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SKID ROAD REHABILITATION TECHNIQUES FOR RESTORING PRODUCTIVITY IN THE B.C. INTERIOR

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ABSTRACT

Ground based harvesting, or ground skidding, is still an acceptable harvesting method on gentler slopes and on less sensitive soils. Skid road rehabilitation is a relatively new treatment; for excavated and bladed trails, rehabilitation became a requirement on many sites under the 1995 Forest Practices Code. It will be required on all sites by June 15, 1998. In order to evaluate how trees have been growing on skidroad rehab, we have sampled sites in the east and west Kootenay that are as old as 1984. These sites are growing trees, and with improved techniques, applied to the least sensitive sites, we don't see any problems restoring soil productivity. More sensitive sites still need more study at this time. Successful skid road rehabilitation starts with a good understanding of the site condition and management constraints. Proper construction is key. Removal of woody debris and outsloping decompaction will ensure drainage restoration, along with regularly spaced, open waterbars. Replacing soil horizons in reverse order with minimal mixing will help restore topsoil, which is then protected and augmented with woody debris and slash loading similar to the surrounding area.

INTRODUCTION

In the B.C. Interior, forest harvesting is done using a number of methods ranging from helicopter and cable systems, to ground based systems. On gentler slopes and sites with less sensitive soils, ground based skidding is still an acceptable harvesting method. As long as site productivity and off-site resource values can be protected, ground skidding may be considered preferred because it may be considered the most economic, yielding higher stumpage for government revenue. Implementation of the Forest Practices Code in 1995 made rehabilitation mandatory for excavated and bladed trails (skid roads) on many sites effective immediately, and on all sites by 1998. Rehabilitation is satisfactory only when productivity and slope hydrology are restored to the satisfaction of the District Manager.

Site productivity loss may occur due to decreased root penetrability, moisture availability, decreased aeration resulting from soil compaction, and nutrient loss caused by the disturbance or removal of surface soil horizons. The impact of skid roads is not necessarily localized, with potential on-site effects such as water diversion and erosion taking place throughout the cut block, and possible off-site impacts such as land slides and sedimentation affecting other resource values.

Several studies have documented varying degrees of reduced tree growth on excavated and bladed skid trails, ranging from a decrease of 15% to 59% averaged over the disturbance type, when compared to trees grown on undisturbed soil in the same cut block (Smith and Wass, 1979, 1980; Thompson et al, 1990). Discrepancies in the findings of tree growth reductions may be due to species and site specific responses to soil disturbance, varying degrees of the severity of disturbance, or other growth limiting factors that may magnify or alleviate the impacts of soil disturbance. Even a conservative estimate of tree growth reductions, when prorated over the area covered by skid roads in a cut block, has significant implications on future volume yields For example: site productivity loss of an average 30% on skid roads covering 13% of the cut block would result in a 3.9% reduction in volume yields, with resulting annual allowable cut (AAC) implications.

Minimizing soil degradation and productivity losses resulting from ground based skidding may be accomplished by cable harvesting where appropriate, or by rehabilitation of skid roads where site conditions and off-site risk are favourable to ground based skidding. Crestbrook Forest Industries Ltd. began rehabilitating roads in their Elko division in 1984, having recognized the improved visual quality of cut blocks and the economic sensibility of maintaining conventional harvesting operations. In the West Kootenay, Atco Lumber Ltd. applied a similar practice on their haul roads. Other licensees have also recognized the potential of skid road rehabilitation and the practice has occurred sporadically throughout the region. Skid road rehabilitation has an estimated cost of $1.50/m^3 utilizes equipment available during the harvesting operation, and provides employment. This compares to an additional cost (loss of government stumpage revenue) of $10.00/nnr over ground based skidding cost for a cable harvesting operation. Most of this is equipment cost, and results in a corresponding loss of government revenue. There is a clear need to balance the practice of skid road rehabilitation as defined by restored site productivity, sensible economics, and employment stability, with site sustainability and environmental risk.

STUDY METHODS

In order to evaluate tree growth on rehabilitation we have started a preliminary study on tree growth at ten historic plantations established between 1984 and 1994 and covering several biogeoclimatic zones and three tree species: lodgepole pine *(Pimts conforta),* Engelmann spruce *(Picea engelmannii),* and Douglas fir *(Pseudotsuga menziesii).* The study sites, listed in Table 1, often represent "worst case scenarios" with regard to soil, climatic and rehabilitation techniques. Our rationale is that if trees are growing okay on these sites, then productivity should definitely be restored under better site conditions or better techniques. The method of rehabilitation in all cases was recontouring of the slope, with the original skid road surface usually remaining intact underneath the fill (outsloping decompaction is now required). In total, 2,200 trees were measured for incremental and total height, and basal diameter in four treatment categories: the inner track, rnidroad, and berm across the original skid road area, with trees growing in the undisturbed medium adjacent to the skid road comprising the fourth category.

