Matlock Forest Productivity Study

Field Tour of September 19, 2011

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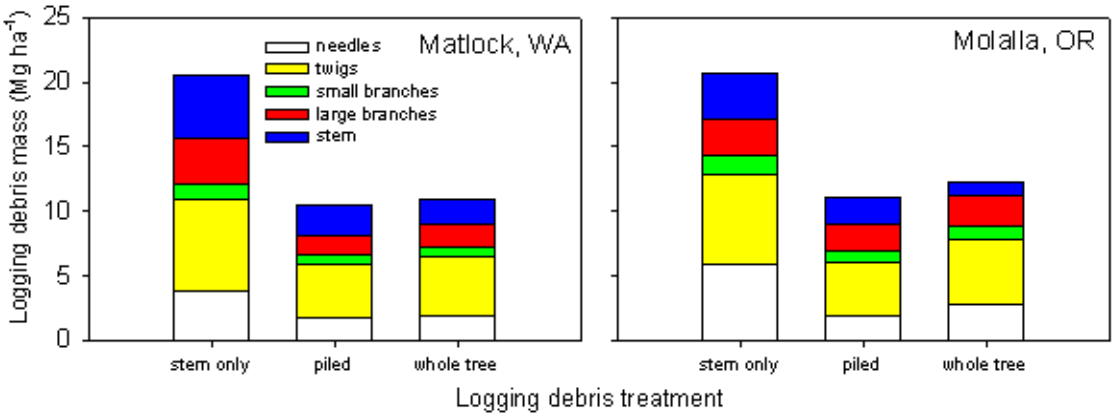
Douglas-fir productivity and soil responses as affected by logging debris and competing vegetation

Rationale and objectives: The Fall River Forest Productivity Study was initiated in 1999 to understand the implications of various harvesting, soil disturbance, and vegetation management treatments on soil processes and productivity of Douglas-fir. In 2003, new studies were established at Matlock, WA and Molalla, OR to contribute to a regional database including the Fall River Study. These contrasting sites were selected to determine how tree and soil responses to silvicultural treatments are influenced by differences in climate and soil texture.

Collaborators: Randall Greggs (Green Diamond Resource Company), Mike Mosman and Jeff Madsen (Port Blakely Tree Farms, LP), Stephen Schoenholtz (Virginia Tech; formerly OSU), Rob Harrison (University of Washington), and Tom Terry (Weyerhaeuser Company; retired). Funding and in-kind support were provided by the Western Region Agenda 2020 Program, Port Blakely Tree Farms LP and Green Diamond Resource Company.

Experimental design: At each site, three levels of logging debris (stem-only harvest, piled, and whole-tree harvest) were replicated 4 times with and without 5 years of vegetation control (see table below). Treatments were initiated in 2003. Douglas-fir seedlings were planted in early 2004.

Logging debris treatment	Competing vegetation control	
1. Stem-only harvest: removal of merchantable logs (minimum diameter 12.7 cm (5 in.) and length 3.7 m (12 ft)) (i.e., *retention* of logging debris)	Initial (year 0)	Annual (years 0-5)s
2. Piled: removal of merchantable logs plus moving of tops and limbs (>5.1 cm (2 in.) diameter) into 2.5-3.0 m (8-10 ft) diameter piles.	Initial	Annual
3. Whole-tree harvest: removal of merchantable logs plus tops and limbs (i.e., *removal* of logging debris)	Initial	Annual



Logging debris in the stem-only treatment ≈ twice that of each of the other two treatments.

Mass estimates for the piled treatment are for inter-pile areas.

