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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. It is designed to assist 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,

Steven D. Tesch
Silviculture Specialist

Inside

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 Hobbs, Adaptive FIR Project Leader at the Medford address.

Because of space limitations, results appear as extended abstracts. Readers who are interested in learning more about an individual study are encouraged to contact the principal investigator or wait for formal publication of more complete results.

Current Research

Adaptive FIR

FIRST-YEAR SURVIVAL UNAFFECTED BY SITE PREPARATION

First-year survival of Douglas-fir at Millcat, the second replication of the machine site preparation study, was unaffected by site preparation treatment. Millcat is located in the Butte Falls Resource Area, Medford District BLM. Except for the control, survival was similar to the early results from the Silvercat study site located in the Grants Pass Resource Area (FIR Report 6(4):5-6).

At Silvercat, the first-year survival on the control was less than 60 percent, compared to an average of 94 percent on the machine-treated plots. The control plots on this site had considerable woody vegetation remaining after harvesting. Although these results demonstrate the importance of site preparation in achieving initial reforestation success, it was difficult to separate the effects of different amounts of competing vegetation from soil productivity effects. Therefore, one change in the study design for Millcat was to remove all woody vegetation on the control plots, basically by hand, so that the vegetation remaining after harvest was similar across all treatments. As a result, initial differences in survival and growth between the control and the machine treatments would result from machines affecting soil productivity or subsequent reestablishment of vegetation.

The second change was to expand the study to a split-plot design. The plan was to control vegetation on half of each plot to separate the effects of machine treatment on vegetation response from the effects that the different intensities of site preparation had on soil productivity. During the first summer, this was accomplished by hand grubbing all grasses and forbs from an area of about 1.5 square meters around each seedling and cutting all sprouts on the subplot.

Survival among treatments was not significantly different after the first summer (Table 1). The subsequent hand grubbing treatment had no effect on survival, but invasion of the study plots by grasses and forbs after the primary treatments were installed was relatively low. Cover of these species seldom exceeded about 20 percent at the end of the growing season.

TABLE 1.--First-summer survival of Douglas-fir seedlings at the Millcat machine site preparation study area and the effects of subsequent hand grubbing of competing vegetation.

Treatment	Survival	
	Not grubbed	Grubbed
	- - - - - - % - - - - - -	
Control	89	86
Scarification	93	90
Scarification and Ripping	93	94
Soil Removal	89	93
Soil Removal and Ripping	92	93

Competing vegetation has increased since the first summer and should become more of a factor affecting survival in the future. Long-term control of vegetation on half of each plot is necessary for a thorough investigation of the effects of machine treatment on soil productivity as compared to the effects of competing vegetation. Toward this goal, all vegetation on the 0.5-acre subplots was again hand grubbed in April 1986. The effect of this sustained control of competing vegetation on Douglas-fir survival and growth will be reported in the future.

DM

Fundamental FIR

FROM STONE AXES TO ISOZYMES: THE VALUE OF BASIC RESEARCH

Periodically, people ask me why we have Fundamental FIR -- the "basic research" component of the FIR Program. It seems impractical, unfocused, esoteric, and expensive. Such perceptions stand in marked contrast to those for Adaptive FIR -- the "applied research" and technology transfer component of the FIR Program, which has a sharp focus, practical bent, low cost, and immediate pay-off.

Having personally worked in both aspects of research, I can attest to the value and limitations of both. Basic research provides the new knowledge needed to make the giant leaps in our understanding of how things tick. Applied research provides the incremental improvements needed to sustain technological progress. Both components are needed in a successful program like FIR, because they are mutually supportive. Without Fundamental FIR, the Adaptive team would not be able to address problems where existing information is lacking. Adaptive FIR, in turn, identifies new information needs when problems are encountered with no known solution. Thus, both components are necessary parts of the research spectrum that leads to the solution of complex forestry problems such as those plaguing southwest Oregon.

Yes, basic research can seem impractical and unfocused; yet it was exploratory work in physics that led to the development of the microchip. Yes, basic research can seem esoteric; yet it was theoretical modeling that unravelled the mysteries of DNA, leading to the current revolution in genetic engineering. Yes, basic research can be inordinately expensive; DuPont has invested millions in R&D, but its scientists did discover nylon -- a single product which has paid for DuPont's R&D investment many times over. My point is that without scientific inquiry into how things tick, quantum jumps in knowledge are unlikely to occur. Consequently, it's been said, "If advances in civilization depended upon applied research, we would have very fine stone axes today!"

