

Site Preparation

1. Alvarez, I.F. and J.M. Trappe. 1983a. Dusting roots of *Abies concolor* and other conifers with *Pisolithus tinctorius* spores at outplanting time proves ineffective. *Canadian-Journal-of-Forest-Research* 13(5): 1021-1023.

Keywords: planting operations
site preparation
mechanical preparation
growth
tree/stand health
mycorrhizal response

Abstract: Dusting roots of *Abies concolor*, *Abies magnifica* var. *shastensis*, *Pseudotsuga menziesii* and *Pinus ponderosa* with *Pisolithus tinctorius* (Pt) spores when planted out produced no Pt mycorrhizae at the end of the first growing season. In the 3rd yr occasional Pt mycorrhizae had formed on *A. concolor*. Inoculations reduced seedling survival in some cases. High rates of spore application may have desiccated roots of the true firs and spore amounts applied need careful attention. Soil scarification and ripping significantly promoted growth of *A. concolor* seedlings compared with scarification alone.

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2. Belz, D. and T.E. Nishimura. 1989. Effects of imazapyr, 2,4-D and metsulfuron methyl on conifer tolerance. *Proceedings-of-the-Western-Society-of-Weed-Science* (Vol. 42): 98-104.

Keywords: site preparation
chemical preparation
release treatments
chemical release
tree/stand health

Abstract: Imazapyr at 0.25-1.0 lb/acre alone or 0.5 lb/acre in combination with 2,4-D 2 lb/acre or metsulfuron 0.3 lb/acre was evaluated for effect on growth and injury to *Pseudotsuga menziesii*, *Pinus ponderosa*, *Tsuga heterophylla* and *Abies amabilis* seedlings in the Pacific Northwest region. Applications were made at 4 times: 3 month pre-planting in Dec., as buds began to swell in Mar., during the spring flush of growth in May, and after bud set in Aug. The effect of different application rates was of less significance than their timings. Application during active growth gave unacceptable injury levels; pre-planting caused least injury, but autumn treatment was acceptable for tolerant species. Species tolerance was in the order *Pinus ponderosa* > *Pseudotsuga menziesii* > *T. heterophylla* > *A. amabilis*.

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3. Bloomberg, W.J. 1988. Modeling control strategies for laminated root rot in managed Douglas-fir stands: model development. *Phytopathology* 78(4): 403-409.

Keywords: planting operations
site preparation
mechanical preparation
tree/stand protection
tree/stand health

Abstract: A model of laminated root rot caused by *Phellinus* [*Inonotus*] *weirii* was developed to assess potential control strategies in managed *Pseudotsuga menziesii* stands. The model mimicked key processes in disease initiation and development quantified as functions of time and space. These processes were horizontal and vertical tree root distribution, root contact with inoculum and among root systems, spread of mycelium through root systems, root decay, reduction of diam. growth in infected trees, tree mortality and persistence of inoculum in roots of stumps and killed trees. The processes were expressed as mathematical functions which were integrated in a computer program to calculate spread of the disease and stand-growth loss and mortality. Data for quantification of functions were obtained by experiments and from the literature. Simulated control practices included infected stump removal, sanitation felling and mixed planting of Douglas fir and resistant species. Accuracy of the model was tested by comparing calculated disease spread and mortality with the following data: (1) spread and damage in two 60-yr-old, 1-ha stands in Oregon, (2) results from a statistically based model for spread and damage that had performed satisfactorily, and (3) observed spread and damage behaviour in stands of different ages and growth rates. Results from the model compared favourably with all of the above situations.

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4. Bloomberg, W.J. and G. Reynolds. 1988. Equipment trials for uprooting root-rot-infected stumps. *Western-Journal-of-Applied-Forestry* 3(3): 80-82.

Keywords: site preparation
mechanical preparation
tree/stand protection
tree/stand health

Abstract: Residual roots from Douglas fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) were measured following stump-root extraction one yr after harvesting a 55-yr-old, 314 stems/ha, 47% Douglas fir, 17% maple (*Acer macrophyllum*), 16% red cedar (*Thuja plicata*), 6% western hemlock stand with 20% infection by *Phellinus weirii* in the Cowichan valley, Vancouver Island, Canada. Extraction was by a Caterpillar D8H with brush-clearing blade, a 180-hp backhoe or a 115-hp backhoe. All 3 machines recovered more than 90% of root vol. The small backhoe left significantly greater numbers and lengths of root residues per m³ soil, though the vol. of residues was greatest for the Caterpillar. An earlier study suggested that a root density of 32 roots/m³ was needed to produce one root contact; as the least efficient treatment by the Caterpillar left 23.2 roots/m³ in the ground, it is suggested that this would provide insufficient contacts with a new tree crop to transmit infection.

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5. Brandeis, T.J., M. Newton and E.C. Cole. 2001. Underplanted conifer seedling survival and growth in thinned Douglas-fir stands. *Canadian-Journal-of-Forest-Research* 31(2): 302-312.

Keywords: planting operations
thinning
commercial thinning
site preparation
chemical preparation
release treatments
chemical release
growth
tree/stand health
regeneration

Abstract: In a multilevel study conducted at the Oregon State University's McDonald-Dunn Research Forest, Oregon, USA, to determine limits to underplanted conifer seedling growth, Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) seedlings were planted in January 1993 beneath second-growth Douglas-fir stands that had been thinned in 1992 to basal areas ranging from 16 to 31 m²/ha. Understorey vegetation was treated with a broadcast herbicide (glyphosate + imazapyr) application prior to thinning, a directed release herbicide (glyphosate, plus triclopyr for tolerant woody stems) application 2 years later, or no treatment beyond harvest disturbance. Residual overstorey density was negatively correlated with percent survival for all four species. Broadcast herbicide application improved survival of grand fir and western hemlock. Western redcedar, grand fir and western hemlock stem volumes were inversely related to overstorey tree density and this effect increased over time. There was a strong indication that this was also the case for Douglas-fir. Reduction of competing understorey vegetation resulted in larger fourth-year stem volumes in grand fir and western hemlock.

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6. Brandeis, T.J., M. Newton and E.C. Cole. 2002. Biotic injuries on conifer seedlings planted in forest understorey environments. *New Forests* 24:1-14.

Keywords: planting operations
site preparation
chemical preparation
release treatments
chemical release
thinning
tree/stand protection
growth
tree/stand health

Abstract: The effects of partial overstorey retention, understorey vegetation management, and protective Vexar(R) tubing on the frequency and severity of biotic injuries in a two-storied stand underplanted with western redcedar (*Thuja plicata*), Douglas-fir (*Pseudotsugamenziesii*), grand fir (*Abies grandis*), and western hemlock (*Tsuga heterophylla*) were investigated. The most prevalent source of damage was browsing by black-tailed deer (*Odocoileus hemionis columbiana*); deer browsed over 74% of Douglas-fir and over 36% of westernredcedar seedlings one or more times over the four years of this study. Neither the spatial pattern of thinning (even or uneven) nor the density of residual overstorey affected browsing frequency. Spraying subplots may have slightly increased browsing frequency, but the resulting reduction of the adjacent understorey vegetation increased the volume of all seedlings by 13%, whether or not they were browsed. Vexar(R) tubing did not substantially affect seedling survival, browsing damage frequency, or fourth-year volume. Greater levels of overstorey retention reduced frequency of second flushing. Chafing by deer and girdling by rodents and other small mammals began once seedlings surpassed 1 m in height. Essentially all grand fir seedlings exhibited a foliar fungus infection.

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7. Carr, W.W. 1987. Restoring productivity on degraded forest soils: two case studies. B.C. Ministry of Forests FRDA-Report 002. vi + 21 p.

