FIR Report

SPRING 1988

VOL. 10 NO. 1

The Southwest Oregon Forestry Intensified Research Program (FIR) is a cooperative effort between the College of Forestry at Oregon State University and the Pacific Northwest Research Station of the USDA Forest Service. The FIR Program assists foresters and other resource management specialists in solving complex biological and management problems endemic to southwest Oregon. FIR specialists organize, coordinate, and conduct educational programs and research projects specifically tailored to meet the needs of this area.

Established in October 1978, the FIR Program is supported jointly by Oregon State University, the Bureau of Land Management, USDA Forest Service, O&C Counties, and the southwest Oregon forest products industry. It represents a determined effort by the southwest Oregon forestry community and county governments to find practical solutions to important forest management problems.

The "FIR REPORT" is one of the principal methods of reporting recent technological advances and research results pertinent to southwest Oregon, and alerts area natural resource managers to upcoming continuing education opportunities. Comments and suggestions concerning the content of "FIR REPORT" are welcome and encouraged. This newsletter is prepared quarterly and is mailed free on request by contacting us at this address: FIR REPORT, 1301 Maple Grove Drive, Medford, OR 97501.

For the FIR Staff,

David H. McNabb
Extension Watershed Specialist

Inside

BRUSHFIELD ECOLOGY
Douglas-fir nearly free of brush competition continues exponential growth — p. 2

REGENERATION POTENTIAL
Summary of survival of 39 sites generally remains high — p. 3

MACHINE SITE PREPARATION
Scarification fails to compact dry soil — p. 4

PREDICTING DOUGLAS-FIR RESPONSE TO NITROGEN
Soil testing fails to improve capability — p. 5

SEEDLING SURVIVAL ON RAVELING SLOPES
Most seedlings are near stumps of the previous stand — p. 6

CONTINUING EDUCATION
Pacific Northwest host to national meetings — p. 7

LIGHTNING FIRES
Fewer large fires occurred when dry-season precipitation was normal — p. 9

PUBLICATIONS
Reprints available on seedling micro-environment, stream habitat, and harvesting — p.10

OREGON STATE UNIVERSITY EXTENSION SERVICE

FORESTRY INTENSIFIED RESEARCH

SERVING SOUTHWEST OREGON THROUGH RESEARCH AND EDUCATION

Adaptive FIR

1301 MAPLE GROVE DRIVE
MEDFORD, OR 97501

(503) 776-7116

FIR Specialists

OLE HELGERSON, Silviculture
STEVE HOBBS, Reforestation
JOHN MANN, Harvesting
DAVE McNABB, Watershed
STEVE TESCH, Silviculture

For specifics on the overall FIR program, contact Jack Walstad, FIR Program Leader, Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, OR 97331, (503) 757-4617; or Steve Tesch, Adaptive FIR Project Leader at the Medford address.

Because of space limitations, articles appear as extended abstracts. Results and conclusions presented herein may be based on preliminary data or analyses. Readers who are interested in learning more about a study are encouraged to contact the principal investigator or wait for formal publication of more complete results.

FROM THE EDITOR

I want to thank Ole Helgerson for the fine job of editing the last volume of the FIR Report, particularly the last issue - the Special Fire Issue. After that Herculean task of bringing 26 contributors together to produce the largest FIR Report ever, he has relinquished the editorship for a well-earned rest.

I also want to thank the many contributors to the 'Special Fire Issue.' Comments from readers throughout the West are that it was well worth the time and effort. Approximately 1,500 copies were mailed to subscribers and several hundred more copies have been distributed since. The issue is being reprinted and is available from our office, or from Forestry Business Office (see page 10).

Volume 10 will emphasize sharing the most recent results of the many Fundamental and Adaptive FIR studies. Timing is particularly critical because of both the ongoing planning by federal agencies and the planned completion of many Fundamental FIR projects by 1989. A concerted effort will be made to share the final results of these latter studies and have a few research scientists provide some summary articles reviewing the main results of their research and the implications for forest management.

The FIR Report will remain a vehicle to share innovative ideas and administrative studies. Effective communication is two-directional; as you obtain results from your field studies or have other questions, please do not hesitate to call.

DM

Current Research
Adaptive FIR

MEASUREMENTS COMPLETED FOR NEGRO BEN MOUNTAIN BRUSHFIELD ECOLOGY STUDY

Data collection was completed in the fall of 1987 in this study to determine the competitive effects of canyon live oak and greenleaf manzanita on Douglas-fir seedling survival and growth. After 5 growing seasons, Douglas-fir seedlings planted in plots nearly free of competition from sclerophyll shrub sprouts averaged 13 times more stem volume than seedlings planted among newly sprouting brush and 43 times that of those planted among 1-meter tall sprouts.

The study site is located on Negro Ben Mountain near Ruch at 1100 meters elevation on a 66-percent, west-facing slope. The soil is a skeletal Xerochrept covered with scree. Douglas-fir seedlings were planted in March 1983, within plots that had been treated as follows: Treatment 1, 2-year-old brush sprouts killed with herbicide 1 year before planting; Treatment 2, mature brush plants slashed with chainsaws just before planting and then allowed to sprout; and Treatment 3, third-year sprouts about 1 meter tall, untreated.

Despite the third consecutive year with nearly 20 percent below normal precipitation and ever-increasing height and cover of competition, survival remained high in all treatments (Table 1). Surprisingly, fifth-year survival averaged 78 percent for the seedlings planted among the 1-m tall sprouts. Some of the canyon live oak sprouts in this treatment are now in excess of 2-m tall. As expressed before, we feel that high quality nursery stock and careful planting have contributed to the high survival, and the shade from the sprouts un-

TABLE 1.--Douglas-fir seedling survival and size in 1987, 5 years after planting.

Treatment	Shrub Cover in 1987	Percent Survival	Height	Diameter
	---- %	----	cm	mm
Treatment 1	22%a[1]	91a	103a	22a
Treatment 2	63%b	85a	58b	8b
Treatment 3	71%b	78a	45b	6b

[1]Values within a column followed by similar letters are not significantly different.

doubtedly reduced evaporative demand for the planted conifers. It should also be noted that herbaceous competition was largely absent from this site, even after the herbicide application to kill the sprouts in Treatment 1.

Although survival is high, growth has been reduced substantially as competition increased. Fifth-year heights and diameters of Treatment 1 seedlings were significantly larger than those for Treatments 2 and 3, which were not significantly different from one another in either characteristic (Table 1). Annual height and diameter growth in 1987 continued to be much greater for Treatment 1 seedlings, but height growth differed less between treatments than diameter. Seedlings in Treatments 2 and 3 apparently responded to shading from sprouts by allocating more growth to height than diameter and now have an etiolated-like appearance (Figure 1). The fifth-year height/diameter ratios of 47,72, and 75 for Treatments 1, 2, and 3, respectively, illustrate this well.

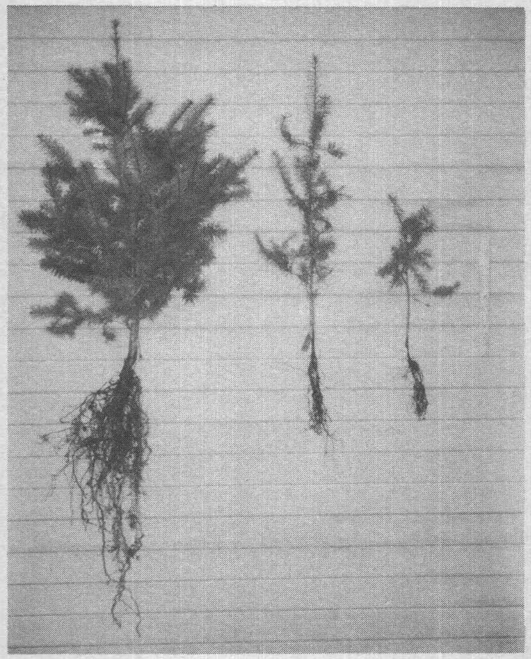

FIGURE 1. Representative seedlings from Treatment 1 (left), Treatment 2 (middle), and Treatment 3 (right), excavated after 5 growing seasons. Ruler on right is .3 m long.