Table 1 Study Site Description

Study Site	Retrospective Study or Established Trial	Species and Age of Trees	Biogeoclimatic Subzone	Elevation (meters)	Aspect
Bell Creek	Retrospective	Fd - 7 years	ICHdw	960	west
Bloomridge	Established	Pl - 4 years	MSdk	1440	
Camp Creek	(to be) Established				
Caven Creek	Retrospective	Pl - 5-9 years[1] at 20 cm stump height in 1995	MSdk	1110	north
Dry Creek	Established	Pl - 4 years	ESSFdk	1720	south
Erie Creek	(to be) Established				
Grave Creek	Established	Pl & Se - 5 years	ESSFdk	1760	east & north[2]
Goldstream Creek	(to be) Established				
Hudu Creek	Retrospective	Pl - 6 years	ICHmw2	1170	south
East Lussier Creek	Established	Pl -3 years	ESSFdk	1760	north
Lussier River	Retrospective	Pl - 7 years	ESSFdk	1530	south west
McMurdo Creek	Retrospective	Se - 6 years	ESSFwm	1700	north
Nickel Creek	(to be) Established				

Data analysis was done using version 6.04 of SAS-PC (SAS Institute Inc. 1985). Analysis of variance (ANOVA) and the following contrasts were the primary analyses used for comparison of treatment

1 Caven Ck. was a naturally regenerated site, recontoured in 1984.
2 The different aspects at Grave Ck. are treated as separate sites, East Grave and North Grave Ck.

types: berm and undisturbed vs. inner track and midroad, berm vs. other treatments, undisturbed vs. other treatments, midroad vs. other treatments, and inner track vs. other treatments.

RESULTS

The data was analyzed to determine region-wide trends, and in species, biogeoclimatic zone, and soil type groupings. In the region wide analysis, the berm trees were found to be growing significantly better compared to the other treatments for three year increment (P values less than or equal to 0.05). The trend of improved growth of the berm vs. the other treatments was also found in biogeoclimatic and species/soil type groupings, along with improved growth in the berm and undisturbed vs. inner track and midroad analysis. Across four blocks and two species in the Rocky Mountain and Purcell grouping, at both height year five and at the total height for the blocks, the above contrasts were significant for total height and three year increment, with berm values ranging from 93% to 121% of the undisturbed. Berm and undisturbed vs. inner track and midroad were close to significant for diameter, and berm vs. other treatments was significant for diameter and close to significant for volume at the maximum height for the blocks, with berm values ranging from 97% to 170% of the undisturbed for diameter, and from 88% to 302% for volume. At height year five, midroad was found to have significantly decreased growth compared to the other treatments for total height, with midroad values ranging from 84% to 95% of the undisturbed. Data for the largest grouping is listed in Table 2, other data is available in an upcoming technical report.

In summary, out of 29 significant comparison (contrasts) among all groupings and variables, a total of 22 were either berm vs. other treatments or berm and undisturbed vs. inner track and midroad. In all cases, it was the berm, or berm and undisturbed, which showed significantly better growth than the main rehabilitated areas (inner track and midroad treatments). Overall, the improved growth of berm treatments indicates the potential that proper skid road rehabilitation has for restoring, and perhaps even improving, site productivity (similar to some forms of site preparation by controlling growth limiting factors such as competing vegetation).

Table 2 Values by block, species, treatment for all blocks at the maximum block height.