Keywords: site preparation
fertilization
tree physiology
growth
soil properties

Abstract: The use of green fallowing was studied at 2 sites, viz. (a) a coastal site at Koksilah, 15 km NW of Shawnigan Lake, British Columbia, where extensive subsoil exposure had resulted from roading operations in a highly productive Douglas fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) stand, and (b) an inland site 30 km S. of Vanderhook including several landings and skid roads which had been deep-ripped to a depth of 50 cm, reducing soil density to 1350 kg/m³. Plots at (a) were seeded in 1976 at 100 kg/ha with a grass/legume mixture including 3 spp. of *Trifolium* and *Lotus corniculatus*, and received NPK (10:30:10) at 450 kg/ha. Site nutrient levels improved substantially over 5 yr with N showing the greatest gains, and Douglas fir seedlings (1+2) planted in 1977 responded with increased foliar N and K contents and 300% greater ht. growth. Plots at (b) were seeded in 1981 at 40 kg/ha with a legume mixture of 3 spp. of *Trifolium*, *Medicago sativa* and *L. corniculatus*, and received NPK (19:19:19) at 300 kg/ha. Nutrient gains were found after 2 yr for P, K and especially N, and although foliar nutrient contents and growth of lodgepole pine (*Pinus contorta*) seedlings showed no increase, the enhancement of site nutrient capital is considered to be a gain likely to benefit commercial forestry production.

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8. Donegan, K.K., L.S. Watrud, R.J. Seidler, S.P. Maggard, T. Shiroyama, L.A. Porteous and G. DiGiovanni. 2001. Soil and litter organisms in Pacific Northwest forests under different management practices. *Applied Soil Ecology* 18:159-175.

Keywords: planting operations
site preparation
prescribed fire
soil properties

Abstract: Soil and litter organisms were monitored for their response to different forest management practices. Litter and soil cores (0-10, 10-20 cm) were collected at approximately 8-week intervals over a 19-month period from a low elevation 110-140-year-old Douglas fir (*Pseudotsuga menziesii*) forest and adjacent 8-year-old clearcut in the Oregon Cascades, and from a high elevation 200-250-year-old Douglas fir forest and adjacent 5-year-old clearcut in the McKenzie River drainage. The low elevation clearcut had been broadcast burned and replanted with Douglas fir trees and a grass (*Dactylis* and *Lolium*)-legume (*Trifolium* and *Lotus*) mixture whereas the high elevation clearcut was not burned, large woody debris was left, and it was replanted with Douglas fir, Noble fir [*Abies procera*], Grand fir [*Abies grandis*], and western white pine [*Pinus monticola*]. The litter and soil cores were analysed for types of microarthropods and numbers of nematodes, fungi, culturable, aerobic bacteria, spore-forming bacteria, and chitin-degrading bacteria. Microbial community metabolic profiles, using the Biolog method, were also generated for the 0-10 cm soil samples. Populations of *Pseudomonas* spp. were analysed in the litter and soil samples using 16S rDNA fingerprints. Plant surveys were conducted to identify potential relationships of soil organisms to plant community composition. At both elevational field sites, there were significantly ($P < 0.05$) higher levels of nematodes and microarthropods in litter and soil in forest plots than in clear felled plots. Bacterial and fungal populations were also significantly higher in litter in forest plots than in clear felled plots at the high elevation site. In the litter and soil at the low elevation site and the soil at the high elevation site, however, microbial levels were higher in clear felled plots than in forest plots. The *Pseudomonas* spp. populations and the microbial community metabolic profiles in the 0-10 cm soil differed significantly between the forest and clear felled plots at the low elevation site but not at the high elevation site. At both elevational field sites, the plant cover (%) and plant density were significantly higher in clear felled plots than in forest plots. These observed differences in the population size and composition of organisms between mature forests and both low management and high management clearcuts demonstrated the impacts forest management practices may have on the soil ecosystem.

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9. Feller, M.C. 1988. Relationships between fuel properties and slashburning-induced nutrient losses. *Forest-Science* 34(4): 998-1015.

Keywords: site preparation
prescribed fire
soil properties

Abstract: The relations between slash load, slash and forest floor consumption variables, and species origin of slash (slash type) on one hand and nutrient (N, P, S, K, Na, Mg and Ca) losses to the atmosphere during slashburning on the other were studied by burning 50 plots, each 2.25 m² in area. The plots contained known amounts of slash materials derived from four major southwestern British Columbia tree species (*Tsuga heterophylla*, *Thuja plicata*, *Chamaecyparis nootkatensis* and *Pseudotsuga menziesii*) and were

burned under different weather conditions. Nutrient losses (g/m²) decreased in the order N > Ca > S > K > Mg > P > Na and were generally within the range of such losses recorded for operational prescribed burns in western North America. Losses of all nutrients except Na were positively correlated with fuel consumption. Nitrogen and S exhibited the best correlations, whereas no correlations were found for Na. Of the fuel consumption variables considered, depth of forest floor consumed, then total slash consumption, were best correlated with nutrient loss. Losses of most nutrients generally increased with slash load and as slash type changed from Tsuga to Pseudotsuga to Thuja/Chamaecyparis. This was partly due to the effects of slash load and slash type on fuel consumption, and partly due to their effects on burning-caused changes in nutrient concn. in slash materials. The study suggests that nutrient losses to the atmosphere during operational slashburns can be minimized by minimizing forest floor and large diameter slash consumption during burning.

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10. Feller, M.C. 1990. Herbicide application followed by prescribed fire to convert a brushfield into a conifer plantation in south coastal B.C.: a combination of the initial effects of two treatments. B.C. Ministry of Forests FRDA Report 146. 40 p.

Keywords: site preparation
chemical preparation
prescribed fire
growth
tree/stand health
soil properties
stand conditions

Abstract: A field study was carried out in *Pseudotsuga menziesii* stands in British Columbia, Canada, to investigate the effects on vegetation of glyphosate applications in September 1987 or July 1988, followed by burning in October 1988. Results did only show slight differences between treatments.

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11. Hacker, A.L. and B.E. Coblenz. 1993. Habitat selection by mountain beavers recolonizing Oregon Coast Range clearcuts. *Journal-of-Wildlife-Management* 57(4): 847-853.

Keywords: site preparation
mechanical preparation
tree/stand protection
tree/stand health

Abstract: In Oregon, mountain beavers (*Aplodontia rufa*) are managed as pests in Douglas fir (*Pseudotsuga menziesii*) stands; they are normally removed from clearcuts prior to reforestation, but recolonization nevertheless poses problems to regenerating stands. Habitat selection by recolonizing mountain beaver was studied on 8 replanted clearcuts, 4 each of 2 different ages (1 yr old and 4-5 yr old), in the Coast Range mountains of Polk and Lincoln counties, Oregon between June

1989 and August 1990. Clearcuts were recolonized throughout, irrespective of distances from edge ($R^2 = 0.01$). Six habitat variables were selected by stepwise logistic regression to model recolonized versus non-colonized habitat. Mountain beavers selected areas with high amounts of small (<25 cm) and large diameter (>25 cm) woody debris, forage plants, and uprooted stumps; they were likely to recolonize areas that had soft soils and areas in drainages. The logistic function that included these 6 variables had a correct classification rate of 85% based on a jackknife procedure. Forest managers should find these habitat features useful for predicting mountain beaver recolonization and damage. Potentially productive approaches to habitat management and site preparation are suggested, including reduction of habitat suitability and colonist numbers by minimizing dead wood accumulations, and provisioning of alternate food sources to minimize tree damage without reducing recolonization.

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12. Haight, R.G. 1993a. The economics of Douglas-fir and red alder management with stochastic price trends. *Canadian-Journal-of-Forest-Research* 23(8): 1695-1703.

Keywords: planting operations
site preparation
prescribed fire
release treatments
chemical release
thinning
precommercial thinning
commercial thinning
tree/stand protection
economics

Abstract: A financial analysis of Douglas fir (*Pseudotsuga menziesii*) and red alder (*Alnus rubra*) management was conducted using yield projections from the Stand Projection Simulator for the Pacific Northwest region of the United States. The analysis included uncertainty in the price trends and stocking levels of both species following reforestation. Results from a case study in which Douglas fir price is likely to increase faster than red alder price show that (i) on more productive sites, greater regeneration investment is justified to increase the likelihood of Douglas fir establishment, (ii) on less productive sites, low-cost regeneration options that produce mixed-species stands have expected present values close to or greater than a high-cost Douglas fir regeneration effort, (iii) optimal precommercial removal of red alder depends on mid-rotation prices and regeneration success, and in many cases growing a mixed-species stand to maturity produces the highest economic return, and (iv) commercial thinning of Douglas fir increases the expected present value of the most intensive regeneration option by up to 10%. The low-cost regeneration options have relatively high expected returns because of low initial investments and the presence of two species that may have high values in the future. The sensitivity of these results to changes in the probability distributions of regeneration success and price trends is discussed.