The combined effects of diameter and height growth are illustrated in Figure 2. Seedlings in Treatment 1 show a strongly exponential annual increase in volume over the 5-year period. Treatments 2 and 3 were not significantly different from one another after 5 years, and have increased in volume slowly. The photograph of seedlings (Figure 1) also shows root volume increasing as competition is reduced. Roots for Treatments 2 and 3 seedlings show little growth beyond the original container potting medium after 5 years.

The results of this study document the value of effective brush control at the time of planting in improving the growth of conifer seedlings planted on droughty sites in southwest Oregon. Vegetation management that allows rapid sprouting will, at a minimum,

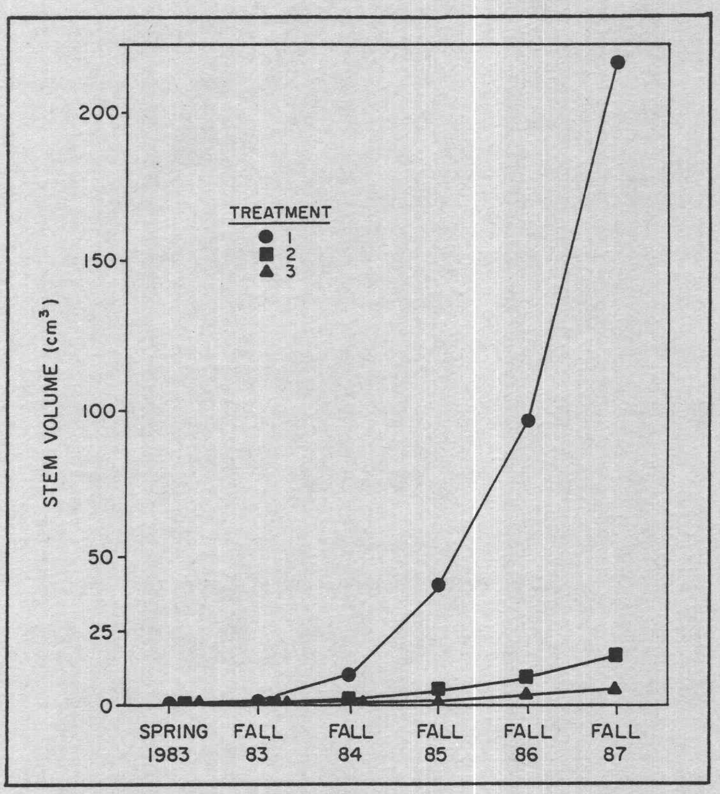

FIGURE 2. Average Douglas-fir seedling stem volume over 5 years of measurements, by treatment.

result in greatly reduced seedling growth. In this particular situation, the slashing strategy for Treatment 2 was associated with an increase in sprout cover from virtually none at planting to greater than 30 percent by the end of the first growing season. The literature indicates that significant reductions in conifer growth occur when competition exceeds 15-30 percent cover, depending on the specific study. Seedlings in Treatments 2 and 3 exceeded these limits during the first growing season.

The volume growth in Treatment 1 should represent close to an upper bound for this particular site, since competitive cover in this treatment was still only 22 percent after 5 growing seasons (Table 1).

Previous results of this study have been reported in FIR Report 3(3):2-3, 4(2):9-10, 5(1):3-4, 6(1):4, 6(4):3-4, 7(4):2-3, and 9(3):5.

ST

1987 SEEDLING SURVIVAL FOR REGEN POTENTIAL STUDY

This study is assessing the potential for artificial reforestation of lands within the Medford District BLM that were perceived to be difficult to reforest. Reforestability is being measured by planting conifer seedlings on a range of sites that represent environmental conditions of the withdrawn lands. Two stocktypes of Douglas-fir (1-0 container grown plugs and 2-0 bareroots) are planted on all sites, and ponderosa pine seedlings (plugs or bareroots) are planted on sites under 2700 feet in elevation. Sugar pine has also been planted on two sites. Vegetation around all seedlings is controlled by a variety of methods including paper or polyester mulches, hand grubbing, and slashing of sprouts; Douglas-fir seedlings also are protected from browsing with Vexar® tubes. Survival and growth of these planted seedlings is being used to indicate the reforestation potential of the withdrawn lands.

Of the 39 sites that have been planted, two have accumulated at least five years of observation on seedling performance. The first site planted, Tin Pan Peak, reached this milestone at the end of the 1986 growing season (see FIR Report 9(3):2 for details). In the fall of 1987, fifth year measurements were taken on seedlings at the Salt Creek site. Detailed results from the treatments installed on this site, which included shading of the Douglas-fir stocktypes, will appear in a subsequent issue of the FIR Report.

Survival, averaged over all study sites, declined between 2 and 5 percent from 1986 for each stocktype, with slightly greater mortality on south-facing slopes. Despite prolonged drought, seedling survival for the first growing season on the two sites planted in 1987 (Lower Grave Creek and Flume Descent) was at least 89 percent (Table 1). Porcupines decimated ponderosa pine planted on the West Left Fielder site after seedling measurement, leaving few pines ungirdled. Of the 22 sites planted with ponderosa pine, porcupines have killed substantial numbers of ponderosa pine seedlings at only two sites.

TABLE 1.--Seedling survival at the end of 1987 for study sites in the regeneration potential study.

Site (Years of observation)	Aspect	Stocktype and Species*					
		1-0 Plug DF	2-0 Bare-root DF	Plug-1 DF	1-0 Plug PP	2-0 Bare-root PP	1-0 Plug Sugar Pine
Tin Pan Peak(5)	W	88	98		90	97	
Salt Creek(5)**	S	66	85			92	
Dutch Herman#1(4)	N	77	87				
Hog Remains(4)	N	61	89				
Julie Creek(4)	S	40	73				
Negro Ben(4)	S	73	71		98		
Forest (Oregon) Belle(4)	S				84		
Peggler Butte(4)	S	49	49				
Rock Creek(4)	S	58	51		75		
Steven's Creek(4)	S	35	51	87	85		
Texter Gulch(4)	W	87	85		91	95	
Walker Return(4)	S	61	81				
Blue Gulch(3)	N	99			99		
Brandt Crossing(3)	S	87	66		96		
Buckhorn #1(3)	S	74	73		60		
Burton Butte(3)	N	72	74		95		
Chrome Umbrella(3)	S	93	94				
Dutch Herman#2(3)	N	90	79				
West Left Fielder(3)	W	89	90		85		
Limp Hog(3)	S	30	17		51		
Marial Ridge(3)	S	71	85				
Millcat(3)	N	86	81		71		
Miller Gulch(3)	S				29		
Myrne Return(3)	N	72	83				
Pickett Again(3)	S	87	71	89			
Rocky Ravel(3)	N	76	87				
Wolf Gap(3)	S	91	93				
South Left Fielder(2)	S	93	81		78		
Buckhorn #2(2)	S	81	54				90
China Ridge(2)	S	97	81		97		
Dutch Herman #3(2)	N	90	85				
Hayes Creek (2)	S	93	83				
Howard Quick(2)	N	55	66				
Low Crow(2)	N	91	52			86	72
Missouri Blowdown(2)	N	99	93				
Old Ben(2)	S	91	87		75		
Totten Creek(2)	S	95	76				92
Flume Descent(1)	SW	97	95		98		
Lower Grave Creek(1)	S	96	96		89		

* DF = Douglas-fir, PP = ponderosa pine.
** Douglas-fir data are averages of shaded and unshaded seedlings.