The directed focus of Fundamental FIR is a unique feature of the Program. Every study has a practical goal in mind, even though the work itself may be one or two steps removed from immediate application. Adaptive FIR studies and technology transfer activities help complete the connection. In this fashion we have combined basic and applied research, and have mobilized a substantial portion of the local forest science community to work on southwest Oregon problems.

So what have we learned from our investments in Fundamental FIR? Here's a brief list of highlights, many of which have been featured in previous issues of the FIR Report:

HEAT LOADS AND MOISTURE STRESS FOR SEEDLINGS HAVE BEEN CHARACTERIZED. Managers needed to know whether the investments in shelterwoods paid off in a better growing environment for seedlings. The only reliable way to find out was to carefully measure the microenvironment around seedlings growing in clearcuts and beneath shelterwoods and calculate the energy loads they received. It required sophisticated meteorological equipment including tiny temperature probes placed in needles and the soil. We now know that soil temperatures are about 5°C higher during the growing season in clearcuts than beneath shelterwoods. We also found that the judicious use of shade cards and weed control can ameliorate such adverse conditions in clearcuts.

ECOLOGICAL CLASSIFICATION CAN AID MANAGEMENT. Since we can't afford to install sophisticated weather stations everywhere, other means had to be found to help foresters anticipate environmental conditions on any given site. The use of plant indicator species was developed to fulfill this need. For example, the presence of mountain hemlock indicates a cold, high-elevation site with a narrow "window" for regeneration. Efforts should be made to save any advanced natural regeneration during harvest operations, because it may be difficult to replant the area.

GENETIC RISK OF SHELTERWOOD MANAGEMENT IS LOW. Concerns that limited numbers of seed trees would lead to poor adaptation of natural regeneration under the shelterwood system led to some basic work in genetics. The analysis of isozyme patterns (biochemical indicators of genetic variability) of seedlings indicate that wide diversity exists in the natural progeny beneath shelterwood stands. Therefore, the gene pool is not restricted to the point where catastrophic losses are likely from insects, disease, frost-kill, and other natural factors.

RESPONSE OF SEEDLINGS TO WEED CONTROL HAS BEEN DOCUMENTED. Several studies have explored the mechanism of plant competition as it affects seedling performance. Competition for moisture has been identified as a key limiting factor, and effective weed control treatments have been shown to greatly enhance seedling survival and early growth. The implementation of cost-effective vegetation management practices promises to be an important cornerstone of successful reforestation in southwest Oregon.

NEW CYTOKININ DISCOVERED THAT IS CORRELATED WITH CONE PRODUCTION. The success of seed orchards and shelterwoods utilizing natural regeneration depends upon cone production. If cone production could be predicted or even manipulated, managers could better determine harvests and obtain reliable seed supplies. Basic work in plant physiology has led to the discovery of a cytokinin (plant growth regulator) never before detected in Douglas-fir. It appears to be inversely correlated with subsequent seed cone production, suggesting potential use in forecasting natural seed crops and perhaps manipulating seed production in seed orchards.

MYCORRHIZAE FOUND TO ENHANCE SEEDLING SURVIVAL. Inoculations of mycorrhizae (fungal symbionts of plant roots) have been used for years to enhance survival and growth of southern pine seedlings. Could a similar technique work with western conifers? Basic research in microbiology provided some answers. For the first time in the Pacific Northwest, mycorrhizae have been shown to improve survival of Douglas-fir. Although the increase was only about 10%, further refinements of this technology promise to be even more beneficial to outplanted seedlings. Mycorrhizae are already being used operationally in nurseries and greenhouses.

NEW TECHNIQUE DEVELOPED FOR TESTING SEEDLING VIGOR. Nursery managers told us it was impossible to determine seedling vigor by visual indicators. Exploratory work in plant physiology linked osmotic concentration of cell sap to seedling vigor. This led to a rapid technique for detecting seedlings damaged by frost under certain circumstances. Use of this technique will help managers avoid outplanting frost-damaged seedlings.

