Forest Sciences

Prince Rupert Forest Region

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Excavator mounding to enhance productivity in hypermaritime forests: Preliminary results

Research Issue Groups:

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Mounding trial near Port Simpson, British Columbia.

Introduction

On the outer north coast of British Columbia, high forest productivity is generally associated with sites on steep slopes with good soil drainage and aeration, and a history of natural disturbance by windthrow or landslide events. These disturbance events tend to mix soil layers, slowing the build up of surface organic material, exposing mineral soil, and improving nutrient availability (Bormann *et al.* 1995). In contrast, the lower productivity cedar-dominated sites found on the gentle terrain of the Hecate Lowlands are imperfectly to poorly drained and have much lower levels of available nutrients (Kranabetter and Banner, in prep). This may be due, in part, to the lack of disturbance on these sites, allowing the accumulation of deep organic layers. These stands are currently the focus of considerable management interest because of their vast extent and the potentially merchantable redcedar and cypress they contain. There is some evidence suggesting that forest productivity following logging and site preparation will be greater than that indicated by the old growth condition. There is also valid concern, however, that logging these wet, lower productivity forests could result in site degradation, paludification (bog formation) and regeneration failure. This Extension Note presents preliminary results from an operational mounding trial established north of Prince Rupert, B.C. (Figure 1). The study is concerned with improving site productivity on imperfectly to poorly drained sites and addresses two specific issues. The first issue, the subject of this extension note, concerns seedling growth response on artificially mounded versus unmounded microsites. Measurements included seedling height, basal diameter (calliper), root and shoot biomass, rooting depth and length of lateral roots. The second issue deals with foliar nutrient status of seedlings on five substrate types created by mixing and mounding treatments. The details of the substrate analysis can be found in Extension Note #45 (Shaw and Banner 2001). Though mounding has been used for site preparation in other areas of B.C. (McMinn and Hedin 1990), there have been no trials in wet north coastal forests until now.

Study description

The Port Simpson Operational Trial was initiated in 1990 and has since been incorporated into a larger integrated research project established in 1997 by Forest Sciences staff in co-operation with the North Coast Forest District. The project, entitled "Pattern, process and productivity in hypermaritime forests", or HyP^3 (pronounced "hip-cubed"), is aimed at developing guidelines for the sustainable management of lower productivity cedar-hemlock forests, currently excluded from the operable land base of north coastal B.C. (for more information on the extent of the HyP^3 project see Extension Note #38 [Banner and Shaw 1999]).

The study area is located 30 km northwest of Prince Rupert near the village of Port Simpson, within the very wet, hypermaritime Coastal Western Hemlock subzone, central variant (CWHvh2, see Banner *et al.* 1993). The study area is largely dominated by the Redcedar-Hemlock-Salal site series (Banner *et al.* 1993), considered zonal for the CWHvh2 variant. The major tree species prior to harvest were western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), yellow cedar or cypress (*Chamaecyparis nootkatensis*), with minor amounts of mountain hemlock (*Tsuga mertensiana*), Sitka spruce (*Picea sitchensis*), and shore pine (*Pinus contorta* var. *contorta*). Mean height and diameter at breast height (dbh) of main canopy trees was 20 m and 65 cm respectively. Gross volume per ha was 500 m^3 and net volume per ha averaged 280 m^3.

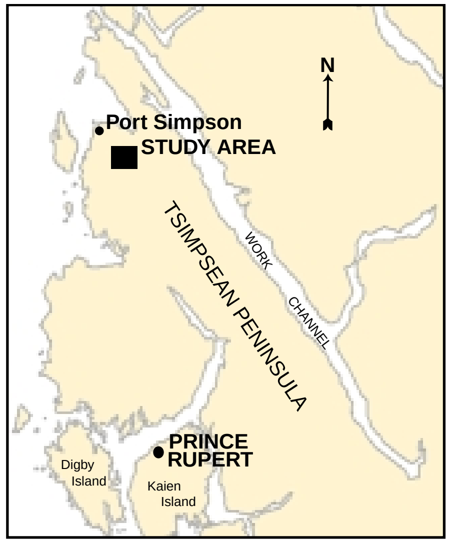

Figure 1. Map of North Coastal British Columbia and location of the Port Simpson study area.

Variability in soil composition and thickness is common on the outer north coast. In general, the soils of the study area are made up of deep surface organic horizons (average depth 52 cm). This organic layer is mostly composed of forest humus on drier microsites and sphagnum peat on wetter ones. In most cases, this layer overlays a thin mantle of mineral soil often less than 50 cm deep. For the most part, the soils are classified as Podzolic and the horizons are derived from metamorphic bedrock (schist and gneiss).

