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Tree Growth for 15 Years Following Stumping in Interior British Columbia

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Strategic Importance

Maintaining long-term site productivity and the quality of the soil are fundamental considerations in any silvicultural treatment. Stumping, an operation associated with high levels of soil disturbance, has been used since the 1970s as a treatment to reduce the impact of Armillaria root rot. While stumping can control the spread of root rot, forest productivity losses from soil compaction and nutrient depletion due to soil displacement may be expected.

We have monitored the growth of planted Douglas-fir, lodgepole pine and western larch seedlings during 15 years after stumping operations at two sites. Bulldozers were used to extract and windrow or pile stumps and to rake the soil to bring roots broken off during stumping to the surface. These actions caused some degree of categorized soil disturbance in almost 100% of the treated areas. Today, the Forest Practices Code of British Columbia limits stump removal operations to less sensitive sites and stresses minimizing detrimental disturbance types. However, the disturbance categories studied on the two sites are essentially the same as those resulting from a variety of forestry operations. These sorts of studies are important to document the long-term impacts of soil disturbance on tree growth and to determine the roles of biogeoclimatic zone, soil type and characteristics, severity of disturbance and the tree species in determining the sensitivity of sites to soil disturbance.

The Studies

Two clearcut and stumped areas in south central British Columbia, at Gates Creek near Vernon and Phoenix near Grand Forks have been studied for 15 years. Post-treatment soil studies determined depth and cause of disturbance, soil characteristics such as bulk density, particle size, strength, and penetrability, and soil chemistry for distinct disturbance categories. Seedlings were planted on disturbed soil and on undisturbed soil and their growth was monitored for 15 years. Results after 8 years have previously been reported and some of these are summarized here as background to the 15 year results (Smith and Wass 1991).

Gates Creek rake treatment showing rake and track disturbance.

Gates Creek

The Gates Creek site is in the Moist Warm Interior Douglas-fir (IDFmw1) biogeoclimatic variant with moderately well drained, gravelly sandy loam (9%-13% clay) soils classified as Gleyed Eluviated Eutric Brunisols.

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The study site was divided into three treatments. One area had stumps extracted and windrowed with a bulldozer equipped with a brush blade (Table 1, treatment A). A portion of this area (Table 1, treatment B) was subsequently raked to bring large roots to the surface using the brush blade. A third area was clearcut and the slash windrowed but stumps were not extracted (Table 1, treatment C).

Disturbed soils were significantly denser and less penetrable than undisturbed soil. All disturbance categories, except for the scalp in the non-raked treatment and the undisturbed soil, exceeded the suggested soil bulk density threshold level of 1.4 Mg/m^3 thought to be detrimental to tree growth (Smith and Wass 1991).

Twelve hundred each of Douglas-fir and lodgepole pine were planted in the spring of 1982 on five disturbance categories and on logged but otherwise undisturbed soil.

Table 1. Gates Creek Site Treatment and Disturbance Categories

Treatment	Disturbance Category
A. Stumped and windrowed (Not raked)	Scalp Track
B. Stumped, windrowed and raked, (Raked)	Rake Track
C. Windrow only (Not stumped)	Undisturbed Track

Phoenix

The Phoenix site is in the Kootenay Moist Cool Interior Cedar-Hemlock (ICHmk1) biogeoclimatic variant having well drained gravelly sandy loam (1%-4% clay) soils classified as Eluviated Dystric Brunisols.

Three adjacent areas were harvested and treated. One area was stumped, piled and raked with a bulldozer equipped with a brush blade (Table 2, treatment A), one was stumped and piled only (Table 2, treatments B and C) and a third area (Table 2, treatment D) was harvested only.

Total soil bulk density did not exceed the threshold level of 1.4 Mg/m^3 considered detrimental for tree growth at the 0-10 cm depth in any of the disturbance categories or the undisturbed soil. However, bulk density on the track in the non-raked treatment disturbance exceeded 1.4 Mg/m^3 at the 10-20 cm depth.

Fourteen hundred each of Douglas-fir and western larch were planted in the spring of 1982 on six disturbance categories and on undisturbed soil.

Table 2. Phoenix Site Treatment and Disturbance Categories

Treatment	Disturbance Category
A. Stumped, piled and raked, (Raked)	Rake Track
B. Stumped and piled, deep rutting (Non-raked – deep)	Scalp Track
C. Stumped and piled, shallow rutting (Non-raked - shallow)	Scalp Track
D. Harvested only, (Non-stumped)	Undisturbed

Results

Gates Creek Site

Average tree volume for Douglas-fir for the first five years was greater on one category of soil disturbance, the same for one and less for three categories of disturbance than on undisturbed soil (Figure 1). At 15 years, average tree volume was significantly reduced on all disturbance categories when compared to undisturbed soil. Up to the fifth year, trees planted on tracks in the raked treatment had extremely low volumes.

For the first five years, average tree volume for lodgepole pine growing in all categories of disturbed soil exceeded that in undisturbed soil (Figure 2). By 10 years, however, volumes were less for four of five disturbance categories than in undisturbed soil. After 15 years, tree volumes were greater on undisturbed soil than for all disturbance categories except the rake.

After 15 years, lodgepole pine had tree volumes that were about three times greater than the Douglas-fir (range 3300 to 5000 cm^3 vs. 600 to 2500 cm^3).

Phoenix Site

Except for the 8-year measurement, the average tree volume of Douglas-fir growing on disturbed soil remained above that on undisturbed soil for 10 years with the difference increasing with time (Figure 3). However, by 15 years, volumes for trees growing on three disturbance categories had fallen below that on the undisturbed soil. Especially notable was the slow growth on tracks in the raked treatment and rapid growth on scalped spots in the non-raked (deep) treatment.