DOUGLAS-FIR RESPONDS WELL TO FERTILIZATION IN SOUTHWEST OREGON. Basic work in soils and biometrics has led to a better understanding of the potential benefits of fertilization in forest stands of southwest Oregon. Contrary to earlier notions, Douglas-fir responds quite well to fertilization in this predominantly moisture-limited region of the state. Growth responses are consistent with those reported from other regions of the Pacific Northwest, reinforcing our confidence in this silvicultural practice as a means of enhancing forest productivity.

The above findings are but a few of the contributions stemming from the Fundamental phase of the FIR Program. Collectively, they encompass a wide variety of scientific disciplines. The common thread, though, is that they are all directed at improving our knowledge about forest resource management in southwest Oregon. This mission orientation is a unique feature of FIR. Coupled with the linkage provided by Adaptive FIR, Fundamental FIR moves basic science rapidly into practice.

Jack Walstad
FIR Program Leader
Corvallis, Oregon

MODELING YOUNG STAND GROWTH

Efforts to initiate a FIR research project aimed at modeling the effects of competing vegetation on young stand growth have been terminated because of funding problems. Most cooperators strongly endorsed a scaled-down proposal that would have produced information on 20-year-old free-to-grow stands within 2 years, but money was simply not available to begin the data collection.

While the outcome of the study proposal is disappointing to me, I'm pleased that most managers now recognize the need for quantitative information on growth of young stands. The need for such information is not reduced because of funding limitations. I'd like to present an option that all managers in southwest Oregon should consider.

A cooperative research program has been chartered in California, with participation by industry, federal agencies, and UC Berkeley. One of five projects this cooperative (California Forestry Research Cooperative) is undertaking is one called Small Tree Modeling. The goal of this effort is similar to the one we proposed for southern Oregon, modeling stand development from establishment to mean stand diameters of about 12 inches. The PSW Experiment Station is taking the lead research role in the project, under the direction of Bob Powers. Charlie Brown, Fruit Growers Supply Company, is chairman of the cooperator support group.

Short-term (2 year) aims are to develop: (1) a mathematical model simulating ponderosa pine plantation performance under varying degrees of stand density and vegetation control measures, (2) a first-approximation model for stands of other species. The former involves supplementing a plantation model already underway with new field measurements provided by cooperators. The latter will be modeled from existing information provided by cooperators.

Long-term (15 year) aims are to refine the first-approximation effort for mixed conifers into a more comprehensive growth projection system for managed stands that will interface with models for larger trees, such as PROGNOSIS, CACTOS, CRYPTOS, and if enough interest is expressed in southern Oregon, perhaps ORGANON (Hann's model). This requires combinations of retrospective field studies (stem analyses), as well as field experiments designed to test specific hypotheses.

The cooperative has invited participation of southern Oregon land managers. Obviously, the ultimate model won't be as fine-tuned to southern Oregon as one developed solely on local data; but, with active participation we can ensure that the model is representative of our conditions. A questionnaire is being sent out asking cooperators to identify existing data that can be used in the short-term effort. The PSW Experiment Station is underwriting a large portion of the initial phase, so cooperator contributions are fairly small. For information regarding participation in the project contact Bob Powers (916-246-5267) or Charlie Brown (916-475-3453).

If you are interested, it is important to act promptly since the initial phase is already beginning and follows an ambitious time schedule.

ST

THE WHITE FIR SERIES OF THE SISKIYOU MOUNTAIN PROVINCE

This report is the eighth of several articles briefly describing major forest and woodland vegetation associations found in southwestern Oregon. Previous articles appearing in the FIR Report include:

Subject	FIR Report
Summary of all Series	Vol. 4(4):6-8
Jeffrey Pine Series	Vol. 5(4):7-8
Mountain Hemlock and Shasta Red Fir Series	Vol. 6(1):4-7
Tanoak Series	Vols. 6(3):6-7, & 6(4):7-10
Oregon White Oak Series	Vol. 7(1):5-7
Western Hemlock Series	Vol. 7(3):8-10

For information on study objectives, data collection procedures or definitions, please refer to the earlier articles.

Here we introduce the White Fir Series, the most widespread series in southwest Oregon. It is the most commonly occurring (approximately one-third of all our plots occur in the Series) and the most diverse. The Series is important because of its many products and opportunities, including timber, wildlife, forage, and recreation. Timber productivity generally ranges from moderate to high levels. Associated tree species range from Alaska-cedar, mountain hemlock, and Shasta red fir, characteristic of cooler sites, to ponderosa pine and Oregon white oak, characteristic of warmer, drier sites. We present a general overview of the Series. A brief description of each association will follow in a future FIR Report.