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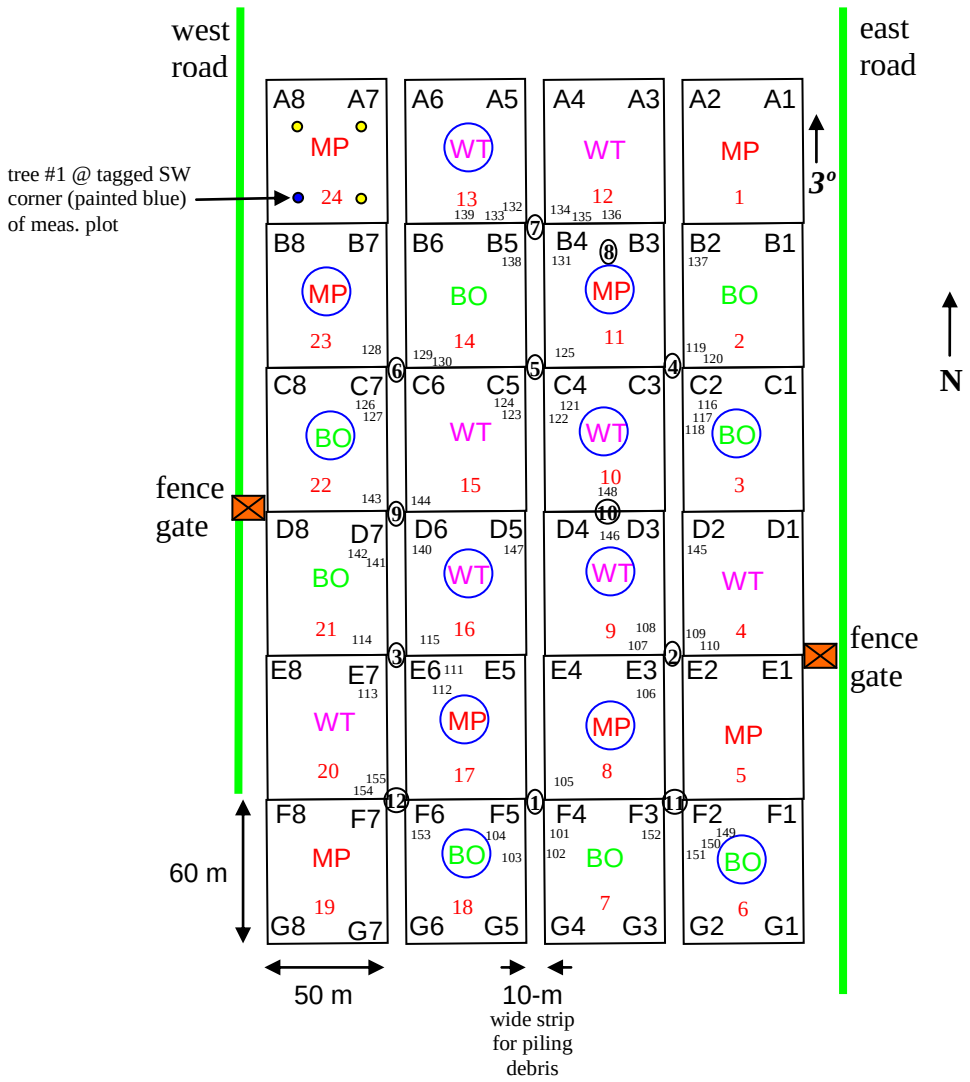
PNW Research Station, USDA Forest Service and Green Diamond Resource Company



T20N R6W S21 W1/2 of NE1/4 (latitude 47.2065°N; longitude 123.4424°W, elevation 118 m)
BO = bole only removal; WT = whole-tree removal; MP = mini-piling of woody debris
Circled trmt codes=competing vegetation control; uncircled trmt codes=no competing vegetation control