Details of this study have been reported in FIR Reports 3(4):4, 4(1):1, 4(4):4, 5(2):6-7, 5(4):4, 6(4):4, 8(4):2-3, and 9(2):2.

OH

SOIL DISPLACEMENT AND COMPACTION BY MACHINE SITE PREPARATION

Machine site preparation is a common practice on flat to gently sloping terrain in southwest Oregon. Machines effectively remove slash and nonmerchantable trees and the larger shrubs but may also cause soil compaction and displacement. This study was specifically designed to determine how much soil compaction and displacement resulted from different machine site preparation treatments.

The site chosen for this study lies at an elevation of about 600 m in the western Cascade Mountains north of Medford. Slopes range from flat to about 30 percent, and the soil is a loamy Xerochrept developing on an ash-flow tuff. The stand was a mixed-age forest of Douglas-fir, and sugar and ponderosa pine. The understory included white oak and madrone in varying amounts and a large number of suppressed sapling and pole-size Douglas-fir.

The site was logged from designated skid trails in June and early July to avoid compacting the soil on treatment plots. Skid trails were spaced approximately 30 m apart to allow establishment of square, 0.20 ha (half acre) plots between the trails that were not compacted during harvesting.

Five treatments in three replications of two plots each were established; one plot in each treatment was to have post-planting vegetation controlled. They were: control (all slash and woody shrubs and trees felled and hand carried from the plot); scarify (a slash rake was used to clear slash and residual trees from the entire site); scarify and till (previous treatment followed by tilling the plot to a depth of at least 50 cm with rock rippers on a spacing of approximately 75 cm); soil displacement (a dozer blade was used to pile slash, trees, and approximately 5 cm of top soil); and soil displacement and till. Soil displacement was evaluated because it successfully controls many hardwood trees and larger shrubs and provides a continuum of soil damage treatments over which to evaluate scarification as a site preparation treatment.

Machine site preparation was performed with a D-7 size machine in late July and August following harvesting. The rake used attached to the dozer blade with teeth extending one foot below the blade. Slash and soil were piled in windrows; all piling was accomplished in a single pass, with the machine backing over its previously cleared path. Both the scarification and soil displacement treatments removed the saplings and the stumps of the smaller felled trees.

The average depth of soil removed from the plots was measured as the difference in elevation beneath a tensioned tape recorded prior to harvesting and the summer following site preparation. The delay in remeasurement allowed time for the soil to settle. Elevations were measured at 20 points along 4 transects in each treatment, for 80 points per treatment and a total of 1200 points. After site preparation, five transects were abandoned because felled trees or damaged stumps displaced the spikes that supported the tape. Soil bulk density was measured at five locations along each transect at depths of 0-10, 10-20, and 20-30 cm with a nuclear densimeter prior to harvest and approximately 16 months after site preparation.

Soil displacement during scarification was not significantly different from the control (Table 1). Remeasurement error of one transect was approximately 0.4 mm. The apparent loss of soil from the control may reflect some settling of the surface soil and a rebound of stumps following felling. Within soil displacement plots, removal of soil was less than the 5 cm planned but removing additional soil was not possible without making a second pass over the site.

TABLE 1.--Soil displacement and changes in bulk density following machine site preparation in the western Oregon Cascades (Millcat).

		bulk density, cm		
Treatment	Displacement	0 - 10	10 - 20	20 - 30
	mm		Mg/m³	
Control	- 3.3a[1]	-0.03ab	0.05a	0.01a
Scarify	- 2.2a	0.02b	0.03a	0.03ab
Scarify & Till	- 7.4a	-0.08a	-0.02a	-0.01a
Displacement	-45.6b	0.07b	0.06a	0.07b
Oisplacement & Till	-38.6b	0.06b	0.15b	0.14c

[1]Within a column, values for soil displacement or bulk density followed by the same letter are not significantly different ($P = 0.05$), Duncan's Multiple Range Test.

Changes in soil bulk density were generally small and not statistically significant except for soil displacement treatments. Scarification alone did not result in an obvious increase in bulk density but tillage of scarified plots did lower bulk density. Immediately after tillage, soil on these plots was very loose but considerable settling had occurred by the time the bulk density was remeasured. By delaying remeasurement of bulk density, a more lasting change in bulk density from tillage is reported.

Soil displacement generally resulted in significant increases in bulk density, particularly at the lower depths. This increase in bulk density is confounded by the removal of soil which results in the remeasurement occurring in deeper, more dense soil horizons. In fact the deliberate removal of soil was not uniform across the site but in several locations resulted in 20 cm or more of soil being displaced because of stump removal. Such large changes in depth readily expose the denser subsoil horizons. The reason for the greater increase in bulk density of soil displacement plots which had been tilled is uncertain, although the largest increases in bulk density were observed in one replication where soil removal exposed the most subsoil.

Several factors account for the small increase in bulk density and soil displacement. The dry, loamy soil was more likely to fall from roots and between the teeth of the rake than would be more moist or clayey soil. The dry soil probably was less susceptible to compaction. The machine treatments were accomplished with minimal traffic: machines only made one pass over the soil; the area actually covered by the tracks of the machine was less than half the area; and the slash was piled in windrows rather than round piles.

These results indicate that restricting machines to designated skid trails during harvesting and limiting machines to one pass over dry soil during site preparation limits the potential for serious compaction. The area of compacted skid trails was less than 10 percent of the total area and soil density increases following scarification were limited because machines only made one pass over less than half the area.

Based on this data, scarification for site preparation is not necessarily incompatible with harvesting from designated skid trails. Restricting machines to designated skid trails reduced machine passage to less than 10 percent of the area while uncontrolled skidding typically results in at least 25 percent of the site being compacted. Harvesting from designated skid trails essentially increases machine availability by lengthening the logging season; this increase should translate into greater availability of machines for site preparation when soils are less susceptible to compaction. During the study, I also observed that felling timber to lead concentrated the slash near the skid trails, potentially reducing the need to pile slash on the entire site.

The performance of 2-0 bareroot Douglas-fir seedlings is being measured on this site. After two years, the differences in survival and growth due to machine site preparation are not statistically significant (FIR Report 8(2):2).

DM

Fundamental FIR

PRELIMINARY RESULTS FROM A FIELD TRIAL OF DOUGLAS-FIR CONTAINER SEEDLINGS INOCULATED WITH BASIDIOSPORES OF RHIZOPOGON VINICOLOR

As an adjunct to the Fundamental FIR study, Reforestation Systems for Douglas-fir in the Siskiyou Mountains (FIR Report 5(4):9, 6(2):4, and 7(2):4) container seedlings that had been inoculated in the nursery with basidiospores of Rhizopogon vinicolor were planted on some of the plots installed in Spring 1985. The main study is a factorial comparison of clearcut vs. shelterwood, burn vs. no burn for site preparation, three planting stock types, and shading or tubing for seedling protection. A 25-seedling row of mycorrhizal inoculated seedlings were planted in 6 plots on a south facing site -- Miller Gulch, and in a total of 10 plots on two north facing sites -- Blue Gulch.

After two years on the south-facing site, Miller Gulch Douglas-fir seedlings, inoculated with Rhizopogon, had significantly better survival and growth than either noninoculated container seedlings or 2-0 bareroot seedlings, regardless of site preparation technique. On one of the north facing sites, Blue Gulch, the Rhizopogon inoculated seedlings had better survival but not growth than the noninoculated container seedlings or the bareroot seedlings when the site was left unburned; the other site showed no differences due to stock type.