Distribution and Ecology of White Fir

White fir (Abies concolor) occurs throughout the Sierra Nevada Mountains of California and regularly throughout the Intermountain and southern Rocky Mountain regions of the Western United States. The northwestern extent of the species is in the Klamath Mountains of southwest Oregon and the central and southern portions of the Oregon Cascades. Coincidental in southwest Oregon is the occurrence of grand fir (Abies grandis), a closely related species. Its range is limited to the coastal mountains of northern California and southern Oregon. Further north the range expands from the coast, east to the northern Rocky Mountains.

In southwest Oregon, the ranges of these two species overlap and they interbreed, producing hybrids with intermediate characteristics. Much discussion revolves around the identity of these hybrids. Although most individuals show hybrid characteristics such as needle and cone size, these trees occupy a landscape position similar to "true" white fir of the Sierra Nevada. Hence we prefer to call all individuals "white fir" except for a few isolated cases at lower elevations near the coast. Individuals at these more temperate sites have characteristics clearly identifiable as grand fir. These instances are infrequent and will not be dealt with in this article.

In the Siskiyou Mountain Province, white fir occurs in a wide elevational band ranging from 250 to over 2000 m. Mean elevation is 1362 m (standard deviation is 213 m). White fir can be found on all aspects, but is more abundant on northerly aspects. White fir can also be found on any parent material. Average total soil depth for the Siskiyou plots is 97 cm.

Description of the Series

A brief discussion of the five climatic regimes present in the Siskiyou Mountain Province will clarify the ecological position of the Series (Figure 1). The Eastern and Western Siskiyous, as defined by Waring (Northwest Science 43(1):1-17; 1969), represent high elevation, mountainous topography between Ashland and Cave Junction. 1) The Eastern Siskiyous (Ashland Ranger District (RD) and extreme east end of Applegate RD) are a rain shadow area with warmer, drier conditions than 2) the Western Siskiyous (Applegate RD and west side of the Illinois Valley RD). To the west is the 3) Rain Shadow which includes the area east of the Coast Range crest (Galice RD and east side of the Illinois Valley RD). It, like the Eastern Siskiyous, is warm and dry. Even further west lie 4) the Coastal and 5) the Coastal Fog Belt regimes. The former extends north from northern California to the Elk River-Rogue River Divide (Chetco RD and Gold Beach RD). It is warm and wet; some areas receive up to 400 cm of precipitation per year. The latter is extremely moist all year and is positioned north of the Elk River-Rogue River Divide (Powers RD).

The environment of the White Fir Series varies from cool, moist to warm, dry. It is best described as "the middle of the mesic middle." In the Siskiyou Mountains, the Series occurs elevationally between the Shasta Red Fir and the Douglas-fir Series (Figure 2). In the Coast Range, the Western Hemlock and Tanoak Series comprise the lower bound (Figure 3). The Series

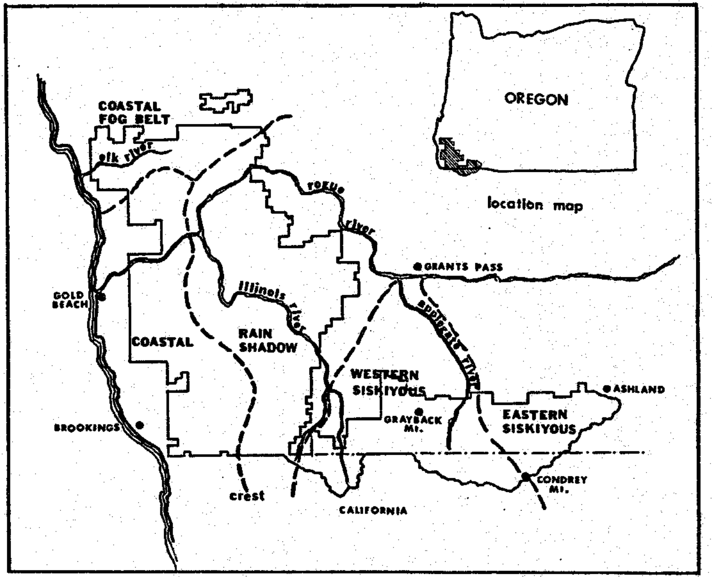

FIGURE 1 Climatic regimes of the Siskiyou Mountain Province.