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13. Haight, R.G. 1993b. Technology change and the economics of silvicultural investment. Rocky-Mountain-Forest-and-Range-Experiment-Station,-USDA-Forest-Service General-Technical-Report RM-GTR-232. ii + 18 p.

Keywords: planting operations
site preparation
prescribed fire
release treatments
chemical release
tree/stand protection
thinning
commercial thinning
precommercial thinning
yield
economics

Abstract: Financial analyses of intensive and low-cost reforestation options are conducted for loblolly pine (*Pinus contorta*) stands with broadleaved competition in the Southern USA, and Douglas fir with red alder (*Pseudotsuga menziesii* with *Alnus rubra*) in the Pacific Northwest. Results show that the expected present values (EPVs) of low-cost options that result in mixtures of conifers and broadleaves are superior in some situations to the EPVs of the intensive options.

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14. Hedin, I.B. 1994. Mechanical site preparation on salal-dominated sites: five-year results. Forest-Engineering-Research-Institute-of-Canada

Keywords: site preparation
mechanical preparation
growth
stand conditions

Abstract: Trials began in 1987 on sites on Vancouver Island where salal (*Gaultheria shallon*) is a competitor to Douglas fir [*Pseudotsuga menziesii*]. Three equipment types were tested: the Mitsui Miike (an excavator-mounted rock grinding attachment), the TTS Delta disc trencher and an excavator with a ripper tooth and live thumb. All three mechanical site preparation treatments were equally effective at reducing the coverage of salal and other competing vegetation and improving Douglas fir growth performance. On sites where the disc trencher can operate, with gentle slopes and light to moderate slash, it is most cost effective because of greater productivity.

[Non-OSU Link](#)

15. Heilman, P. 1983. Effects of surface treatment and interplanting of shrub alder on rowth of Douglas-fir on coal spoils. *Journal-of-Environmental-Quality* 12(1): 109-113.

Keywords: planting operations

site preparation
mechanical preparation
growth
tree physiology
soil properties
tree/stand health

Abstract: Annual growth of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) planted on topsoiled spoils at a coal mine near Centralia, Wash., was monitored for the first 6 y after planting. Treatments were contour bedding, contour bedding plus interplanted Sitka alder (*Alnus sinuata* (Reg.) Rydb.), and unbedded control. The bedding significantly increased growth of Douglas-fir in all 5 y of the study. Total height growth after 5 y was 35% greater than control on the bedding only plots, and 43% greater on the bedding plus Sitka alder plots. Height growth of Douglas-fir in the mixed stand was significantly greater during the 2nd and 3rd y of the study, but after 5 yr, no significant difference was evident in total height between the mixed and pure Douglas-fir plots. Concentration of N in Douglas-fir foliage was significantly increased by bedding in the fifth but not in the fourth year. Interplanting with Sitka alder had no significant effect on N in Douglas-fir foliage. The top 0.3 m of soil in the ridged portion of the bedded area contained significantly less moisture over a summer than did the top 0.3 m of the unbedded soil. At deeper depths, however, soil moisture was not significantly affected by bedding. Wind damage caused by a severe storm that occurred after 5 y was very much greater on the unbedded plots (49% wind-thrown vs. 9 to 15% wind-thrown on the bedded plots) despite the smaller size of the trees on unbedded plots.

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16. Helgerson, O.T., D.H. McNabb and S.D. Hobbs. 1991. Survival and growth of Douglas-fir seedlings after prescribed burning of a brushfield in southwest Oregon. *Western-Journal-of-Applied-Forestry* 6(3): 55-59.

Keywords: site preparation
prescribed fire
tree/stand health
growth

Abstract: Five years after planting, survival of 2-0 bare root Douglas fir (*Pseudotsuga menziesii*) seedlings was high on both burned and unburned plots (89 and 87%, respectively), but seedling stem height, diameter, and volume were greater in burned than in unburned plots.

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17. Hermann, R.K. and D.P. Lavender. 1999. Douglas-fir planted forests. *New-Forests* 17(1/3): 53-70.

Keywords: genetic tree improvement
nursery operations
planting operations

site preparation
release treatments
fertilization
thinning
pruning
tree/stand protection
growth
yield

Abstract: A combination of superior wood quality and high productivity has made Douglas fir (*Pseudotsuga menziesii*) one of the premier timber trees in the world. As such, it is grown as a plantation species in several countries in Europe and South America, and in New Zealand and Australia, as well as throughout its extensive natural range in western North America. Decades of experience with the silviculture of young stands have demonstrated that practices such as planting, the use of genetically improved seedlings, precommercial and commercial thinning, and fertilizing may dramatically increase the yield of industrial products over that of natural forests. Further, such silviculture is compatible with the production of desired amenities. Vigorous implementation of such practices wherever Douglas fir is cultivated will increase the world's timber resources, and be an effective strategy for reducing the pressure, occasioned by the world's rapidly increasing population, to harvest the fragile tropical and boreal forests.

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18. Ketchum, J.S., R. Rose and B. Kelpsas. 1999. Weed control in spring and summer after fall application of sulfometuron. *Western Journal of Applied Forestry* 14:80-85.

Keywords: site preparation
mechanical preparation
chemical preparation
stand conditions

Abstract: This study tested the residual spring and summer efficacy of sulfometuron after applications in the autumn in second growth Douglas fir (*Pseudotsuga menziesii*) with red alder (*Alnus rubra*) and bigleaf maple (*Acer macrophyllum*) forest sites in the central Coast Range, Oregon, USA, which had been harvested in the summer. Sulfometuron alone (S) and sulfometuron plus imazapyr and glyphosate (SIG) were applied to vegetation on mechanically scarified sites and unscarified sites. The applications were replicated each month throughout autumn 1994. Vegetation cover was assessed in mid-June and mid-August 1995. The SIG treatment gave better control of vegetation than the S treatment, although cover was significantly lower for both herbicide treatments (9% to 54% for summed cover) compared to the control site (64% to 104% for summed cover). On scarified sites, the month of application, early or late autumn, did not significantly influence the efficacy of either treatment. On unscarified sites, however, applications of the SIG treatment later in autumn were less effective than early autumn treatments. Results suggest that autumn applications of sulfometuron are still effective in spring and may eliminate the need to treat sites again in the spring in order to achieve effective weed control.

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19. Ketchum, J.S., R. Rose and B. Kelpsas. 2000. Comparison of adjuvants used in fall-release herbicide mixtures for forest site preparation. *Tree-Planters' Notes* 49(3): 66-71.

Keywords: site preparation
chemical preparation
release treatments
chemical release
tree/stand health
stand conditions

Abstract: Tank mixes of the herbicides imazapyr and glyphosate were applied at 3 rates with 3 adjuvants (LI-700Reg., Nu-Film-IRReg., Silwet L-77Reg.) over California hazelnut (*Corylus cornuta* var. *californica*), vine maple (*Acer circinatum*), and brackenfern (*Pteridium aquilinum* var. *lanuginosum*) on a 2-year-old clearcut of Douglas fir (*Pseudotsuga menziesii*) in Oregon. The herbicide 2,4-D was applied at 3 rates with 2 adjuvants (HerbimaxReg., Nu-Film-IR) over greenleaf manzanita (*Arctostaphylos patula*) on a 4-year-old Douglas fir clearcut in Oregon. Tank mixes of imazapyr and glyphosate with LI-700 or Nu-Film-IR were sprayed at 3 rates over 1-year-old seedlings of Douglas fir on 2 sites in Oregon. The herbicide rate strongly influenced the percentage of foliage injured and percentage of stems killed for all herbicide treatments. The adjuvants evaluated did not influence efficacy of herbicide applications on California hazelnut, vine maple, or brackenfern. Herbimax increased visual foliar damage resulting from 2,4-D application on greenleaf manzanita. Douglas fir foliage was damaged by the higher herbicide rates; the damage was greater from Nu-Film-IR than from LI-700.