Peyton Owston
Michael Castellano
PNW, Corvallis

PREDICTING DOUGLAS-FIR RESPONSE TO NITROGEN FERTILIZATION

Reliable variables to predict Douglas-fir response to nitrogen (N) fertilization are needed to select stands most likely to respond and to avoid fertilizing those that are not. Although nearly 70 percent of the Douglas-fir fertilizer plots in the Pacific Northwest respond to nitrogen, fertilizing those stands with the highest potential for response improves the economic returns from forest fertilization.

A reliable index of soil nitrogen availability is a logical choice for predicting response to fertilizer. In fact, several studies have found soil test data to be useful either alone or in combination with other site and stand variables for predicting tree or stand response to fertilization. Stand variables alone effectively predict Douglas-fir response and are less costly to collect if the soil data are not readily available.

The objective of this study was to determine if soil test data could substantially improve predictions of response to fertilizer in southwest Oregon over that possible from stand and site variables. The data are for a subgroup of 64 trials at locations in western Oregon from south of Salem to the California border. A total of the 111 trials fertilized with 200 lb N/ac occur in the area but some trials were eliminated from the analysis because of excessive variability within trials of either site index, estimated rooting depth, soil series, aspect, or slope. The trials selected included installations of the Regional Forest Nutrition Research Project, Forest Service, Weyerhaeuser, Roseburg Lumber, Boise Cascade, and Georgia-Pacific. Response data are for a period of 5 to 14 years of which 41 of the 64 trials have a common measurement period of 8 years.

Soil scientists from the Bureau of Land Management and USDA Forest Service collected mineral soil samples from the 0-15 cm depth at 24 locations within a trial but outside of the plots and buffers. Samples were analyzed for total nitrogen, carbon, and mineralizable nitrogen (an index of nitrogen availability). Total nitrogen and carbon were used to calculate the C/N ratio.

Stand variables were 50-yr site index, breast-high age, and relative density; these variables predicted response to nitrogen fertilization in previous investigations (FIR Report 8(4):4-6). These stand variables were included in a basic regression equation to predict fertilizer response, to which site-climatic and soil variables were added to determine if they had additional predictive value. Site-climatic variables included average annual precipitation, solar radiation, elevation, effective soil depth (soil depth reduced for coarse fragment volume), and available moisture-holding capacity. Soil test variables were the last variables added to the equation.

Average response to 200 lb N/ac of nitrogen was an annual increase of approximately 1.0 ft^2/ac in basal area and nearly 40 ft^3/ac in volume for both the 8-year and entire period of response measurement; these increases correspond to approximately an 18 percent increase in growth following fertilization, but individual stand response varied over a wide range.

All equations for estimating absolute basal area or volume response were either not statistically significant or accounted for less than 10 percent of the residual variation. Equations for predicting percentage response were significant, with the volume equations accounting for more of the residual variation than did the basal area equations. Equations for 8-year response also accounted for more variation than the total (5-14 yr) response estimates. Site-climatic variables were not statistically significant, and C/N ratio was the only soil variable which made a significant contribution to the base equation.

The volume equations for 8-yr, percentage response to 200 lb/ac of nitrogen with and without the C/N ratio follow:

$$\%\text{ Volume Response} = 1.089 - 0.99616\ SI - 0.00983\ A - 0.00327\ RD - 0.0000743\ SI*A \quad (R^2 = 0.37)$$

$$\%\text{ Volume Response} = 0.6024 - 0.00331\ SI - 0.00396\ A - 0.00396\ RD + 0.0000201\ SI*A + 0.00684\ C/N \quad (R^2 = 0.46)$$

The independent variables are: SI (site index at breast-high age of 50 yrs), A (breast-high age in years) RD (relative density computed from stand basal area/square root of the diameter of the tree of average basal area), and C/N (carbon/nitrogen ratio of soil at the 0-15 cm depth).

As individual variables, mineralizable nitrogen, total nitrogen and carbon/nitrogen ratio were all significantly correlated ($P = 0.05$) with percentage volume response. When added to an equation composed of stand variables, however, the soil test variables were unable to account for sufficient additional variation to justify inclusion. Failure of soil variables to account for a substantial amount of the variation in equations including stand variables may occur because site index is already significantly correlated with soil variables.

The average response to a 200 lb/ac application of nitrogen fertilizer was an 18 percent increase in volume growth. The regression equations indicate that the response is greater in stands of lower site index, age, and relative density; sites with a higher C/N ratio tend to respond more to fertilization than those with a lower C/N ratio. At the present time, the high cost of collecting and analyzing soil samples is not justified by a practical improvement in our ability to predict Douglas-fir response to nitrogen fertilization in Southwest Oregon.

DHM
Dick Miller, PNW-Olympia
John Hazard, formerly
PNW-Portland

SEEDLING SURVIVAL ON STEEP, RAVELING SLOPES IN SOUTHWEST OREGON

Seedling survival within clearcuts on steep, raveling slopes is often spotty. Stumps from the pre-

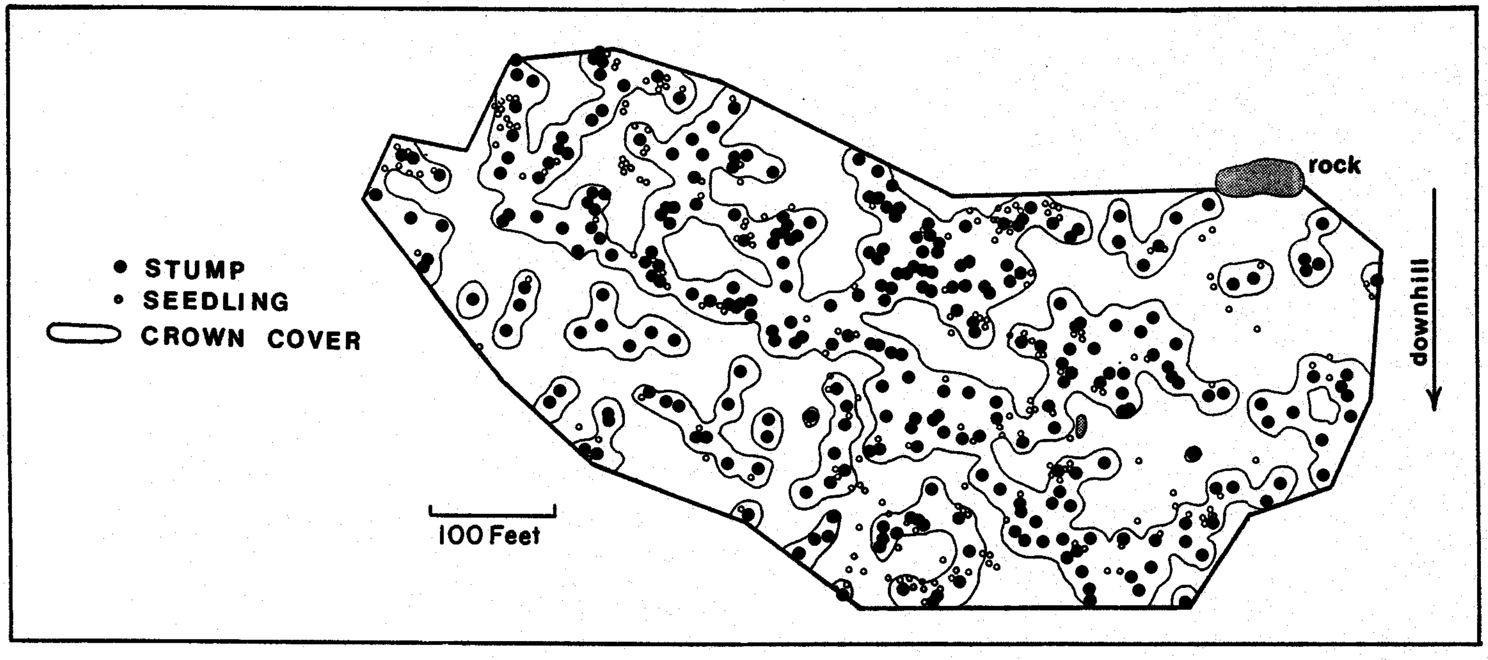

FIGURE 1.

vious stand of trees may provide clues to where trees planted on these harsh sites are most likely to survive.