The study area was skidder logged in late summer/fall of 1990. Following harvest, the treatment area was divided into eight plots, four to be mounded and four to be left as controls. Average plot size was approximately 0.18 ha. Once layout was complete, mounds were created using a John Deere 790 DLC excavator equipped with a bucket and thumb attachment. The objective was to build the mounds by overturning one scoop of soil and mixing the mineral horizons with the surface organic horizons. Mounds averaged 0.5 m in height and 1.5 m in diameter. Mound density varied from 250 to 670 per ha. In the spring of 1991, mounded and unmounded plots were planted with equal proportions of western hemlock, western redcedar and shore pine. Height and calliper of planted trees were measured in 1991, 1992, 1994, and 1996. In 1997, 63 trees were manually excavated to compare root development between the mounded and unmounded plots. The other aspects of this study

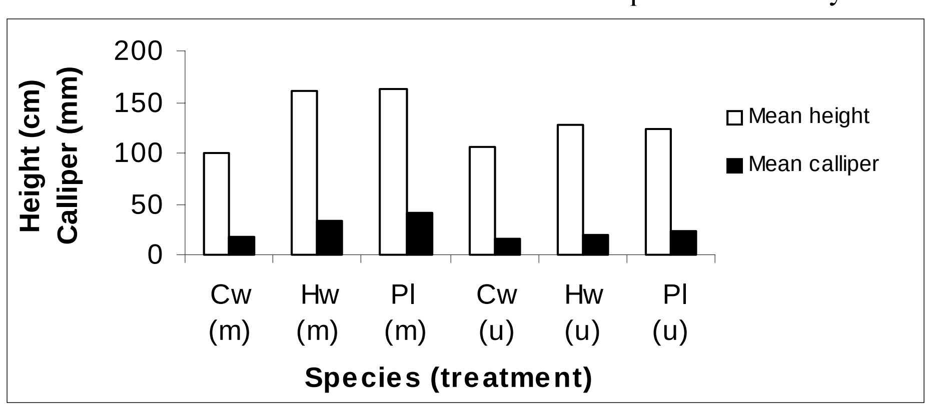

Figure 2. Mean height and mean calliper of western redcedar (Cw), western hemlock (Hw), and shore pine (Pl) five years after planting on mounded (m) and unmounded (u) plots.

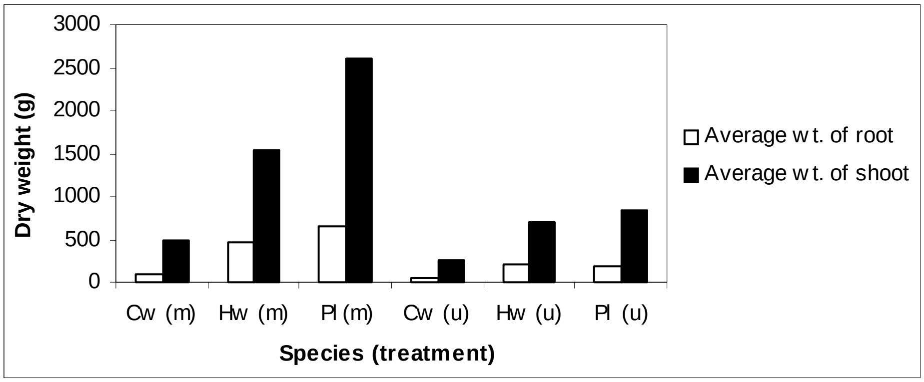

Figure 3. Root and shoot biomass of western redcedar (Cw), western hemlock (Hw), and shore pine (Pl) six years after planting on mounded (m) and unmounded (u) plots.

concerning measurements of vegetation succession, hydrological changes, foliar nutrient chemistry and variation in soil physical and chemical properties related to seedling growth, will be addressed in future publications.

Results and Discussion

Five years after planting, pine and hemlock showed significant treatment effects ($p < 0.05$). Both species exhibited a 30% increase in mean height growth and a 66-68% increase in mean calliper growth on the mounded sites (Figure 2). Redcedar, however, did not exhibit a significant difference between treatments ($p > 0.05$). Preliminary results showed redcedar is marginally better on mounded sites with respect to average height growth, but differences in calliper growth were negligible between treated and untreated areas.

Although there was no difference in root to shoot ratios between treatments, the mean weight of root biomass and shoot biomass increased on the mounds for all species. Hemlock and pine both exhibited significant increases in root biomass and shoot biomass between treatments (Figure 3). Both mean above ground and mean below ground biomass were doubled for hemlock and tripled for pine on mounded sites. Cedar also showed increases in root biomass and shoot biomass between treatments, but the differences were not significant ($p > 0.05$).

Rooting depth on mounded sites also showed a significant difference for all species (Figure 4). Mean rooting depth was 75 to 100% greater for all three species growing on mounded sites compared to unmounded sites (Figures 5 and 6). The mean length of the longest lateral root was also greater on the mounds, especially for hemlock (28% increase) and pine (37% increase). In many cases lateral roots extended well beyond the limits of the mounds.