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20. Knapp, W.H., T.C. Turpin and J.H. Beuter. 1984. Vegetation control for Douglas-fir regeneration on the Siuslaw National forest: a decision analysis. *Journal-of-Forestry* 82(3): 168-173.

Keywords: planting operations
site preparation
chemical preparation
mechanical preparation
prescribed fire
release treatments
chemical release
manual release
growth
yield
economics

Abstract: Records from 324 plantations in Oregon were used to calculate the effect on stocking of various methods of controlling competing vegetation before and after plantation establishment. A

decision tree analysis using 6 management regimes on 5 stocking classes indicated that if no site preparation or release (other than broadcast burning to reduce fuels) were practised, the forest would produce 63% of the m.a.i. and 35% of the present net worth (PNW) expected if all means of control (chemical, manual and burning) were available and used. If only manual control methods were used 78% of the max. m.a.i. and 57% of the max. PNW would be expected. When all methods except phenoxy herbicides were available, the expected m.a.i. and PNW were reduced to no less than 90%. The yield reduction varied with aspect, and the type of prelogging vegetation. Declines were least on SW-facing sites that were originally predominantly conifers, and greatest on NE-facing slopes that had supported broadleaves. Limitations of the analysis are discussed.

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21. Knowe, S.A. and W.I. Stein. 1995. Predicting the effects of site preparation and protection on development of young Douglas-fir plantations. *Canadian-Journal-of-Forest-Research* 25(9): 1538-1547.

Keywords: site preparation
release treatments
tree/stand protection
growth
tree morphology
tree/stand health
stand conditions

Abstract: Diameter prediction models based on the Weibull distribution function and stand-table projection models based on changes in relative diameter were developed for 2- to 10-year-old Douglas fir (*Pseudotsuga menziesii*) plantations in Oregon. Both modelling approaches incorporated the effects of site preparation, animal protection, and competing vegetation. The diameter distribution approach is appropriate when information on initial diameters is not available. The stand-table projection approach may be applied when tree diameters in a plantation are measured two or more growing seasons after planting. At young ages, the stand-table approach provided more accurate representation of observed diameter distributions than the diameter distribution approach. At age 10 the two methods provided comparable diameter distributions. The equations derived for predicting survival, height growth of dominant trees, height-diameter relationships, and the development of woody vegetation over time will facilitate the study and comparison of stand structure and dynamics after various site-preparation and animal protection treatments.

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22. Knowe, S.A., W.I. Stein and L.J. Shainsky. 1997. Predicting growth response of shrubs to clear-cutting and site preparation in coastal Oregon forests. *Canadian-Journal-of-Forest-Research* 27(2): 217-226.

Keywords: planting operations
site preparation
chemical preparation

mechanical preparation
prescribed fire
stand conditions

Abstract: Cover-projection models were developed based on algebraic difference formulations of an exponential-power function to describe shrub recovery and development patterns following clear cutting, site preparation and Douglas fir (*Pseudotsuga menziesii*) planting at 4 sites in the Siuslaw National Forest, Oregon. The sites formed part of the Coastal Site Preparation Study initiated in 1980, in which the effects were tested of 6 treatments on shrub growth patterns. Treatments were: none other than scalping a 30-cm spot when each 2-0 seedling was planted (control); spot clearing by cutting to 15 cm height all woody vegetation within a 1.2 m radius of the seedling; spraying with glyphosate (2.52 kg a.e./ha) in early autumn 1980; broadcasting burning slash in midsummer 1980; manually slashing all woody vegetation in June 1980 and broadcast burning later in the summer; and spraying with picloram + 2,4-D (Tordon 101) in May or June 1980 (at 1.49 + 5.97 kg a.e./ha) and broadcast burning in the summer. Results on the development of Douglas fir and associated vegetation to age 10 yr have already been reported for this study (Stein (1995) Research Paper - Pacific Northwest Research Station, USDA Forest Service, No. PNW-RP-473; Knowe & Stein (1995) Canadian Journal of Forest Research 25 (9) 1538-1547). The shrub cover-projection models were developed by incorporating indicator variables into the model rate and shape parameters for the recovery of 3 specific shrubs (salal, *Gaultheria shallon*; thimbleberry, *Rubus parviflorus*; and salmonberry, *Rubus spectabilis*), and all shrubs. For salal, the shape parameter included an adjustment for burning treatments that delayed maximum cover by several years in comparison with unburned treatments. The rate parameter in the thimbleberry model was adjusted for burning treatments; maximum cover occurred about 2 yr earlier in burned than in unburned treatments. Both rate and shape parameters in the salmonberry model were adjusted for burning treatments; delayed established but increased growth rate and less salmonberry cover are characteristic of burned treatments compared with the unburned treatments. The rate and shape parameters in the model for the shrub group included adjustments for burning treatments. Overstorey removal fostered shrub development, whereas site preparation treatments slowed and curtailed it. The final cover-projection models accounted for 68-92% of the total variation in cover, with the adjustments for burning accounting for 1.5-3.3% of the variation. The predicted growth patterns are consistent with trends in site occupancy and published autecological characteristics.

[OSU Link](#)

[Non-OSU Link](#)

23. Little, S.N. and D.R. Waddell. 1987. Highly stocked coniferous stands on the Olympic Peninsula: chemical composition and implications for harvesting strategy. Pacific-Northwest-Research-Station,-USDA-Forest-Service Research-Paper PNW-RP-384. 29 p.

Keywords: site preparation
mechanical preparation
soil properties

Abstract: An assessment is presented of macronutrients and their distribution within highly stocked, stagnant stands of mixed conifers on the Quilcene Ranger District, Olympic National Forest, northwest Washington, USA. These stands consisted of predominantly three species: western hemlock (*Tsuga heterophylla*), coast Douglas fir (*Pseudotsuga menziesii* var. *menziesii*), and western redcedar (*Thuja plicata*). Preliminary investigation suggested that the living crown contained a

small portion of the nutrient capital on the site. Extracting this material from the site during harvest or site preparation should not pose a threat to future production of biomass. Bioassays suggested that no macronutrients were deficient for growth of Douglas fir seedlings. However, care should be taken during harvest and site treatment to protect the nutrient capital in dead material and in the forest floor.

[OSU Link](#)

[Non-OSU Link](#)

24. McDonald, P.M. and G.O. Fiddler. 1993. Feasibility of alternatives to herbicides in young conifer plantations in California. *Canadian-Journal-of-Forest-Research* 23(10): 2015-2022.

Keywords: genetic tree improvement
site preparation
prescribed fire
release treatments
manual release
chemical release
growth
economics

Abstract: A research programme (involving 40 studies) was started in 1980 to compare the effectiveness and cost of various vegetation management techniques used for enhancing growth of 1- to 3-yr-old conifer (*Pseudotsuga menziesii*, *Pinus ponderosa*, *P. jeffreyi*, *Abiesmagnifica* and *A. concolor* var. *lowiana*) plantations in California. The studies were ended after 10 yr when competition became intraspecific. The techniques used included direct methods such as manual manipulation, mulching, herbicides (Garlon 3A [triclopyr], 2,4-D or Velpar [hexazinone]), and grazing for releasing conifer seedlings from undesirable vegetation, and several silvicultural practices (broadcast burning, group selection, genetically improved seedlings) that serve as indirect methods for reducing or avoiding vegetation problems. Manual release and mulching were effective but expensive. Herbicides were effective, applicable to almost all plant communities, and relatively inexpensive. Grazing was good for cattle and sheep, but did not significantly enhance conifer seedling growth. Silvicultural control of weeds was promising, but there was not enough information to evaluate feasibility. It was concluded that in most instances, forests cannot be managed economically without herbicides, if the objective is to grow seedlings at the potential of the site and the plant community includes sprouting broadleaves and shrubs or rhizomatous forbs and ferns. If the objective is to create a forest with several age-classes and variable structure, but with slower seedling growth, longer rotations, and less species diversity in early seral stages, then it is possible to accomplish this using other vegetation management techniques.