We selected a 2.1 ha (5.2 ac) clearcut on a slope above Pass Creek in the headwaters of the North Umpqua River. Logging occurred four years prior to the study. Freeze core soil samples taken at various locations in the clearcut revealed the presence of a surface gravel layer averaging 217 mm (8.5 in) in depth. The surface layer to a depth of 305 mm (12 in) was mostly coarse fragments. Fourteen percent of the material was gravel greater than 51 mm (2 in) in diameter, 33 percent was gravel between 25 and 51 mm (1 to 2 in), while only 9 percent was fine soil (< 2 mm).

Average slope of the site was 68 percent. However, slopes averaged 86 percent at stumps, indicating ravel accumulation above the stumps and soil loss without replacement below the stumps.

We mapped all stumps and noted their species and diameter (outside bark). Stump diameter provided an estimate of crown diameter using equations developed by Bones (1960), Larsen and Hann (1985), and Paine and Hann (1982). We also mapped seedlings, both natural and planted (Figure 1).

The stand of old-growth included 305 trees greater than 200 mm (8 in) at stump height, equivalent to 145 trees per hectare (59 trees/acre). The average stump diameter outside bark was 850 mm (33.5 in).

The projected canopy cover of the previous stand was 47 percent of total area. Seedling density averaged 169 per hectare (68 per acre) in areas covered by the previous canopy, but only 47 per hectare (19 per acre) elsewhere. Seedling establishment was least outside the previous canopy and where thick accumulations of large gravel covered underlying soil layers.

Additional reforestation efforts at this site should concentrate on interplanting in areas covered by the previous canopy. As a rule-of-thumb this means planting within 15 to 18 feet of existing stumps.

Reforestation efforts on steep, raveling slopes should consider the composition of the previous stand. If the distribution of trees in the original stand is variable and covers less than 50 percent of the unit, it seems unreasonable to expect a more uniform spacing in the new stand on these harsh sites. Estimates of crown cover using stump locations and diameters can help isolate zones with higher potential of regeneration success within the clearcut.

Henry Froehlich
OSU

Continuing Education

SEVENTH NORTH AMERICAN FOREST SOILS CONFERENCE

July 24-28, 1988. Vancouver, B.C. The theme of this conference is Sustained Productivity of Forest Land and is jointly sponsored by the Canadian Institute of Forestry, Society of American Foresters, Canadian Soil Science Society, and Soil Science Society of America. Papers and field trips will cover both site processes and changing productivity. CONTACT: 7th North American Forest Soils Conference Secretariat, UBC Conference Centre, University of British Columbia, Vancouver, B.C. V6T 1K2. (604) 228-5441.

FOREST GENETICS: IMPLICATIONS FOR SEED AND SEEDLING TRANSFER IN SOUTHWEST OREGON

Fall 1988. Medford and Roseburg, OR. Identical one-half day programs to summarize the results of recent research on forest genetics in southwest Oregon. Workshop director: Steve Tesch. CONTACT: Lenore Lantzsch, Adaptive FIR, (503) 776-7116.

INTERNATIONAL MOUNTAIN LOGGING AND PACIFIC NORTHWEST SKYLINE SYMPOSIUM

December 12-16, 1988. Portland, OR. Topics to include major aspects of timber harvesting and transportation in mountainous areas, with an emphasis on steep terrain. A call has been issued for papers and posters. Proceedings of the symposium will be published. CONTACT: William A. Atkinson, Program Committee Chairman, Department of Forest Engineering, Oregon State University, Corvallis, OR 97331. (503) 754-4952.

PROTECTING THE HEALTH OF PACIFIC NORTHWEST FORESTS THROUGH INTEGRATED PEST MANAGEMENT: A SYMPOSIUM FOR FOREST MANAGERS

January 17-18, 1989. Corvallis. The symposium is designed for forest resource managers responsible for the stewardship of managed forests and the control of insect, disease, weed, and vertebrate pests that are a threat to the health and productivity of the forests. The program will blend pest management with other silvicultural considerations and present new techniques and strategies for dealing with pest problems. CONTACT: Conference Assistant, Oregon State University, Corvallis, OR 97331. (503) 754-2004.

REFORESTATION OF HIGH ELEVATION SITES IN SOUTHWEST OREGON AND NORTHERN CALIFORNIA

Winter 1989. Medford, OR. Program will address the general problems of reforestation of high elevation sites including the climate, soil physical, chemical, and biological environment, pests, and artificial and natural reforestation strategies. Workshop director: Ole Helgerson. CONTACT: Lenore Lantzsch, Adaptive FIR, (503) 776-7116.

APPLICATION OF FOREST SOILS INFORMATION TO FOREST MANAGEMENT IN SOUTHWEST OREGON

Winter and Spring 1989. Medford and Roseburg, OR. Two separate one-day programs to be held at each location. One program will discuss the soil physical environment and the second will discuss the nutrient and biological environment. The programs will review forest soils, the specific knowledge gained about forest soils in southwest Oregon in the last decade and the application of this information to forest management. Workshop director: Dave McNabb. CONTACT: Lenore Lantzsch, Adaptive FIR (503) 776-7116.

Of Interest

PRELIMINARY HEIGHT-GROWTH AND SITE-INDEX CURVES FOR MOUNTAIN HEMLOCK

Higher elevation stands are a significant resource in some portions of southwestern Oregon. Management of these stands is limited, however, by lack of knowledge in areas such as reforestation, and growth and yield. Height-growth and site-index curves will soon be available for mountain hemlock (*Tsuga mertensiana*) to fill part of that gap.

Trees in unmanaged stands were sampled from near Mount McLoughlin in the southern Oregon Cascades to near Mount St. Helens and Mount Adams in the southern Washington Cascades. One-hundred-eleven dominant and codominant trees with no visible signs of top breakage or radial growth suppression in cores were dissected. Cross-section disks were removed every 60 to 200 cm and their location measured. Ages were then determined by counting rings on whole or partial disks in the laboratory, and used to construct a height-over-age curve for each tree. Trees whose height-over-age curves showed probable top damage or suppression were rejected, thus paring the data to the 95 trees used to build height growth and site index curves.

The preliminary height-growth equation is

$$HT = 1.37 + [a + b\,(SI-1.37)]$$
$$(1 - \exp[c\,(SI-1.37)^{0.5}\,A])^{[d + e/(SI-1.37)]}$$

where HT = total height (m), SI = total height (m) at breast-height age 100 (site index), A = breast-height age, a = 22.87, b = 0.9502, c = -0.0020647, d = 1.3656, e = 2.0460. It fits the data well at all but the least productive sites where it underestimates height by slightly more than one meter. Height growth curves based on this equation are shown in Figure 1a.

The preliminary site index equation is

$$SI = 1.37 + a + (b + cA^{d})$$
$$(HT - 1.37 - e\,[1 - \exp(f\,A)]^{g})$$

where a = 17.22, b = 0.58322, c = 99.127, d = -1.18989, e = 47.926, f = -0.00574787, g = 1.24160. It fits the site index data well up to age 260 where it underestimates at low heights and overestimates at high heights with a bias of 1 to 2 meters. Curves based on this equation are shown in Figure 1b.

These curves or equations should be used for southwestern Oregon instead of western hemlock curves, or the mountain hemlock curves produced by Greg Johnson for the Deschutes National Forest in central Oregon. They will be useful for indexing site quality in stands without suitable site trees of other species for which curves are available.

