface Erosion Hazard	Moderate
Mass Wasting Hazard:	Moderate

3 SITE DISTURBANCE SURVEYS

The procedure for assessing site sensitivity and soil disturbance following harvesting and site preparation has undergone several changes during the past 5 years. The information collected at this study site was categorized according to the disturbance categories and definitions outlined in Curran and Thompson (1991 and 1991a), as follows:

"L" – light machine traffic	—	<5-cm impression into the mineral soil
"1" – heavy machine traffic	—	5–10-cm impression into the mineral soil
"G" – deep gouge	—	> 30-cm deep at the survey point
"D" – deposit	—	deposits of organic/slash/mineral material including piles > 33% mineral soil (minimum mineral soil deposit depth is 3 cm, organic material depth 15 cm)
"U" – undisturbed	—	undisturbed soil, forest floor intact
"O" – other disturbance	—	disturbances not described by other classes

The gridpoint-intercept survey was modified to account for the small plot sizes. Transect lines were laid out diagonally from each plot corner to avoid falling along the same alignment as linear disturbances such as trenches. Four pairs of 30-m transect lines were used to assess soil disturbance in each treatment unit for a total of 720 observations per site preparation treatment type. The plots were surveyed after harvesting to account for logging disturbance, and again after site preparation.

TABLE 1. Percent soil disturbance caused by site preparation techniques

Site preparation technique	**Soil disturbance class (% of treatment area)**					
	L	**1**	**G**	**O**	**D**	**U**
Disc trench						
postharvest	9.7	1.3	0	12.4	0	76.3
after site prep	13.6	0	0.1	15.4	33.5	25.4
change	3.9	-1.3	0.1	3.0	33.5	-50.9
Pile-and-burn						
postharvest	10.3	4.2	0	13.1	0	75.8
after site prep	38.8	2.5	0	10.7	11.8	36.1
change	28.4	-1.7	0	-2.4	11.8	-39.7
Broadcast burn						
postharvest	6.1	0.4	0	11.8	0	81.7
No treatment						
postharvest	12.4	0.1	0	8.8	0	78.8

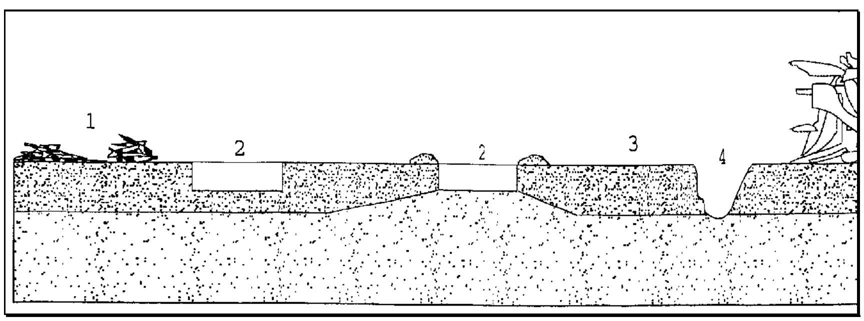
Results of soil disturbance surveys, before and after site preparation, are given in Table 1. Before treatment, there was light soil disturbance over 9.6% of the area, on average, caused by skidder and feller-buncher traffic. This disturbance probably occurred as the depth of the snowpack declined during logging, exposing the soil to machine traffic.

Among site preparation treatments, the pile-and-burn treatment resulted in the highest levels of soil disturbance: 28% of the area sustained a level of disturbance rated as 'light'. In comparison, disc trenching resulted in only 3.9% of the area being affected by light disturbance. Although light disturbance categories are not currently categorized as detrimental soil disturbance, there is potential for some degree of productivity loss from 'light' compaction on some sites, particularly those with fine soil textures associated with damage to surface soil structure and decreased porosity and infiltration rates. It was relatively common to find water ponding in excavator tracks, even though track impressions were generally less than 5 cm deep.

4 MICROSITES CREATED BY SITE PREPARATION TREATMENTS

Site preparation can reduce logging debris and create easily identified microsites, making tree-planting operations more efficient. The untreated plots had excessive accumulations of debris piles, which made planting slow and difficult in approximately 25–35% of the total area.

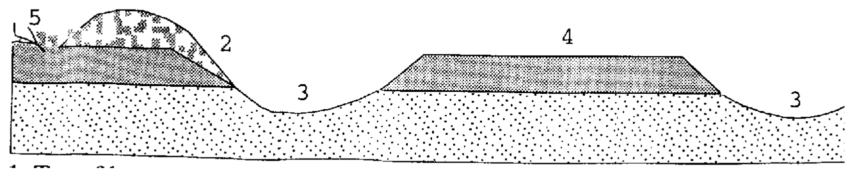
The disc-trenching and pile-and-burn plots were surveyed to determine the proportions of the various types of microsites created by the treatments. For the pile-and-burn treatment (Figure 1), the burned windrow microsite, which is often a favourable planting spot, made up only 8% of the treatment area. Poorer microsites, such as the deep excavator tracks and the unburned windrow pile, made up 15% of the area, which is not a large enough proportion to interfere with achieving acceptable stocking levels.