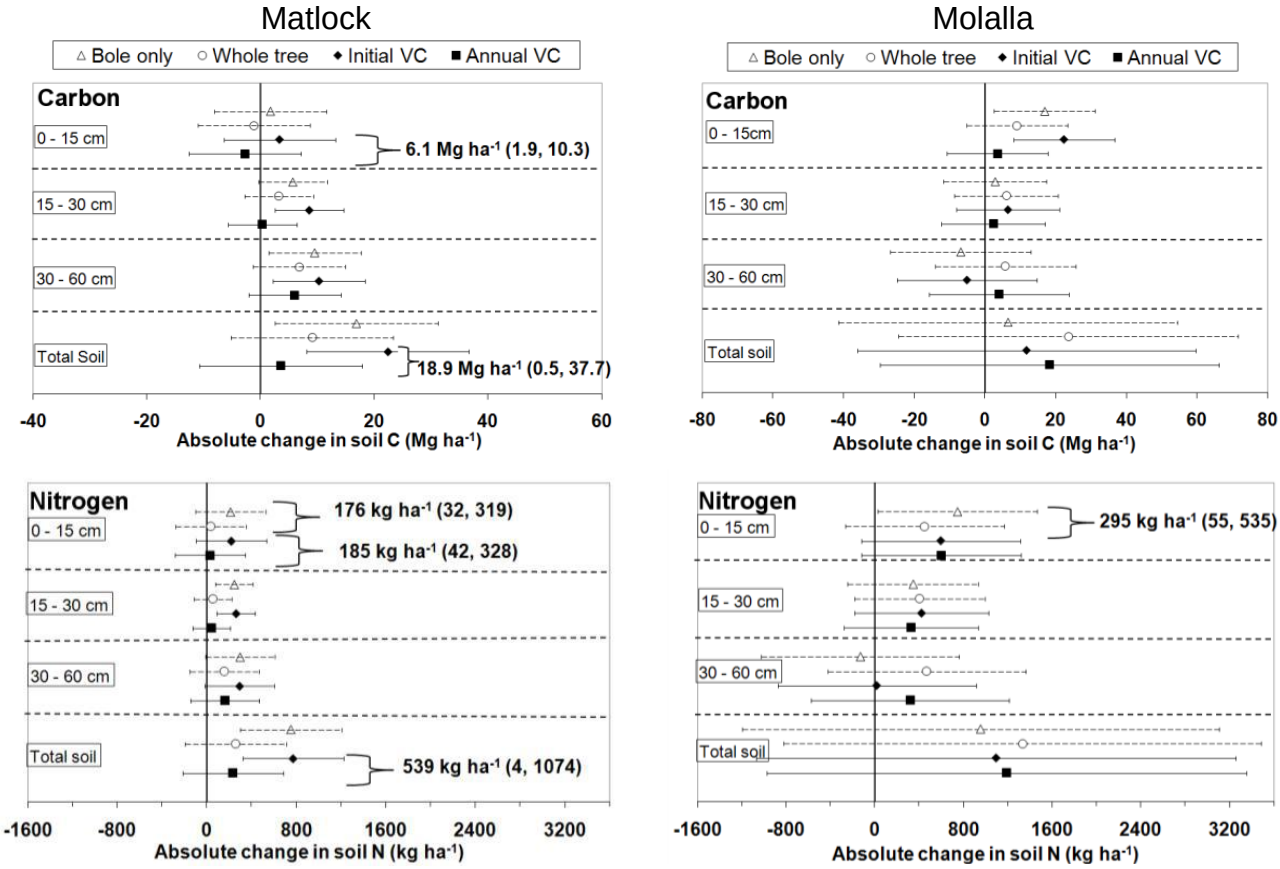
Site Characteristics

Characteristic	Matlock	Molalla
Elevation (m)	118	449
Mean annual precipitation (cm)	240	160
Site index$_{50\ yr}$ (m)	36	36
Particle size distribution (% sand/silt/clay)	65 / 14 / 21	37 / 34 / 29
Bulk density (Mg m^{-3})	1.45 (0.05)	0.98 (0.02)
Coarse fragments by mass (%)	67.6 (1.3)	37.7 (2.2)
Water holding capacity (mm)	170	297
Total soil C (Mg ha^{-1})	92.4 (5.8)	169.5 (12.0)
Total soil N (kg ha^{-1})	3300 (150)	7220 (410)

Matlock soil characteristics: Dystric Xerorthent (Grove series), formed in glacial outwash. Soil is deep, with a loamy sand texture with greater than 50% coarse fragments, and somewhat excessively drained. Profile development is limited, with a Bw horizon in the top 50 cm, overlain by a shallow forest floor (~5 cm depth).