[OSU Link](#)

[Non-OSU Link](#)

25. McLeod, A.A., R.C. Evans and R.K. Scagel. 1993. Conversion of understocked salal sites at Woss Lake, British Columbia. B.C. Ministry of Forests FRDA-Report 194. vi + 15 p.

Keywords: nursery operations
site preparation
mechanical preparation

fertilization
growth
tree/stand health
economics

Abstract: A trial comparing the effect of spot scarification and slow release NPK fertilizer application on stock types of coastal Douglas fir (*Pseudotsuga menziesii*) was conducted in a 25-year-old backlog site occupied by a thick carpet of salal (*Gaultheria shallon*) in the CWHxm2 habitat of Vancouver Island, British Columbia. Bare root and container stock types were planted and treated, and mortality and growth were measured for 3 years. Despite the high fertilizer-related mortality of the bare-root stock type in the first year, the 3-year height growth performance of all treatments was better but more variable than that of the untreated seedlings. The value of site preparation and fertilizer for stimulating early growth varied by stock type. Bare-root stock did not respond strongly enough to fertilizer or site preparation to justify the cost of either of these treatments. Container stock types did not respond strongly enough to site preparation alone to justify the high cost of site preparation. The largest growth gains in the container stock types were associated with the combination of site preparation and fertilization.

[OSU Link](#)

[Non-OSU Link](#)

26. McNabb, D.H., K. Baker-Katz and S.D. Tesch. 1993. Machine site preparation improves seedling performance on a high-elevation site in southwest Oregon. *Western-Journal-of-Applied-Forestry* 8(3): 95-98.

Keywords: site preparation
mechanical preparation
tree/stand health
stand conditions
growth

Abstract: Douglas fir (*Pseudotsuga menziesii*) seedlings planted on areas receiving one of four site preparation treatments (scarify, scarify/till, soil removal, and soil removal/till) and on unprepared control areas were compared for 5 yr at a high-altitude, nutrient-poor site in the western Siskiyou Mountains. Fifth-year survival of seedlings was at least 85% among machine-prepared plots, compared to 42% on control plots. Cover of competing vegetation remained less than 25% during the period for all machine treatments. In contrast, vegetation cover on control plots was 30% at the time of planting and increased to nearly 75% after 5 yr. Competing vegetation clearly impeded seedling performance. The effects of unusually droughty conditions at the time of planting in 1982 were examined further by interplanting additional seedlings in the soil-removal treatment in 1985. The interplanting was followed by more normal spring precipitation, and seedlings grew better over 5 yr than those planted in 1982. The slow recovery of competing vegetation and generally poor seedling growth on all treatments during both planting years are attributed to low soil fertility.

[OSU Link](#)

[Non-OSU Link](#)

27. Minore, D. 1986a. Effects of site preparation on seedling growth: a preliminary comparison of broadcast burning and pile burning. Pacific-Northwest-Research-Station,-USDA-Forest-Service Research-Note PNW-RN-452. 12 p.

Keywords: site preparation
prescribed fire
growth
soil properties

Abstract: In studies in SW Oregon, measured and potential heights were similar for 5-yr-old planted seedlings of Douglas fir (*Pseudotsuga menziesii*) on areas that had been broadcast burned. Measured heights were less than potential heights on most of the pile-and-burn plantations, suggesting that site quality is damaged by this site preparation method.

[OSU Link](#)

[Non-OSU Link](#)

28. Minore, D. and H.G. Weatherly. 1990. Effects of site preparation on Douglas-fir seedling growth and survival. *Western-Journal-of-Applied-Forestry* 5(2): 49-51.

Keywords: site preparation
mechanical preparation
prescribed fire
growth
tree/stand health
soil properties

Abstract: The effects of 5 site preparation treatment combinations (A: cable yarding + broadcast burning - B: tractor yarding + broadcast burning - C: machine piling + broadcast burning - D: machine piling + off-site burning - and E: machine piling + off-site burning + tilling) on Douglas fir (*Pseudotsuga menziesii*) growth and survival were studied in 1984-87. Seedling height, potential seedling height, survival percentages, soil-penetration resistances, and occurrence of visible soil humus were evaluated on 149 progeny-test plantations in western Oregon. Survival was not improved by mechanical site preparation (survival at 5 years was 84.8% for treatment A, 73.7% for C and 78.1% for E). Seedlings grown on compacted soils with low humus, associated with piling slash off site, did not grow as tall during their first 5 years as seedlings grown on similar sites where slash had been broadcast-burned (height 77 cm for treatments D and E, compared to 93 cm for A). Mechanical site preparation was not essential for Douglas fir survival, as long as competing vegetation is controlled. Increased soil compaction, loss of humus, and reduced 5 year height growth associated with mechanized slash removal indicated detrimental effects on site quality as well as tree growth.

[OSU Link](#)

[Non-OSU Link](#)

29. Monleon, V.J., M. Newton, C. Hooper and J.C. Tappeiner, II. 1999. Ten-year growth response of young Douglas-fir to variable density varnishleaf ceanothus and herb competition. *Western-Journal-of-Applied-Forestry* 14(4): 208-213.

Keywords: site preparation
chemical preparation
release treatments
chemical release
growth

Abstract: The effect of different densities of varnishleaf ceanothus (*Ceanothus velutinus* var. *laevigatus*) and herbaceous vegetation control on stem diameter, height, and volume of Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) seedlings was examined during the 10 yr following planting on a site near Springfield, Oregon, in winter 1996-97. Initial densities of ceanothus ranged between 0 and 15 000 seedlings/ha and were obtained by interplanting ceanothus germinants or chemical thinning after clearcutting and broadcast-burning. Herbaceous vegetation control was achieved by a single application of glyphosate following planting, with shrub seedlings covered. Ceanothus density in the range of 0 to 6750 plants/ha did not have an effect on Douglas fir diameter, height, or volume at age 10; however, Douglas fir growth was significantly decreased when ceanothus densities reached 15 000 plants/ha. Ten years after planting, Douglas fir volume in the treatments with ≤ 6750 ceanothus/ha was 1.7 times greater than that in the 15 000 ceanothus/ha treatment. In contrast, removal of herbaceous vegetation after planting significantly increased tree diameter, height, and volume, regardless of ceanothus density. Even 10 yr after application of the treatment, trees without early herb competition grew faster and had mean dbh, height, and volume that were 1.02 cm, 0.55 m, and 12.98 dm³/tree greater respectively than those with herbs. Thus, a treatment at plantation establishment to control herbaceous vegetation and to reduce ceanothus density to less than 7000 plants/ha will ensure an increase in growth and stocking for at least 10 yr.

[OSU Link](#)

[Non-OSU Link](#)

30. Newton, M., E.C. Cole and D.E. White. 1993. Tall planting stock for enhanced growth and domination of brush in the Douglas-fir region. *New-Forests* 7(2): 107-121.

Keywords: nursery operations
site preparation
prescribed fire
release treatments
chemical release
growth
tree/stand health

Abstract: Two long-term experiments in Oregon followed the development of planted stock of various sizes, origins, and species. In one experiment, multi-year comparisons of container, 2+0 bare rooted, and 3-yr-old Douglas fir (*Pseudotsuga menziesii*) transplants showed a strong positive relation between initial height and long-term (10-14 yr) growth under a range of site conditions with high probability of brush development. In another experiment, Douglas fir, western hemlock (*Tsuga heterophylla*), and Sitka spruce (*Picea sitchensis*) were planted on brushfield sites (disturbed by logging 0 and 4 yr previously) where salmonberry (*Rubus spectabilis*) was or had been dominant. Half the seedlings were released with glyphosate 6 months after planting. Western hemlock and Douglas fir bare rooted stock all grew well if planted in a fresh burn, despite rapid regrowth of salmonberry, but virtually all seedlings less than 60 cm tall except Sitka spruce were killed by 4-yr-old salmonberry if not released. Release

improved growth of seedlings in the fresh burn by 6%, gaining an average of about 0.6 year toward reaching a height of 6 m. Release improved growth of survivors in 4-yr-old salmonberry by 51% in height, 72% in diameter, and 325% in volume at age 12 yr. Sitka spruce grew well until damaged by insects. Western hemlock growth was equal to or greater than that of Douglas fir of comparable initial height. In all comparisons, the probability of being overtopped by brush decreased with increasing initial stock height, and the effect of suppression on growth was also inversely related to initial height. Tall wilding seedlings had comparable advantages to nursery-grown seedlings, although Sitka spruce survival was not reliable.