For the first four years, the average tree volume for western larch was the same or less on disturbed soil than on

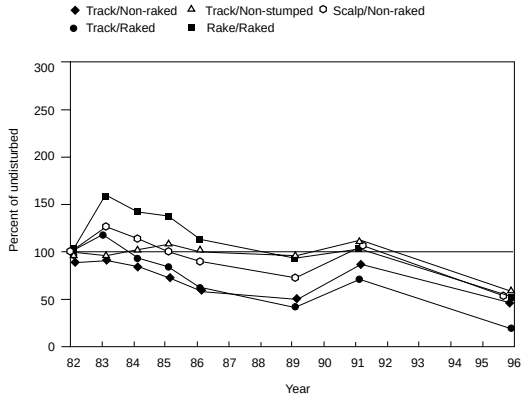

Fig. 1. Average volume of Douglas-fir growing on six categories of disturbed soil as a percentage of volume on undisturbed soil at Gates Creek.

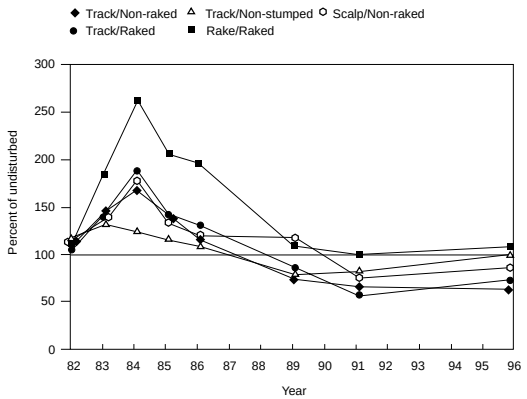

Fig. 2. Average volume of lodgepole pine growing on six categories of disturbed soil as a percentage of volume on undisturbed soil at Gates Creek.

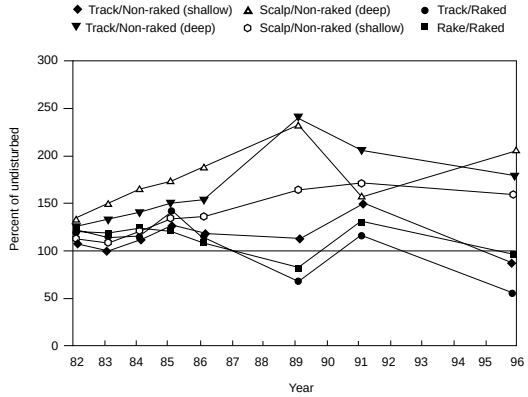

Fig. 3. Average volume of Douglas-fir growing on six categories of disturbed soil as a percentage of volume on undisturbed soil at Phoenix.

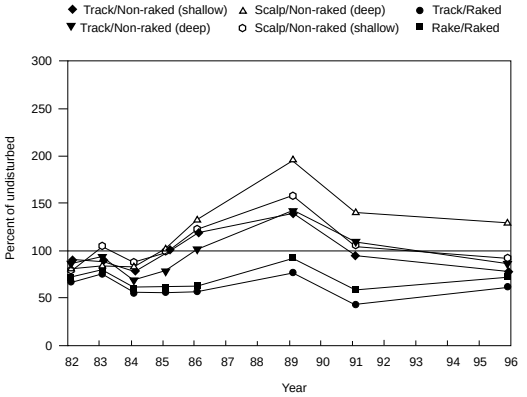

Fig. 4. Average volume of western larch growing on six categories of disturbed soil as a percentage of volume on undisturbed soil at Phoenix.

undisturbed soil (Figure 4). By 10 years, growth was better on three of the six disturbance categories than on undisturbed soil. However, by 15 years average tree volumes on five disturbance categories were less than those on undisturbed soil. Particularly low average volumes occurred for western larch on rakes and tracks in the raked treatment.

After 15 years, western larch had average tree volumes that were about eight times greater than the Douglas-fir (range 5000 to 10,300 cm^3 vs. 500 to 1500 cm^3).

Some Comparisons Between the Two Sites

Since Douglas-fir trees were planted on both sites, their responses to soil disturbance reflect the sensitivity of each site to disturbance. With reference to Figures 1 and 3, it is apparent that tree growth on the Gates Creek site has been more adversely impacted than on the Phoenix site. Undisturbed soils at Gates Creek were considerably denser, less penetrable and moister (gleyed) than undisturbed soils at Phoenix. Furthermore, disturbance increased density and decreased penetrability to a greater extent at Gates Creek than Phoenix. Sensitivity ratings for the two sites reported earlier correspond to tree growth response, i.e., “moderate” for Gates Creek and “low” for Phoenix.

In addition to tree growth, seedling survival was less on tracks at Gates Creek than on undisturbed soil, whereas, at Phoenix, all categories of soil disturbance enhanced tree survival compared to undisturbed soil.

Management Implications

Avoid planting in vehicle tracks or in depressions subject to seasonal ponding.

Initial seedling growth responses may be deceiving. Tree growth has to be followed long enough to overcome the impact of nursery influences and short-lived (transitory) site conditions. Growth trends over the 15-year period indicated that a minimum of 10 years growth is needed to predict the impact on long-term productivity on these sites due to the stumping operation and even 15 years may not be long enough.

Site condition and susceptibility to compaction such as increases to bulk density or decreases to penetrability should guide applications of practices.

Although the objective should be to minimize the amount of soil displacement and compaction in any operation, over time only the most severe impacts significantly reduced productivity on the sites studied.

Where possible, eliminate windrowing and leave stumps in place, possibly upended in the holes left after stump extraction.

Using sufficiently wide, rear-mounted equipment for root raking would decompact the tracks and help restore and maintain soil productivity.

Plant suitable early seral species such as lodgepole pine and western larch on disturbed soils.

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Additional Reading

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