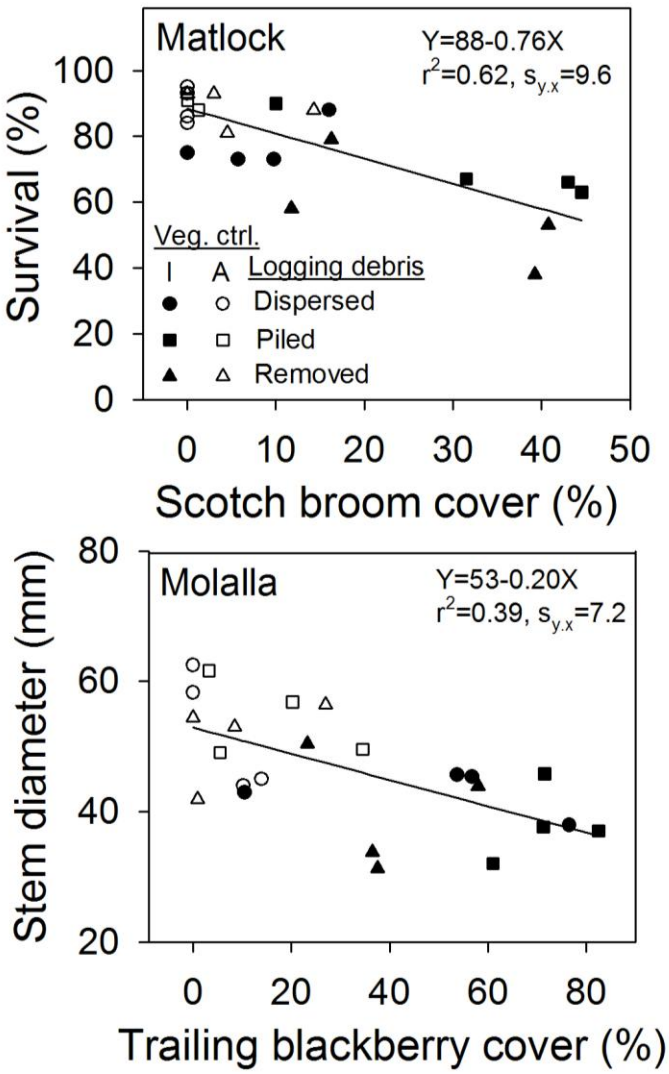
5th-Year Soil Carbon and Nitrogen Responses

- At Matlock, total pools of C, N, Ca, and Mg to a depth of 60 cm were greater than pre-harvest levels in the stem-only harvest and initial vegetation control treatments.
- At Molalla, increases in total N and K were only observed in the 0-15 cm depth.
- Larger total C and N pool sizes at Molalla probably buffered changes since harvest.
- Results are from a paper by Slesak et al. (*For. Ecol. Manage.* 262: 1722-1728).



5-Year Douglas-fir Growth and Survival Responses

- Douglas-fir growth differed primarily due to effects of vegetation control.
- Where annual vegetation control was applied, Douglas-fir growth and survival did not differ among debris treatments, suggesting negligible short-term effects of debris manipulation on soil productivity.
- At Matlock, shoot dieback from Cytospora canker and Douglas-fir twig mining beetle was more prevalent following initial vegetation control. Seedling injury from these native pest species are often indicators of site resource limitations (Dan Omdal, personal communication).



- Debris effects on vegetation abundance were associated with a 30% reduction in survival of Douglas-fir at Matlock and a 30% reduction in stem diameter at Molalla (see figure at left).
- Covers of Scotch broom at Matlock and trailing blackberry at Molalla were over 20% greater where debris was piled versus dispersed.
- Results are from Harrington and Schoenholtz (CJFR 2010 vol. 40: 500-510).