[OSU Link](#)

[Non-OSU Link](#)

31. Parke, J.L., R.G. Linderman and J.M. Trappe. 1983b. Effects of forest litter on mycorrhiza development and growth of Douglas-fir and western red cedar seedlings. *Canadian-Journal-of-Forest-Research* 13(4): 666-671.

Keywords: site preparation
mechanical preparation
prescribed fire
mycorrhizal response
growth

Abstract: Preparation of forest regeneration sites for conifer planting often includes slash burning or physical removal of soil organic matter. Experiments were conducted to determine if organic matter contributes to the mycorrhizal fungus inoculum potential in forest soils and to compare the growth of Douglas fir and western red cedar (*Thuja plicata*) in untreated or pasteurized soils from undisturbed or cleared and burned forest sites with and without addition of untreated or pasteurized litter. Mycorrhizas were abundant on Douglas fir seedlings grown in undisturbed forest soil but developed similarly on red cedar seedlings in either type of soil. Litter and humus were found to include inoculum of both vesicular-arbuscular (VA) and ectomycorrhizal fungi. Litter amendment usually enhanced growth of host seedlings, but growth enhancement could not be fully attributed to addition of mycorrhizal inoculum or nutrients provided by litter. These findings suggested that other biological factors stimulated the growth of conifer seedlings and (or) activity of mycorrhizal fungi.

[OSU Link](#)

[Non-OSU Link](#)

32. Piatek, K.B., C.A. Harrington and D.S. DeBell. 2003. Site preparation effects on 20 year survival and growth of Douglas-fir (*Pseudotsuga menziesii*) and on selected soil properties. *Western-Journal-of-Applied-Forestry* 18(1): 44-51.

Keywords: site preparation
mechanical preparation
prescribed fire
tree/stand health
growth
soil properties

Abstract: Long-term effects of site preparation on tree performance and soil properties are not well known. Five site preparation treatments were evaluated to determine how they affected survival and growth of Douglas-fir (*Pinus menziesii*) 3, 10, and 20 years after planting, and soil bulk density, C, N, P, and organic matter concentrations at 0 to 20 cm soil depth 21 years after planting. The site preparation treatments were imposed following logging of three harvest units of old-growth forest on a volcanic soil in southwestern Washington, USA; the units were logged to leave 17, 38, and 53 tonnes/ha of woody residue. The site preparation treatments were hand-pile-and-burn, machine-pile-and-burn, scarification, broadcast burn, and control. Mean survival ranged from 86% at age 3 to 70% at age 20, and average tree heights at 3, 10, and 20 years were 0.6, 4.1, and 11.7 m. The scarification treatment had the best growth; at age 20, its average tree was 21% taller, 26% larger in diameter, and 82% greater in volume than the control. The hand-pile-and-burn treatment did not differ from the control in tree growth; the machine-pile-and-burn and broadcast burn treatments were intermediate in their growth response. Average soil bulk density was 0.74 g/cm³, organic matter concentration was 118 g/kg, and C, N, and P concentrations were 49, 1.6, and 0.7 g/kg with no significant treatment effects. Site preparation may have benefited growth of the trees on these units by decreasing competition from invading and regrowing vegetation, increasing nutrient availability, or increasing soil temperature.

[OSU Link](#)

[Non-OSU Link](#)

33. Pilz, D.P. and D.A. Perry. 1984. Impact of clearcutting and slash burning on ectomycorrhizal associations of Douglas-fir seedlings. *Canadian-Journal-of-Forest-Research* 14(1): 94-100.

Keywords: site preparation
prescribed fire
mycorrhizal response

Abstract: The results of field and greenhouse studies. Twelve ectomycorrhizal types were found in 3 western Cascade Mountain sites in Oregon on seedlings planted in soils on burned and unburned portions of clear felled areas and on undisturbed forest. *Rhizopogon* sp. and an unidentified brown type consistently formed at least two-thirds of the ectomycorrhizal root tips. Regardless of soil origin, more ectomycorrhizae formed in clear-felled areas than in undisturbed forest (primarily due to more brown mycorrhizae). Soil origin did not affect total numbers of ectomycorrhizae; however, more different types formed in undisturbed forest soils than in clear-felled soils, irrespective of aboveground environment. More nonmycorrhizal tips occurred in clear-felled soils. Seedlings grown in the same soils formed the same proportions of *Rhizopogon* and brown types in field and greenhouse, but not the same proportions of less common ectomycorrhizal types. Soil pasteurization increased root-tip numbers. Inoculated soils (1 part nonpasteurized: 9 parts pasteurized) produced as many ectomycorrhizae as nonpasteurized field soils and generally fewer tips than pasteurized soils. Formation of major (but not minor) ectomycorrhizal types on all sites was influenced more by aboveground changes that accompany clear felling and site preparation than by alterations in soil chemistry or biology.

[OSU Link](#)

[Non-OSU Link](#)

34. Roberts, S.D., C.A. Harrington and T.A. Terry. 2005. Harvest residue and competing vegetation affect soil moisture, soil temperature, N availability, and Douglas-fir seedling growth. *Forest-Ecology-and-Management* 205(1/3): 333-350.

Keywords: site preparation
chemical preparation
release treatments
chemical release
soil properties
growth
tree physiology

Abstract: Decisions made during stand regeneration that affect subsequent levels of competing vegetation and residual biomass can have important short-term consequences for early stand growth, and may affect long-term site productivity. Competing vegetation clearly affects the availability of site resources such as soil moisture and nutrients. Harvest residues can also affect the availability of site resources. We examined second and third year seedling performance of a Douglas fir (*Pseudotsuga menziesii*) plantation with different vegetation control and biomass retention treatments on a highly productive site in the coast range of Washington, USA. Treatments included a bole-only harvest without vegetation control (BO-VC), a bole-only harvest with complete vegetation control (BO+VC), and a total tree harvest with complete vegetation control that also included removal of all coarse woody debris and harvest residues (TTP+VC). The VC treatment involved: (a) in the first year, broadcast application of Oust and Accord concentrate applied with a surfactant 2 weeks before planting; (b) in the second year, a March broadcast application of Atrazine and a directed spot-spray of Accord Concentrate on the vegetation between rows in April-May; and (c) in the third year, a March broadcast application of Atrazine and Oust, a direct spot-spray application of Accord Concentrate, and a spot-spray of Transline with surfactant on April-May to control persistent shrub species. The study was conducted to determine if vegetation control and residue retention treatments affected soil moisture, soil temperature, and apparent nitrogen (N) availability, and whether these differences in site resources were correlated with seedling size and growth. In both second and third growing seasons, volumetric soil moisture at 0-20 cm depth was lowest on plots that did not receive vegetation control (BO-VC). Seedlings on these plots also had the lowest diameter and volume growth. In year 2, which was fairly moist, volume growth on TTP+VC plots was slightly higher than on BO+VC plots. TTP+VC plots did have lower soil moisture, but soil temperatures were slightly warmer. In year 3, a drier year, growth was greatest on BO+VC plots, which had consistently higher soil moisture levels. Apparent N availability in year 3 also varied with vegetation control. Douglas fir foliar N concentrations averaged 2.3% on the plots where competing vegetation was eliminated, compared to 1.8% on plots where competing vegetation was not controlled. Douglas fir foliar N concentrations did not differ between residue retention treatments, although N concentrations of competing vegetation were higher where residual biomass was retained. Higher apparent N availability was correlated with greater seedling growth. Based on the results from years 2 and 3, it appears that soil moisture, particularly late in the growing season, had the greatest effect on seedling growth in both years. Available N may also have played a role, although the effects of N cannot be completely separated from those of soil moisture. When soil moisture is adequate, it appears that available N and soil temperature exert greater influence on growth. Vegetation control and residue retention can influence all 3 of these factors. The relative importance of each factor may depend on the year-to-year variation in environmental conditions.