Mountain hemlock rarely grows rapidly. Most of our sample trees were 150 to 350 years old and had site index values of 7 to 28 m (mean 16 m). Best height growth of mountain hemlock is achieved on warmer sites also occupied by other species that can probably grow more rapidly. We recommend that timber management be for the associated species -- for example Shasta red fir and lodgepole pine -- on sites where this is possible.

On sites too cold to support species other than mountain hemlock and white bark pine, wood production may not be cost effective. The fifteen dominant and codominant trees sampled from the mountain hemlock/-smooth woodrush (*Luzula hitchcockii*) community type on high elevation, north slopes, for example, averaged only 10 m tall at breast-height age 100. Although trees in managed stands may have different height-growth patterns from those in the natural stands we sampled, timber productivity is going to be low.

Height-over-age curves for individual trees had different forms in different plant-community types.

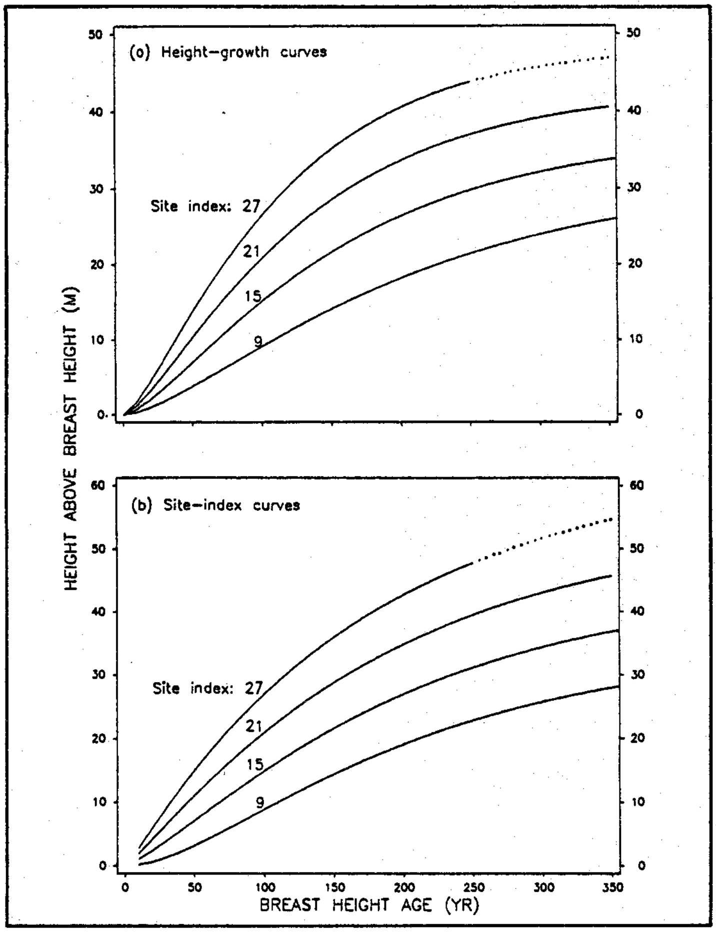

FIGURE 1.--Mountain hemlock height-growth (a) and site-index (b) curves based on data from 95 trees. Dots indicate extrapolations beyond the data.

Results for communities will be reported in a later publication.

For more information, contact the lead author at the Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, OR 97331. (503) 757-4415.

Joseph E. Means
Forestry Sciences Laboratory
Corvallis, OR

Mary H. Campbell
Statistics Dept., University of Massachusetts,
Amherst, Mass.

Gregory P. Johnson
International Paper Company
Veneta, OR

WILDFIRES AND DRY-SEASON PRECIPITATION IN 1987

In late July, 1985, more than 200 fires were started by a lightning storm on the Siskiyou National Forest and Southwest Oregon District of the Oregon Department of Forestry; most fires remained small with the largest reaching about 25 acres in size. In contrast, the lightning storms of August 30, 1987, caused about 60 fires but 8 of those fires burned from 1,500 to 97,000 acres each (another 10 fires in the Roseburg area burned over 1,000 acres each). Differences in weather factors are most likely responsible for such large differences.

Dave Willson (National Weather Service, Medford) is analyzing the weather associated with the 1985 and 1987 lightning storms and has found some major differences. The 1985 storm was part of a moist weather front that resulted in increased relative humidities in the 48 hours following the lightning storm. Furthermore, the first night following the storm, precipitation was common throughout the region. In contrast, relative humidity remained very low following the 1987 storm, and no precipitation was reported during the storm or the following days. The 1985 storm also occurred earlier in the season when fuel moistures were more likely to be higher. This can help explain the differences in number and size of fires caused by the two lightning storms.

An unusual phenomenon of the 1987 lightning storm, however, was that most of the fires over 1,000 acres in size occurred in the Siskiyou Mountains or near Roseburg where the density of lightning strikes was relatively low. The lightning strike density was severalfold higher in the Cascade Mountains with the highest strike densities around Mt. McLoughlin, Mt. Bailey, and Diamond Peak. Although many fires occurred in the Cascades, only one fire larger than 1,000 acres occurred east of the Willamette Meridian.

Differences in dry-season precipitation across southwest Oregon probably were an important factor affecting the occurrence of large fires (Table 1).

TABLE 1. Dry-season precipitation (May 1 through September 30) in southwest Oregon for 1987.

Site (location, elevation)	May	June	July	Aug	Sept	Total	Avg[1]	Percent of normal
	- - -	- - -	- - -	inches	- - -	- - -	- - -	
Siskiyou Mtns								
Silvercat (T.35S,R9W, 4000 ft)	2.60	0.31	0.71	0.08	0	3.70	9	41
Spring-White (T38S,R7W, 2200 ft)	0.94	0.39	1.18	0	0	2.51	5	50
Skeleton Mtn (T33S, R3W, 3700 ft)	0.87	0.71	2.48	0	0.04	4.10	7	58
Millcat (T33S, R1W, 1900 ft)	0.43	0	1.54	0	0	1.97	5	39
Grants Pass (T36S, R5W, 948 ft)	0.22	0.06	1.08	T	0	1.36	3.5	39
Cascade Mtns								
Howard Prairie (T39S, R4E, 4600 ft)	0.83	1.26	4.21	T	0	6.30	5.5	115
Lemolo Lake (T26S, R5E, 4100 ft)	2.93	1.95	3.85	0.11	0.10	8.94	8.0	112
Toketee Falls (T26S, R3E, 2100 ft)	2.05	0.35	4.46	0.13	0	6.99	7.0	100
Ashland (T39S, R1E, 2000 ft)	1.73	0.36	2.66	0	0	4.75	4.0	119

[1]McNabb, D.H., H.A. Froehlich, and F. Gaweda. 1982. Average dry-season precipitation in Southwest Oregon, May through September. Extension Service, Oregon State Univ., Corvallis, OR. Misc. Pub. EM 8226. 7 p.

Dry-season precipitation at four, widely scattered Adaptive FIR research sites in the Siskiyou Mountains was only 39 to 58 percent of normal in 1987. Whereas precipitation was normal or above normal for the same period in the Cascades. July was particularly wet, with most Cascade stations receiving four or more inches of precipitation during the third week. In contrast, only 0.71 inches of precipitation fell over the same period at Silvercat which was about two miles from the northeast boundary of the Silver Complex Fire.

Although July precipitation in the Cascades increased the moisture content of 1000-hour fuels for only a few weeks, this precipitation most certainly had a longer lasting effect on soil moisture, plant-water potentials, and the moisture conditions of deep forest floors that could slow the rate that fires spread.