Block	Species	Treatment	Volume (cm)	Diameter (cm)	% Volume	% Diameter
BELL	Fd	BERM	752.04	3.80500	366.731	169.866
BELL	Fd	INNER	300.15	2.74500	146.365	122.545
BELL	Fd	MIDROAD	738.15	3.86500	359.956	172.545
BELL	Fd	UNDIST	205.07	2.24000	100	100
BLOOM	Pl	BERM	18.07	1.06071	56.812	80.663
BLOOM	Pl	INNER	18.94	1.10000	59.569	83.650
BLOOM	Pl	MIDROAD	26.06	1.15000	81.958	87.452
BLOOM	Pl	UNDIST	31.80	1.31500	100	100
CAVEN	Pl	BERM	664.95	3.25500	62.643	82.405
CAVEN	Pl	INNER	648.92	3.12105	61.132	79.014
CAVEN	Pl	MIDROAD	817.11	3.28500	76.977	83.165
CAVEN	Pl	UNDIST	1061.49	3.95000	100	100
DRY	Pl	BERM	4.74	0.62800	167.673	122.896
DRY	Pl	INNER	6.53	0.72600	231.145	142.074
DRY	Pl	MIDROAD	6.94	0.76000	245.630	148.728
DRY	Pl	UNDIST	2.83	0.51100	100	100
EAST GRAVE	Pl	BERM	129.58	1.99286	98.084	101.567
EAST GRAVE	Pl	INNER	85.16	1.74592	64.459	88.982
EAST GRAVE	Pl	MIDROAD	104.66	1.91200	79.218	97.446
EAST GRAVE	Pl	UNDIST	132.11	1.96211	100	100
EAST GRAVE	Se	BERM	45.90	1.51770	78.319	93.154
EAST GRAVE	Se	INNER	33.82	1.32931	57.708	81.591
EAST GRAVE	Se	MIDROAD	37.86	1.33917	64.605	82.196
EAST GRAVE	Se	UNDIST	58.61	1.62925	100	100
NORTH GRAVE	Pl	BERM	90.16	1.62500	89.052	92.835
NORTH GRAVE	Pl	INNER	66.60	1.51515	65.783	86.559
NORTH GRAVE	Pl	MIDROAD	69.65	1.59397	68.796	91.062
NORTH GRAVE	Pl	UNDIST	101.25	1.75042	100	100
NORTH GRAVE	Se	BERM	42.44	1.38981	98.425	103.785
NORTH GRAVE	Se	INNER	32.52	1.24259	75.426	92.791
NORTH GRAVE	Se	MIDROAD	26.14	1.24035	60.615	92.624
NORTH GRAVE	Se	UNDIST	43.12	1.33913	100	100
HUDU	Pl	BERM	1589.15	4.97500	192.740	131.094
HUDU	Pl	INNER	1196.88	4.20000	145.164	110.672
HUDU	Pl	MIDROAD	2190.85	5.49500	265.717	144.796
HUDU	Pl	UNDIST	824.50	3.79500	100	100
LUSSIER	Pl	BERM	691.80	3.53871	186.263	130.179
LUSSIER	Pl	INNER	205.69	2.18548	55.380	80.398
LUSSIER	Pl	MIDROAD	252.96	2.31613	68.107	85.204
LUSSIER	Pl	UNDIST	371.41	2.71833	100	100
McMURDO	Se	BERM	65.20	1.73000	302.104	170.724
McMURDO	Se	INNER	42.30	1.47833	195.979	145.888
McMURDO	Se	MIDROAD	37.76	1.44333	174.947	142.434
McMURDO	Se	UNDIST	21.58	1.01333	100	100

Site specific growth limiting factors ranged from dry soil and competing vegetation to cold, wet soil and competing vegetation, to nutrient poor (calcareous) soils. Growth limiting factors are discussed in the context of growth differences among disturbance types, and with regard to the nature of the rehabilitative work done.

This study was designed to examine the growth of healthy, unbrowsed trees in order to provide a clear picture of the effects of skid road rehabilitation on tree growth. The data was initially analyzed without the browsed trees, and then analyzed to include all trees. 20 out of the 29 significant contrasts from the unbrowsed data set were also found to be significant in the analysis of all trees demonstrating a similar trend in the data when browsed trees are included.

CONCLUSIONS

Practices which attempt to return the soil and slope characteristics to the original state, with regard to site specific growth limiting factors, have the potential to enhance seedling establishment and initial productivity, as shown by the improved growth in the berm treatment in this study. If the running surface is ripped outsloping to restore slope hydrology, the soil reconstructed to resemble its original state, and the practice is restricted to the appropriate conditions, ground based skidding with full rehabilitation of skid roads appears to be a viable practice.

The sites in this study were selected for individual local site characteristics in order to examine tree growth on rehabilitated skid roads in blocks which have extreme growing conditions, including nutrient deficient soils, short growing season, and wet sites. The ICHdw, MSdk, and ESSFdk biogoeclimatic subzones have experienced some successful rehabilitation, while the ICHmw2 (Hudu Creek) and ESSFwm (McMurdo Creek) biogeoclimatic subzones have experienced only limited successful rehabilitation. These sites thus represent the outer limit of successful rehabilitation. The consistently improved growth of the berm treatment at McMurdo Ck, and of all skid road treatments at Hudu Ck. provides important information regarding the effectiveness of skid road rehabilitation at locations with limited use of the practice. Overall, the improved growth of berm treatments indicates the potential that skid road rehabilitation has for restoring, and even improving, site productivity.