[OSU Link](#)

[Non-OSU Link](#)

35. Schneider, W.G., S.A. Knowe and T.B. Harrington. 1998. Predicting survival of planted Douglas-fir and ponderosa pine seedlings on dry, low-elevation sites in southwestern Oregon. *New-Forests* 15(2): 139-159.

Keywords: site preparation
mechanical preparation
prescribed fire
tree/stand health
tree morphology
stand conditions

Abstract: Four equations were developed by logistic regression for predicting the probability of Douglas fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) survival for the first (0-1) and first to third (1-3) growing seasons after applying mulching, radial scalping (removal of all vegetation and a thin layer of soil in a 1-m radius area around each tree), or artificial shading (shade cards) treatments in plantations in SW Oregon. Most of the sites had been burned by wildfire or prescribed fire before planting. Variables describing conifer size, levels of competing vegetation, presence of silvicultural treatments, site factors, and climate factors were collected from 13 sites up to 6 yr after planting and examined as potential predictors of survival. Age, stem diameter, a competition index for shrubs, severity of growing season at time of treatment, average annual precipitation, aspect, and slope angle were predictors of Douglas fir survival during 0-1 and 1-3 growing seasons after treatment; the presence of silvicultural treatments was also a predictor only during the first growing season after treatment. Age, aspect, and slope angle were predictors of ponderosa pine survival over both 0-1 and 1-3 growing seasons after treatment; height-diameter ratio, competition indices for herbs, shrubs, and hardwoods, silvicultural treatment, severity of growing season at time of treatment, and average annual precipitation were also predictors only during the first growing season after treatment; crown width was a predictor of survival only during 1-3 growing seasons after treatment. When significant in the models (equations), predicted probability of survival increases with treatments, less severe weather conditions, diameter, crown width, age, and precipitation; probability decreases with increasing height-diameter ratio and competition indices for herbs, shrubs, and hardwoods.

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[Non-OSU Link](#)

36. Stein, W.I. 1997. Ten-year survival and growth of planted Douglas-fir and western redcedar after seven site-preparation treatments. *Western-Journal-of-Applied-Forestry* 12(3): 74-80.

Keywords: site preparation
chemical preparation
prescribed fire
tree/stand protection
growth
tree/stand health
stand conditions

Abstract: Western redcedar (*Thuja plicata*) and Douglas fir (*Pseudotsuga menziesii*) were planted together after applying seven site-preparation methods at one cable-logged site in the Oregon Coast Ranges. The treatments, applied during 1980, were: untreated control; spot clear by cutting; aerial spraying with glyphosate; broadcast burning; slash and burn; spray with Tordon 101 (picloram + 2,4-D) and burn; and burn and sow grass. Planting was done in early 1991, and vegetation and trees were measured periodically to 1990. Survival and growth of cedar were markedly less than Douglas fir on this favourable site where both species were components of the original stand. Repeated browsing severely impeded the cedar. Site preparation by broadcast burning generally yielded the best results, but sowing grass after broadcast burning produced Douglas fir responses similar to those for no site preparation. Where grass was sown, herbaceous cover was more abundant and taller, salmonberry (*Rubus spectabilis*) differed little in density but was slightly taller, and development of red alder (*Alnus rubra*) was delayed. Red alder is currently overtopping conifers in all treatments, and release is needed to ensure sufficient conifer survival.

[OSU Link](#)

[Non-OSU Link](#)

37. Tesch, S.D. and S.D. Hobbs. 1989. Impact of shrub sprout competition on Douglas-fir seedling development. *Western-Journal-of-Applied-Forestry* 4(3): 89-92.

Keywords: site preparation
chemical preparation
growth

Abstract: In 1983, 1+0 container-grown Douglas fir (*Pseudotsuga menziesii*) seedlings were planted on a site in Oregon, USA, subject to summer drought under 3 amounts of sprout competition from greenleaf manzanita (*Arctostaphylos patula*) and canyon live oak (*Quercus chrysolepis*). Seedlings were planted among 0.25-m herbicide-killed sprouts, mature shrubs slashed just before planting, or 1-m tall sprouts, which represent an increasing order of competition. After 3 yr, Douglas fir survival did not differ significantly between treatments. However, percent cover of competing shrubs was negatively correlated with conifer root and shoot biomass. Under the least competition, root biomass increased 25x and shoot biomass 103x over dry wt. at planting, but dry wt. in other treatments increased <5 times. Douglas fir seedling growth did not increase significantly following shrub removal when vigorous sprouting occurred during the first year. After 3 yr, however, competitor cover in the minimum-competition plots was less than 15%, and conifer biomass had increased exponentially.

[OSU Link](#)

[Non-OSU Link](#)

38. Thies, W.G. and E.E. Nelson. 1988. Bulldozing stumps and nitrogen fertilization affect growth of Douglas-fir seedlings. *Canadian-Journal-of-Forest-Research* 18(6): 803-806.

Keywords: site preparation
mechanical preparation
fertilization
growth

Abstract: Eight treatments involving stump removal (either all stumps removed or the plot left undisturbed) and broadcast application of ammonium nitrate (N at 0, 336, 672 or 1345 kg/ha) were applied to 0.04-ha circular plots in a clear felling on the Olympic Peninsula, Washington. *Pseudotsuga menziesii* seedlings were planted several months after treatment; d.b.h. and height were recorded 5 and 8 yr after planting. Results showed that either bulldozing stumps or application of nitrogen increased seedling growth. After 8 yr, bulldozing had increased seedling height and d.b.h. by 23 and 43%, respectively; increases caused by nitrogen fertilizer were 13 and 17%, respectively.

[OSU Link](#)

[Non-OSU Link](#)

39. Thies, W.G., E.E. Nelson and D. Zabowski. 1994. Removal of stumps from a *Phellinus weirii* infested site and fertilization affect mortality and growth of planted Douglas-fir. *Canadian-Journal-of-Forest-Research* 24(2): 234-239.

Keywords: site preparation
mechanical preparation
fertilization
tree/stand protection
tree/stand health
growth
soil properties

Abstract: A field study was established in a 4.9 ha clearcut on the west slope of the Cascade Range (44 degrees 21'N, 122 degrees 39'W), Oregon, to evaluate the effects of stump removal (of both infested and non-infested stumps) and fertilizing with ammonium nitrate on the incidence of laminated root rot (caused by *Phellinus weirii*) in Douglas fir (*Pseudotsuga menziesii*) seedlings. A 2x4 set of factorial treatments of stump removal in combination with nitrogen fertilizing was applied in August 1980 to 0.04-ha circular plots within the clearcut. Treatments included stump removal (either all stumps removed or the plot left undisturbed) and broadcast application of ammonium nitrate (0, 336, 672, or 1345 kg N/ha). Diameter at breast height and height of Douglas fir, planted as 2+1 bare root seedlings 4 months after treatment (in January 1981), were recorded 5 and 9 seasons after outplanting. Soil bulk density in the upper 20 cm was measured with a single-probe neutron densimeter. Stump removal reduced the number of seedlings killed by laminated root rot but had no significant effect on seedling growth. Stump removal increased soil bulk density only 7% as measured 9.7 years after treatment. Fertilizer increased the growth in diameter at breast height, and height growth of the seedlings but had no effect on mortality. There were no significant interactions between fertilizing and stumping treatments. Increased total soil N could still be detected on fertilized, nonstumped plots 9.7 years after treatment.

[OSU Link](#)

[Non-OSU Link](#)

40. Thies, W.G. and R.N. Sturrock. 1995. Laminated root rot in Western North America. Pacific Northwest Research Station, USDA Forest Service General Technical Report GTR-PNW-349. iv + 32 pp. p.