In general, redcedar performed poorly compared to pine and hemlock, and showed no significant difference in height and calliper between treatments ($p > 0.05$). Overall mortality throughout the study area was also greatest for cedar (68%), compared to hemlock (26%) and pine (14%). The increased mortality and poorer growth response was largely attributed to the poor condition of the cedar stock, especially low root to shoot ratios, and heavy deer browsing after planting. Although these factors have complicated the interpretation of treatment effects on redcedar, the biomass and root growth data showed some positive trends related to treatment (though generally not significant at $p<0.05$). Redcedar's response to site treatments will have to be tested further before any conclusions can be reached.

Initial trends suggest that mounding treatments can have a positive impact on shoot growth, above and below ground biomass, and root development for seedlings planted on these imperfectly to poorly drained sites. The mounding treatment also resulted in soil mixing that revealed some important trends in seedling growth and nutrition. The variable thickness of mineral and organic horizons and the nature of the soils throughout the study area created considerable variation in mound characteristics. We observed trends in seedling response that reflected this variation in substrate type with the best growth occurring on mixed mineral/organic mounds and the poorest growth response on pure organic (especially peat, rather than forest humus) mounds. Though initial results suggest that mounding improves microsite drainage, it could be the mixing of mineral and organic horizons, similar to the turbation resulting from natural windthrow and landslides, that is

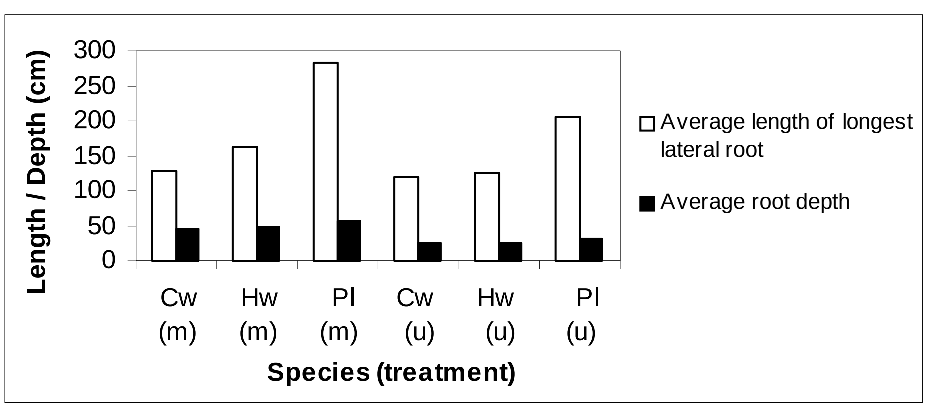

Figure 4. Rooting characteristics of western redcedar (Cw), western hemlock (Hw), and shore pine (Pl) six years after planting on mounded (m) and unmounded (u) plots.

more critical in improving soil nutrient regimes (Bormann *et al.* 1995). A preliminary analysis of seedling nutrition response to substrate types created by varying degrees of mixing at the Port Simpson site is presented in Extension Note #45.

Operational questions still remain regarding the invasiveness of mechanical treatments. One such question is: what level of disturbance is required (or acceptable) to improve overall site productivity? Elevated microsites cannot be created without also creating wetter depressions that soon revegetate with sphagnum and other mosses (Asada, in prep.). In addition, what are the long-term implications of these changes to the site ecology and hydrology, and how long are treatment effects likely to persist? Tree growth response as well as vegetation succession (including natural seedling regeneration) will continue to be monitored at five year intervals at the Port Simpson trial.

The data gathered at Port Simpson provides an initial look at treatment effects, but more data are necessary prior to widespread application on the north coast. Another operational trial is currently underway at Oona River, Porcher Island. Harvesting was completed in 2000 and site treatments were carried out during the summer of 2001. At Oona River, we will be building on our experience from Port Simpson by emphasizing soil mixing while creating slightly elevated microsites. In addition to these two trials, we are seeking other sites on the north coast for future research trials.

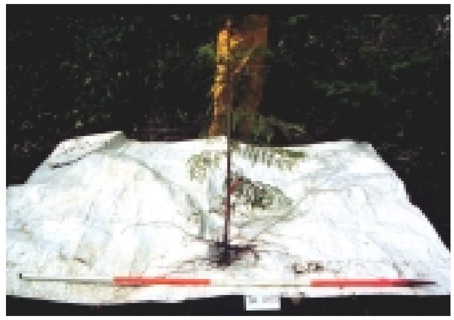

Figure 5. Root development of western redcedar (Cw) growing on unmounded plot six years after planting.

Figure 6. Root development of western redcedar (Cw) growing on mounded plot six years after planting.

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