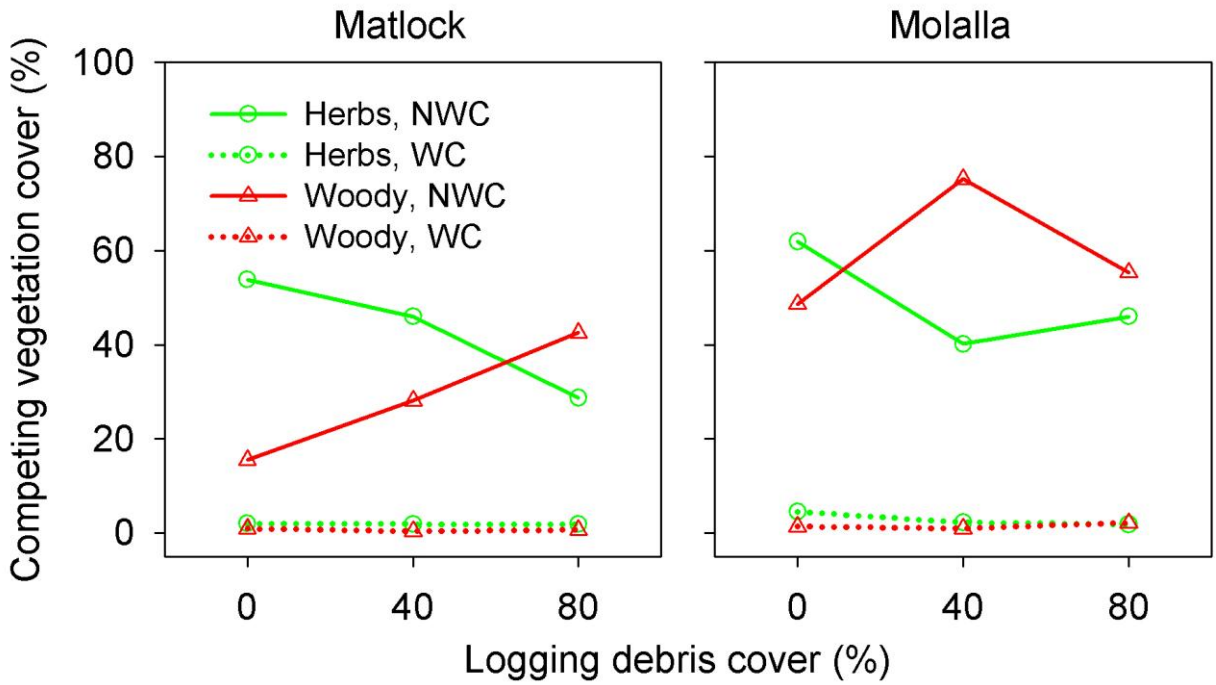
Individual-Tree Study to Identify Factors Limiting Forest Productivity

Approach: An individual-tree study was established in early 2005 at each site to determine mechanisms by which logging debris and competing vegetation influenced Douglas-fir growth. The experimental unit was the 2- x 2-m growing space surrounding an individual tree.

Experimental design: 8 replications x 3 levels of logging debris x 2 levels of vegetation control = 48 trees at each site. Treatments:

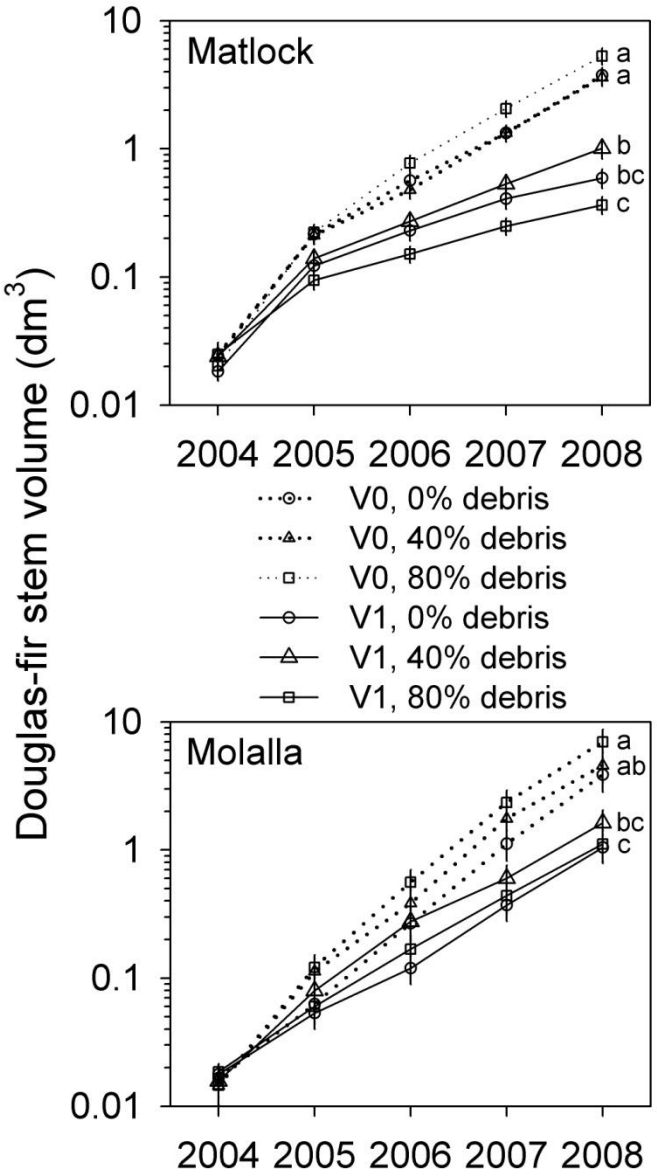
- Logging debris (2-5" diameter) was collected from areas adjacent to the study plots, and one of three levels of logging debris cover (0, 40, or 80%) was randomly assigned to each of the 48 Douglas-fir seedlings one year after being planted.
- Complete vegetation removal was randomly assigned to half of the trees; treated area = 2 m x 2 m.