1. Burned windrow pile (8%)
2. Under excavator track, all materials (10%)
3. Between-piles and tracks, forest floor intact (62%)
4. Scrape or scalp to mineral (3%)
5. Unburned windrow pile (5%)

FIGURE 1. Cross-sectional diagram of pile and burn treatment showing microsite types and proportions.

Disc trenching creates a variety of different microsites (Figure 2). Berm microsites made up 20% of the area and averaged 25 cm in height (height decreased by 20% after the first year). Trenches accounted for 17% of the area and were 15 cm deep, on average (trenches were often discontinuous due to interference from stumps and large slash). Spaces between passes were approximately 2.5 m wide and occupied 30% of the area. The area beyond the edges of the berm, where slash and forest floor materials were deflected, was not plantable, and represented 16% of the area. Overall, the total soil displacement (trench microsite) was 17%, which is well below the maximum displacement (40%) allowed for low to moderate hazard ratings.



1. Top of berm (intermixed mineral/organic material) (20%)
2. Hinge (intermixed, mineral, forest floor) (17%)
3. Trench (mineral) (17%)
4. Between trench (intact forest floor) (30%)
5. Mixed slash/forest floor between flipped berms (16%)

FIGURE 2. Cross-sectional diagram of disc-trench treatment showing microsite types and proportions.

5 CONCLUSIONS

The potential benefits of mechanical site preparation include more efficient planting and improved microsites for seedling establishment and growth. One of the possible risks is detrimental soil disturbance, which may reduce long-term site productivity. Risks associated with machine traffic may be higher for mechanical site preparation than for harvesting because mechanical site preparation cannot be done on snow or on frozen soils. On these sites, the soil moisture can be relatively high throughout the growing season, substantially increasing the susceptibility of the site to compaction and puddling.

This study showed that pile-and-burn treatments are more likely to cause unwanted soil disturbance compared to disc trenching. Light disturbance from excavator tracks was observed over 28% of the treatment area, compared to 4% for disc trenching. Soil bulk density measurements suggest that this disturbance could negatively affect site productivity (Yole and Kranabetter 1996). Soil disturbance classified as 'light' (< 5-cm impression into mineral soil) may nevertheless cause concern because of the negative effect on seedling growth. The windrow microsites often show good seedling survival and growth, but only 8% of the treatment area is made up of this microsite. In addition, the pile-and-burn treatment can reduce the distribution of coarse woody debris across the site, with unknown ecological consequences. Of the site preparation treatments examined, the pile-and-burn treatment represents the largest risk to long-term site productivity, with the smallest return in microsite enhancement.

Disc trenching was found to cause less soil disturbance than pile-and-burn, and to create more-enhanced microsites for planting (Yole and Kranabetter 1996). The risk of detrimental soil disturbance is related more to displacement, such as long gouges, than to compaction. Lower amounts of compaction occur because the discs are aligned with the skidder wheels, so the soil is displaced immediately after being driven on. However, the exposed soil in the trench was found to be relatively poor, which could affect subsequent root growth across that microsite.

Broadcast burning has the benefit of less potential soil disturbance from compaction or displacement, but creates other risks associated with nutrient loss from severe burns, or from fire escapes and off-site damage. The no-treatment option offers the least risk of soil disturbance, but also provides the least favourable microsite for seedling growth. The effects of site preparation on seedling establishment and growth will be considered in a future memo.

LITERATURE CITED

British Columbia Ministry of Forests. 1993. Land Management Handbook #8. Hazard assessment keys for evaluating site sensitivity to soil-degrading processes—Interior sites. Victoria, B.C. 16 p.

Curran, M. and S. Thompson. 1991. Measuring soil disturbance following timber harvesting. B.C. Min. For., Nelson, B.C. Land Manage. Handb. Field Guide Insert 5. 25 p.

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More information on methodology and treatment response is contained in the second-year progress report, which can be obtained through the British Columbia Ministry of Forests Regional Forest Science Section (Smithers).

[AC1]Page: 1

Just a suggestion, but it is better not to have the same main title for several memos. In any case, the titles of these two memos should be changed.

[AC2]Page: 1

I assume this is what you mean. It is unclear whether the use of broadcast burning has declined compared to mechanical treatments, or if the costs, risks, and restrictions for broadcast burning have increased compared to the costs, risks, and restrictions for mechanical treatments.