RECOMMENDED REHABILITATION TECHNIQUE

The primary objective in skid trail rehab is to restore the natural hill slope drainage, thereby preventing erosion and/or drainage diversion. When subsurface drainage hits a cut skid trail, it will usually surface and run down the trail until it is directed off by a waterbar, dip, or outsloping section of trail. These are all important drainage control features to build into a trail and maintain until rehabilitation (remember that major runoff events can occur at any time, even during the harvesting operation). Not only do intact skidroads increase the risk for erosion, but even when waterbarred, they concentrate the snowmelt that should be available for summer drought, downslope, away from hill slope seedlings.

In addition to restoring slope hydrology, every reasonable effort is made to re-establish the natural soil horizons on a cut skid trail. In forest soils, it is primarily the forest floor and the top 30 cm of mineral soil that are the favourable growing medium or topsoil that is important to carefully handle for successful rehabilitation. Deeper mineral soil often represent unfavourable subsoil, such as calcareous or dense horizons.

During trail construction branches and woody debris are first removed and placed on the downhill side; forest floor and topsoil are then stripped and placed on top of the branches. The running surface is constructed out of subsoil, with the topsoil safely stored beneath this. An excavator is required for excavated and bladed trails (those with 30 cm or greater cutbank height).

To rehabilitate a trail you first remove any woody debris from the running surface because this may act as a wooden culvert and pipe subsurface water. The running surface is then decompacted in an outsloping manner Running surface decompaction should not be done with ripper teeth because continuous rips will divert water. Decompaction is best done by fluffing with the excavator bucket or other attachment being used for rehabilitation. Use two strokes, shallower on the inner track (we don't want to intercept more water), and deeper on the midroad (about 30 cm or 1 foot). Forget the outer track, it will be decompacted during recontouring.

Soil materials are then replaced in reverse order, subsoil first. Topsoil is replaced and the natural slope contour re-established. When restoring the contour it is important not to disturb the natural duff above the trail, or cut more into the cutbank, nor gouge deeper than the sidecast on the lower side (placing branches below the trail during construction can help with topsoil salvage).

Slash and other woody debris are placed back on top of the rehabilitated trail to a similar level as the surrounding cutblock; this is done to provide cover to protect the soil from raindrops and erosion, and shade for seedling regeneration. Do not over do it on the slash, too much will obstruct seedling regeneration and growth, and create an eyesore. It is the fine material that is most important for restoring the forest floor through decomposition.

To ensure subsurface drainage is restored, deep waterbars are still strongly recommended because the loose, rehabilitated soil may still pipe some water. Deep water bars are left open and run from the inner track out, through the sidecast. Spacing should be the same as normal deactivation and logs may be placed in these if visuals are of concern.

Winter Trails

Winter skid trails are constructed using as much snow as possible. Snow is effectively treated as both a first topsoil layer, and then also used to finalize the running surface. First, snow is scraped off the cut area and compressed in the side cast area. A minimal cut is then made the same way as summer constructed trails, with the topsoil safely stored under the running surface. Snow is typically mixed with the subsoil to create a running surface that sets up very hard overnight.

Winter constructed skidtrails must be rehabilitated the same winter, as they are impassable after snowmelt and drainage control is needed before snowmelt occurs. Winter rehab is similar to summer, except that decompaction is less of a concern if a good snow running surface has been used. Woody debris is first removed and the snowy running surface ripped up and snowy chunks discarded. The original soil surface is checked for compaction, decompacted if necessary, and then the subsoil and surface soil is replaced. The woody debris is then placed back on top to achieve a similar slash loading to the rest of the cutblock. Remember the trail will settle as the snow melts out, so recontour thicker than summer trails to compensate for this.

Haul Roads and Landings

Rehabilitation of haul roads follows the same principals as skid roads and has been successfully carried out by some West Kootenay Licensees since the mid 1980s, such as Atco Lumber Ltd. Landings can also be rehabilitated similarly to skidroads, but those with large cutbanks typically involve so much unfavorable subsoil that it is usually only practical to rehabilitate the outer half or two-thirds of the landing.

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