Competing Vegetation Responses



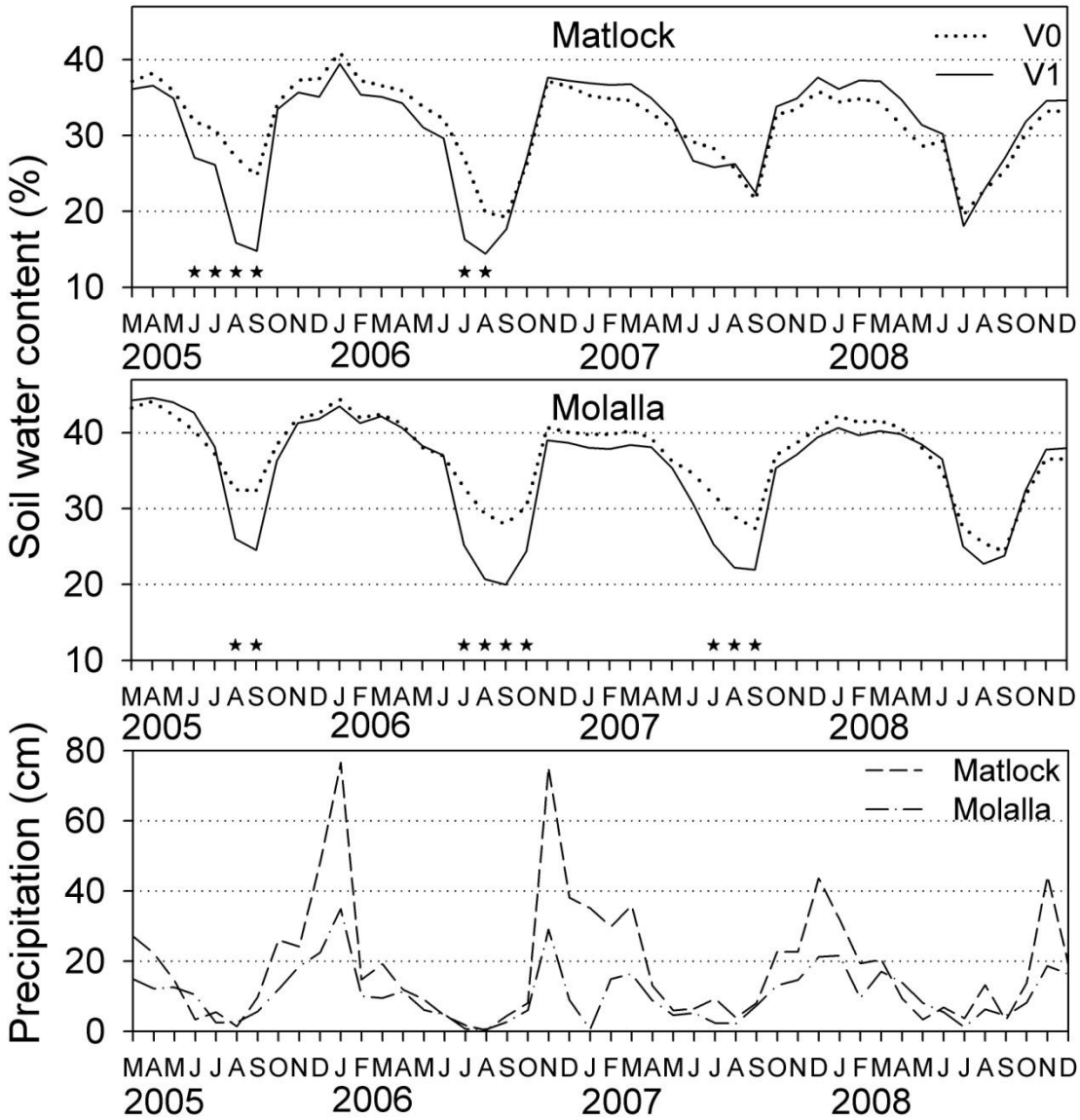
- Logging debris was associated with reductions in herb cover at each site.
- At Matlock, composition of competing vegetation shifted from herbaceous to woody species with increasing cover of logging debris.
- At Molalla, 40% debris cover had the highest blackberry cover and the lowest herb cover.
- Results are from a paper by Harrington et al. (in preparation).