Differences in the weather associated with the two lightning storms need to be evaluated in more detail. These few observations suggest that the threat of large wildfires is a function of the weather associated with the lightning storm and dry-season precipitation preceding the storm. Such information could help guide planning and fire suppression activities in the first few hours following a lightning storm.

DM

Recent Publications

Copies of the following publications are available from the source noted in parentheses at the end of each abstract. Addresses for sources are listed below:

(INT) - Intermountain Research Station,
324 25th St., Ogden, Utah 84401

(OSU) - Forestry Business Office, College of
Forestry, Oregon State University,
Corvallis, OR 97331

PREDICTING FIELD PERFORMANCE OF DOUGLAS-FIR SEEDLINGS: COMPARISON OF ROOT GROWTH POTENTIAL, VIGOR AND PLANT MOISTURE STRESS by D.D. McCreary and M.L. Duryea. 1987. New Forests 3:153-169. Douglas-fir seedlings were evaluated by three measurements of seedling quality - root growth potential or RGP, vigor, and plant moisture stress or PMS - and the results were correlated with subsequent field performance. Measurements made by each method were significantly ($p \leq 0.05$) correlated with first- and second-year survival and terminal height growth. Seedlings from lots that grew many new roots during a 28-day interval in a growth room (RGP evaluation) or that survived for 6 weeks in the growth room and initiated rapid budburst (vigor evaluation) or whose plant moisture stress values remained fairly constant during 1 week after potting (PMS evaluation) had the greatest field survival and height growth. The RGP evaluation was the best predictor of first-year height growth, while the vigor evaluation was the best predictor of first- and second-year survival. All evaluations predicted second-year height growth equally well. (OSU)

EFFECT OF SHADING, MULCHING AND VEGETATION CONTROL ON DOUGLAS-FIR SEEDLING GROWTH AND SOIL WATER SUPPLY by L.E. Flint and S.W. Childs. For. Ecol. Manage., 18: 189-203. Harsh environmental conditions on many harvested sites in southwest Oregon necessitate site modifications for successful regeneration of Douglas-fir. We conducted a 2-year study with 350 seedlings to assess the effects of twelve soil-surface shading, mulching, and vegetation control techniques on seedling growth and soil temperature and moisture environments. Treatments modified a variety of environmental conditions. Major effects of treatments were to lower soil surface temperature, reduce soil surface evaporation, and reduce vegetative competition for soil water. These modified conditions affected seedlings by adjusting the timing of seedling growth and reducing soil water loss to increase available water for seedling use. Final seedling shoot volume and stem diameter both differed among treatments. Seedlings in treatments where competing vegetation was controlled showed significantly greater growth than seedlings in other treatments. Soil water loss in treatments where either soil surface evaporation was controlled by mulching, or where competing vegetation was controlled, was significantly less than water loss from the shaded and control treatments. Soil water loss in treatments with vegetation controlled by herbicide was significantly less than in treatments with vegetation controlled by scalping. Seedlings showed greatest growth with treatments that elicited the most efficient use of available microsite water either by reducing soil surface evaporation or vegetation competition. (OSU)

EFFECT OF SHADECARDS, SHELTERWOODS, AND CLEARCUTS ON TEMPERATURE AND MOISTURE ENVIRONMENTS by S.W. Childs and L.E. Flint. 1987. For. Ecol. Manage., 18:205-217. This paper presents a comparison of two common techniques used to improve seedling survival on hot, dry reforestation sites. Adjacent shelterwood and clearcut sites were located and instrumented to compare temperature and moisture environments. In addition, cardboard shadecards were placed beside half of the seedlings studied so that effects of this treatment could be assessed. Seasonal measurements or observations of soil moisture, soil temperature, solar radiation, air temperature, stomatal diffusion resistance, seedling phenology and survival provided the basis for comparisons. Shelterwoods and shadecards improved seedling survival in relation to the clearcut. Both treatments affected soil temperature but the nature of the effects was different. The shelterwood canopy decreased solar radiation incident at the soil surface and caused cooler soil temperatures throughout the soil profile. Shadecards reduced soil temperatures only to a depth of 2 mm. Both treatments reduced the duration of periods of high soil temperature. The shelterwood treatment delayed seasonal water loss and decreased seedling water loss as measured by stomatal resistance. Shadecards did not significantly affect seedling stomatal resistance. The differences in seedling survival caused by shadecards and shelterwoods are apparently due to different influences on the seedling microclimate. The shelterwood caused a large reduction in soil temperature as well as decreased seedling water stress. Shadecards modify the soil temperature environment less extensively and so have less effect on seedling survival. (OSU)

EFFECT OF SOIL TRANSFER ON ECTOMYCORRHIZA FORMATION AND THE SURVIVAL AND GROWTH OF CONIFER SEEDLINGS ON OLD, NONREFORESTED CLEAR-CUTS by M.P. Amaranthus and D.A. Perry. 1987. Can. J. For. Res. 17:944-950. Small amounts of soil from established conifer plantations and mature forest were transferred to planting holes on three clear-cuts in southwest Oregon and northern California to enhance mycorrhiza formation. The clear-cuts, 8-27 years old and unsuccessfully reforested, included a range of environmental conditions. At Cedar Camp, a high-elevation (1720 m) southerly slope with sandy soil, transfer of plantation soils increased 1st-year Douglas-fir seedling survival by 50% and tripled seedling basal area growth but soil from mature forest did not improve survival and growth. Less dramatic effects owing to soil transfer were evident on other sites, which were lower in elevation and had clayey soils. Results suggest that adequate mycorrhiza formation is critical to seedling growth and survival on cold, droughty sites. Populations of mycorrhizal fungi, and perhaps other beneficial soil biota, decline if reforestation is delayed or other host plants are absent. These declines can be offset by soil transfer from the proper source; in this study, soil from vigorous young plantations. (OSU)

HARVESTING FACTORS AFFECTING FINANCIAL FEASIBILITY OF THINNING IN SOUTHWESTERN IDAHO by R. Giles and J. Sessions. 1987. West. J. Appl. For. 2(4):105-110. The financial feasibility of thinning in southwestern Idaho is not well established. A logging cost model, LOG-COST, was developed to estimate harvesting costs for seven major tree species. The financial feasibility of thinning depends heavily on species, tree size, skidding or yarding method, topography, and truck transport distance. In order to provide financially feasible thinnings, biologically similar stands may have to be managed quite differently if truck transport distance or terrain vary significantly. (OSU)

BUD PRODUCTION OF DOUGLAS-FIR (PSEUDOTSUGA MENZIESII) SEEDLINGS: RESPONSE TO SHRUB AND HARDWOOD COMPETITION by J.C. Tappeiner II, T.F. Hughes and S.D. Tesch. 1987. Can. J. For. Res. 17:1300-1304. Shrubs and hardwoods in five plantations of Douglas-fir in southwestern Oregon were treated to obtain four or five levels of competition; cover ranged from 0 (complete control) to 100% (no treatment). On four of the five plantations, Douglas-fir seedlings significantly increased bud production on the leader in the first growing season after treatment. Buds were more responsive to level of competition than were leader length or growth in stem diameter, for which significant differences were not usually observed until the second growing season after treatment. Bud number on the leader apparently is a good indicator of seedling vigor. Leader, stem diameter, and stem cross-sectional area growth in the 2nd and 3rd years after treatment were positively correlated with the number of buds produced on the leader in the first growing season following treatment. (OSU)

GUIDE TO UNDERSTORY BURNING IN PONDEROSA PINE-LARCH-FIR FORESTS IN THE INTERMOUNTAIN WEST by B.M. Kilgore and G.A. Curtis. 1987. Intermountain Research Station Gen. Tech. Rep. INT-233, Ogden, UT. Summarizes the objectives, prescriptions, and techniques used in prescribed burning beneath the canopy of ponderosa pine stands, and stands of ponderosa pine mixed with western larch, Douglas-fir, and grand fir. Information was derived from 12 districts in two USDA Forest Service Regions and seven National Forests in Montana and Oregon. (INT)