Keywords: planting operations
site preparation
mechanical preparation
fertilization
thinning
tree/stand protection
tree/stand health

Abstract: Laminated root rot, caused by *Phellinus weirii*, is a serious root disease affecting Douglas fir (*Pseudotsuga menziesii*) and other commercially important species of conifers in northwestern North America. This report gives an overview of the disease as it occurs in the Pacific Northwest in Canada and the USA. Information on recognizing crown symptoms and signs of the disease is presented. The disease cycle of laminated root rot, from initiation to intensification and distribution within infected stands, is described. Finally, disease management strategies during stand development and at stand regeneration are discussed. Features on the nomenclature of the fungus and on its management by silvicultural and mechanical approaches also are included.

[OSU Link](#)

[Non-OSU Link](#)

41. Vihnanek, R.E. 1987. The effects of prescribed burning on the growth and nutrition of young Douglas-fir plantations in some salal [*Gaultheria shallon*]-dominated ecosystems [in British Columbia, Canada]. *Forestry-Abstracts* 48(11): 641.

Keywords: site preparation
prescribed fire
growth
tree physiology

[OSU Link](#)

[Non-OSU Link](#)

42. Vihnanek, R.E. and T.M. Ballard. 1988. Slashburning effects on stocking, growth, and nutrition of young Douglas-fir plantations in salal-dominated ecosystems of eastern Vancouver Island. *Canadian-Journal-of-Forest-Research* 18(6): 718-722.

Keywords: site preparation
prescribed fire
growth
tree physiology
stand conditions

Abstract: Stocking, ht. growth, basal diam. growth, and foliar nutrient concn. of 5- to 15-yr-old Douglas fir (*Pseudotsuga menziesii*) were evaluated on burned and unburned areas within each of 20 sites on eastern Vancouver Island, which were characterized by ecosystems dominated by salal (*Gaultheria shallon*). Burning significantly reduced salal ht. and cover and significantly increased Douglas fir stocking, ht. growth, basal diam. and foliar P, K, Ca, Fe, and B concn. Foliar concn. of N, Mg, S,

Zn and Cu were not significantly affected. FoliarMn concn. were significantly reduced but remained very far above the deficiency threshold.

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43. Wagner, R.G. and S.R. Radosevich. 1991a. Interspecific competition and other factors influencing the performance of Douglas-fir saplings in the Oregon Coast Range. *Canadian-Journal-of-Forest-Research* 21(6): 829-835.

Keywords: site preparation
prescribed fire
growth
tree morphology

Abstract: Regression models describing total height, stem diameter, stem volume index, and crown volume index of individual 4- to 9-year-old saplings of Douglas fir (*Pseudotsuga menziesii*) were developed from a retrospective analysis of two site preparation experiments (with/without prescribed burning). Measurements of 787 Douglas fir saplings were taken at nine sites during July and August 1984. The variables included in the models were age, interspecific competition index, height, animal damage (browsing and clipping), use of prescribed burning, and slope angle and azimuth. The models, which integrate environmental and morphological factors that can influence the performance of Douglas fir saplings into one set of equations, accounted for 64-73% of the variation in individual tree size. Interspecific competition and amount of animal damage were negatively correlated with tree size. Tree age, 1st-year height, and the use of prescribed burning were positively correlated with tree size. When factors were held constant, trees were largest on steep southeast slopes. The models indicated that tree age, competing vegetation, animal damage, and initial seedling size had a dominant influence on the performance of Douglas fir saplings, while prescribed burning and topography were of relatively minor importance.

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44. Wagner, R.G. and S.R. Radosevich. 1991b. Neighborhood predictors of interspecific competition in young Douglas-fir plantations. *Canadian-Journal-of-Forest-Research* 21(6): 821-828.

Keywords: site preparation
stand conditions
growth

Abstract: Neighbourhood models describing the effect of interspecific competition on the height and stem diameter of 4- to 9-year-old saplings of Douglas fir (*Pseudotsuga menziesii*) were developed from site preparation experiments in the Oregon Coast Range. Existing study records and maps were used to randomly select 787 saplings from 78 study plots at nine sites. The influence of abundance measures, height, distance, and spatial arrangement of nonconiferous woody plants surrounding individual saplings was examined. Optimum neighbourhood heights and radii were defined. The best interspecific competition index for predicting Douglas fir height and stem diameter was total

percentage cover for all woody species within a 2.1-m radius. Visual estimates of neighbour cover were superior to objective measures of crown area. The cover of woody species equalling or exceeding the height of the tree provided the best prediction for tree height. Woody species cover equalling or exceeding one-half the height of the tree provided the best index for predicting stem diameter. Accounting for the spatial arrangement of neighbouring woody plants did not improve the competition index. Interaction between the competition index and tree age indicated that the negative effect of interspecific competition on Douglas fir size increased with time. The age-adjusted competition index accounted for 11% of the variation in height and 19% of the variation in stem diameter. Douglas fir stem diameter was more sensitive to neighbouring woody plants than was height.

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45. Wass, E.F. and R.B. Smith. 1997. Impacts of stump uprooting on a gravelly sandy loam soil and planted Douglas-fir seedlings in south-coastal British Columbia. Pacific-Forestry-Centre,-Canadian-Forest-Service Information-Report BC-X-368. vi + 15 p.

Keywords: site preparation
mechanical preparation
tree/stand protection
soil properties
stand conditions
growth

Abstract: Studies to determine levels and impacts of soil disturbance caused during root-disease control by stump removal were initiated on a cutover on southern Vancouver Island immediately prior to the control operation and the establishment of a plantation of Douglas-fir (*Pseudotsuga menziesii*). Soil surface condition was assessed on the stumped area. Soil disturbance was measured at 699 planting spots. Vegetation development was assessed at 10% of the spots. Of all planting spots, 180 were undisturbed soil, 277 deposits and 242 gouges. The soil, a gravelly sandy loam, increased naturally in soil density with depth from 1.05 t/m³ at the surface to over 1.60 t/m³ at depths more than 40 cm. Disturbance did not significantly increase soil density. Unlike previous studies of this nature, ease of soil penetrability was increased by the stump uprooting disturbance and vegetation development was not greatly dissimilar between disturbed and undisturbed soil. The relatively low soil impacts were attributed to the ability of the excavator to pile stumps without pushing topsoil, and the low site sensitivity to compaction. These low impacts on soil and reduced vegetative competition on disturbed soil resulted in tree growth rates which were significantly greater after 10 years on deposits (12% in height and 18% in diameter) and gouges (6% in height and 8% in diameter) than on undisturbed soil.

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46. Woods, J.H., D. Kolotelo and A.D. Yanchuk. 1995. Early selection of coastal Douglas-fir in a farm-field test environment. *Silvae-Genetica* 44(4): 178-186.

Keywords: genetic tree improvement

planting operations
site preparation
mechanical preparation
release treatments
chemical release
manual release
genetic relationships
wood quality
growth

Abstract: Farm-field tests are progeny tests established using intensive site preparation, close spacing and nearly complete weed control. Early growth and wood density of coastal Douglas-fir (*Pseudotsuga menziesii*) in a farm-field environment for up to 7 years from seed were compared with stem volume and wood density from 11 field sites at age 13 (20-25 of commercial rotation). The farm-field test material comprised 70 full-sib families from six 6-tree half-diallels (some reciprocals and missing crosses) without selfs. Parent trees were from natural stand selections in the coastal area of British Columbia, Canada, and the farm-field test was conducted on southern Vancouver Island. Family heritabilities were high for almost all traits in both the farm-field and field sites. Breeding-value correlations of farm-field heights with field stem volume at age 13 increased from a low of 0.5 for farm-field age 1 and levelled off at about 0.7 by farm-field age 3. Farm-field diameter with field volume age 13 breeding-value correlations were initially lower than those for height, but increased to 0.82 by age 7. Wood density breeding value correlations between field pilodyn assessments at age 13 and farm-field stem sections at age 6 were 0.83. Maximum family-selection efficiency per year (including a 5-year breeding delay), relative to direct selection on field volume 13, reached 162% using index selection on farm-field height and diameter at age 3. Within-family selection efficiencies per year were highest at age 1 and declined quickly thereafter. All selection in the farm-field test had a higher efficiency per unit time than selection in field tests. It is concluded that correctly established farm-field tests will provide greater per year gains in stem yield and wood density traits than field sites.

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