4-Year Douglas-fir Growth Responses



- Stem volume is shown here plotted on a logarithmic scale to illustrate differences in relative growth rate.
- Douglas-fir growth responses to treatment were largely attributable to presence versus absence of competing vegetation.
- Where competing vegetation was absent (V0), mulching effects of debris (soil water conservation) probably increased tree growth.
- Where competing vegetation was present (V1), 40% debris cover was associated with moderate increases in tree growth at both sites.
- Debris facilitated increases in site occupancy by trees and other woody vegetation via reductions in herb cover.
- Typical covers of logging debris (30-40%) remaining after stem-only harvest may provide short-term benefits to plantation establishment by increasing seedling access to soil water through shifts in vegetation composition.
- Results from Harrington et al. (in preparation).

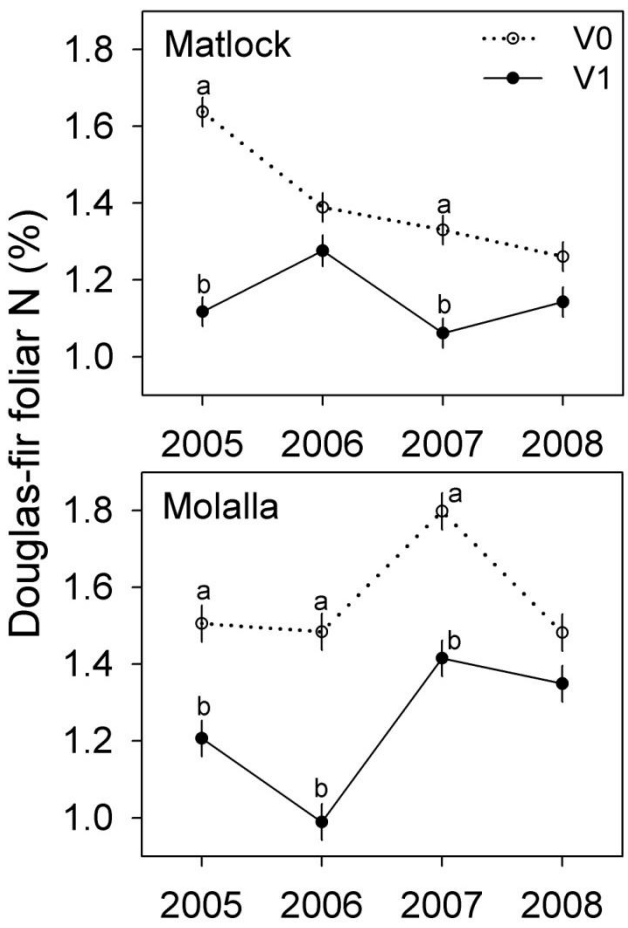
4-Year Soil Water Responses to Competing Vegetation



- Increases in tree growth (see previous page) from absence of competing vegetation (V0) were primarily a result of increases in soil water.

- In this tree-centered study, increases in soil water from absence of competing vegetation were only detected during the first 2 years at Matlock and during the first 3 years at Molalla because in the following year the focal Douglas-fir had fully occupied its growing space.

Douglas-fir Foliar Nitrogen Responses



- Increases in Douglas-fir foliar N concentration due to absence of competing vegetation (V0) decreased with time at Matlock because of increasing occupancy of growing space by the focal Douglas-fir.
- The same trend was not evident at Molalla, but differences were no longer statistically significant by 2008.
- These results confirm that seedling growth responses to the treatments, including the rate of growing space occupancy, were mediated by the inherent limitations in soil resources at each site.
- Through year 5, soil water and nitrogen were strongly limiting to tree growth at Matlock, whereas only soil water was strongly limiting at Molalla.