OCCURRENCE OF CONIFER SEEDLINGS AND THEIR MICROENVIRONMENTS ON DISTURBED AREAS IN CENTRAL IDAHO by K. Geier-Hayes. 1987. Intermtn. Res. Sta. Res. Pap. INT-383, Ogden, UT. Microsite seedbeds and covers were surveyed for six conifer species following various silvicultural-site preparation combinations in three central Idaho habitat types. Seedling occurrence was related to seedbeds, cover, site preparation method, and silvicultural method. An index was developed to indicate potential beneficial or detrimental seedbeds or covers for each species. Recommendations are listed for silvicultural-site preparation practices to obtain desired natural regeneration in the three habitat types. (INT)

CONCEPTUAL MODELS OF SEDIMENT TRANSPORT IN STREAMS, p. 387-419 by R.L. Beschta. 1987. In: Sediment Transport in Gravel-bed Rivers, John Wiley & Sons Ltd. The movement of sediment in stream systems is influenced by a wide range of factors including variable source areas of sediment, transient flows, variable particle sizes, non-uniformity of channel geometry and flow, and dynamic/adjusting channels. Variations of suspended sediment concentration are often illustrated in the hysteresis of sediment rating curves, seasonal flushing, effects related to time rate changes in flow and other patterns. A supply-based model is described which is able to reproduce the sediment concentration dynamics of complex storm hydrographs. Although suspended load and bed load are characteristically identified as the two major modes of sediment transport in stream systems, these delineations become indistinct for particles in the range of approximately 0.1-1 mm in diameter. Bed load transport has high temporal and spatial variability, making accurate prediction difficult with hydraulically-based bed load formulae. Part of this variability may be associated with local aggradation and degradation of the bed during high flow events. Research needs are identified that may ultimately improve our capability to predict suspended sediment and bed load sediment transport in streams more accurately. (OSU)

STREAM TEMPERATURE AND AQUATIC HABITAT: FISHERIES AND FORESTRY INTERACTIONS, p. 191-232 by R.L. Beschta, R.E. Bilby, G.W. Brown, L. B. Holtby and T.D. Hostra. 1986. In: Pro. of Symposium at University of Washington, Feb. 12-14. The temperature of water entering a forest stream system typically resembles that of the watershed's subsoil environment. As this water continues to flow down the stream system, seasonal and diurnal water temperatures are strongly influenced by solar radiation. Pronounced differences in stream temperature patterns are evident for streams draining watersheds throughout the Pacific Northwest. Seasonal and diurnal patterns of stream temperature influence a wide range of responses by instream biota. Furthermore, logging activities can initiate pronounced temperature changes by the removal of forest vegetation along channels. Buffer strips of forest vegetation are an effective means of minimizing stream temperature impacts associated with logging. Although direct mortality of fish is probably not a major concern throughout the Pacific Northwest when stream temperatures are altered by management activities, temperature changes can influence rates of egg development, rearing success, species competition, and other factors. (OSU)

DETERMINING COSTS OF LOGGING-CREW LABOR AND EQUIPMENT by S.P. Bushman and E.D. Olsen. 1987. Forest Research Lab. Res. Bull. 63, Oregon State Univ., Corvallis. Small, independent logging contractors can benefit from the established procedures of cost control and cost planning compiled in this report. Ways of tracking labor and equipment costs of a logging crew and the production records available for determining the volume removed from an area for a given time are described. Example costs are from Oregon contractors, but the principles can apply to logging companies elsewhere. Cost and production for a given time period can be used to determine the unit cost of production. (OSU)

LOGGING INCENTIVE SYSTEMS by E.D. Olsen. 1988. Forest Research Lab. Res. Bull. 62, Oregon State Univ., Corvallis. The use of crew incentives in logging operations in the western United States is an effective way to reduce costs and provide attractive wages. However, such systems require a reliable method of setting the price, a good estimate of the daily costs of labor and equipment, and a method of tracking production output. The introduction of an incentive system requires a substantial initial investment of company managerial time as well as the goodwill and trust of workers. The cost and wage behaviors, as well as the advantages and disadvantages, of five incentive systems are described in this paper. Calculations for the systems are demonstrated. The principles described can be applied to cutting, hauling, yarding and loading, or road construction. They are applicable to the operations of independent contractors or large companies and to union or nonunion crews. (OSU)

MYCORRHIZAE, MYCORRHIZOSPHERES, AND REFORESTATION: CURRENT KNOWLEDGE AND RESEARCH NEEDS by D.A. Perry, R. Molina and M.P. Amaranthus. 1987. Can. J. For. Res. 17:929-940. Although not a panacea, management of mycorrhizae and associated organisms is an important reforestation aid. Its three major components are protection of the indigenous soil community and evaluation of inoculation needs, integration of inoculation programs into existing reforestation technology, and research. Clear-cutting frequently results in reduced mycorrhizae formation, particularly when reforestation is delayed and no other host plants are present to maintain fungal populations. Implications of such reductions for reforestation vary with environmental factors and tree species. Adequate mycorrhiza formation is especially critical for ectomycorrhizal trees growing on poor soils or in environments where seedlings must establish quickly to survive. It may also be important where early successional, noncrop plants do not support the same mycobiont as the crop. In such circumstances, a self-reinforcing trend may develop, with poor mycorrhiza formation reducing seedling survival and poor tree stocking leading to further loss of mycorrhizal inocula. Inoculating nursery seedlings with mycobionts holds promise for improving outplanting per- formance only if site-adapted fungi are used. A practical alternative is to improve nursery practices to enhance natural populations of mycorrhizal fungi. Seedlings leaving the nursery with diverse mycorrhizae may perform better than those leaving with only one or a few nursery-adapted types. Research is needed in three broad areas: on adaptations of mycorrhizal fungi to particular environmental factors; on interactions between tree seedlings and processes occurring within the sphere of influence of roots (the rhizosphere) or of mycorrhizal roots (the mycorrhizosphere); and on the role of mycorrhizae and associated organisms in ecosystem structure and processes, particularly nutrient cycling, plant-plant interaction, and soil structure. (OSU)

ROAD LOCATION AND CONSTRUCTION PRACTICES: EFFECTS ON LANDSLIDE FREQUENCY AND SIZE IN THE OREGON COAST RANGE by J. Sessions, J.C. Balcom and K. Boston. 1987. West. Journal of Appl. For. 2(4):119-124. The effects of road location and construction practices on landslide frequency and size were studied in a 300,000-ac area of the Oregon Coast Range. Roads were divided into two groups. Roads in Group I had been built using a combination of steep road grades and full-bench, endhaul construction to minimize slide risk. Group II roads were built using location and construction practices typical of the late 1960s and early 1970s. Using steep road grades to maintain ridgetop locations and full-bench endhaul construction did reduce landslide frequency and size on Group I, as compared to Group II, roads. The marginal cost of reducing slide volumes/road-mile from the volumes found on Group II roads to the volumes found on Group I roads was six times greater in more plastic than in less plastic soils when roads crossed slopes of equal steepness. When roads crossed slopes with a sideslope steeper than 50%, the estimated cost of reducing the volume/road-mile of slide from Group II to Group I levels ranged from \$81/yd³ (\$154/ac) to over \$12,000/yd³ (\$3675/ac), depending on landtype, sideslope, and endhaul distance. (OSU)

FIR
1301 MAPLE GROVE DRIVE
MEDFORD, OR 97501

(503) 776-7116

Oregon State System of Higher Education

Non-Profit Org.
U.S. Postage
PAID
Permit No. 200
Corvallis, OR 97331

To correct your name or address, please return the mailing label with changes indicated.