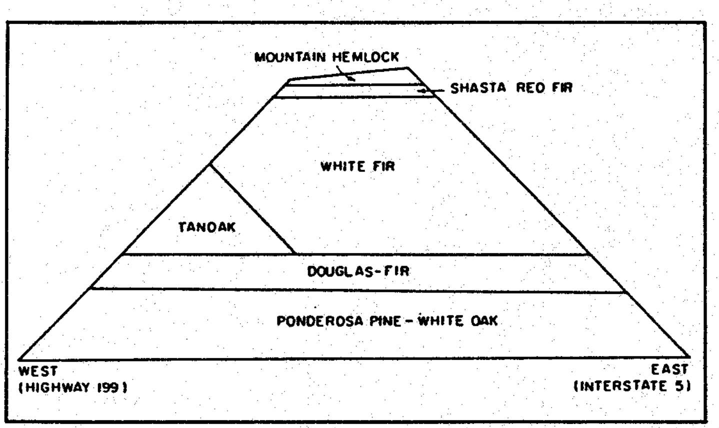

FIGURE 2 Schematic representation of the relative position of the White Fir Series in the Siskiyou Mountains.

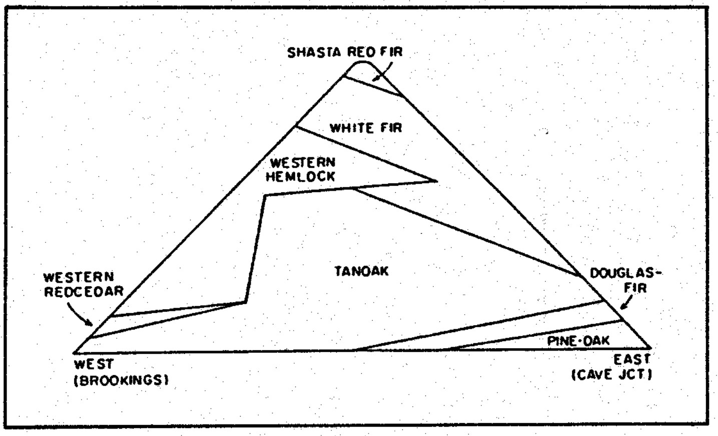

FIGURE 3 Schematic representation of the relative position of the White Fir Series in the Southern Coast Range.

ranges in elevation from 600 to 1900 m. Mean values for elevation, aspect, slope, and soil depth by Association are presented in Table 1.

TABLE 1.--Summary of the White Fir Associations.

Association Name (common)	Elev (m)	Aspect (degrees)	Slope (%)	Soil Depth (cm)	# of Plots
Shasta red fir/currant	1522	311	32	91	7
Shasta red fir/baldhip rose	1541	38	32	102	8
Shasta red fir/creeping snowberry	1671	345	39	102	18
Sadler oak/western prince's-pine	1424	344	40	117	8
Sadler oak/dwarf Oregongrape - Oregon boxwood	1358	4	47	91	16
Sadler oak/dwarf Oregongrape	1351	136	42	81	10
Sadler oak/golden chinquapin	1387	151	37	86	15
Alaska-cedar	1701	306	35	127	1
Brewer spruce/thin-leaved huckleberry	1440	25	48	76	7
Brewer spruce/slender salal	1302	357	29	97	4
Brewer spruce/western prince's-pine	1307	259	42	71	9
Port-Orford-cedar	1320	317	27	97	8
Port-Orford-cedar/Depauperate	1398	91	30	94	7
Pacific yew	1129	3	33	109	16
Tanoak	1147	265	35	91	25
Dwarf Oregongrape	1310	8	47	91	25
Rocky Mountain maple	1510	345	49	109	15
Herb	1515	346	32	99	17
Douglas-fir	1260	334	45	102	19
Douglas-fir/dwarf Oregongrape	1353	346	37	94	14
Douglas-fir/Depauperate	1469	181	36	81	9
Douglas-fir/creambush oceanspray	1435	309	41	91	17
Ponderosa pine	1411	4	43	104	9
Creeping snowberry	1493	140	42	97	32

The White Fir Series is found at mid to high elevations east of the coastal mountain crest. It occurs primarily in the western Siskiyous, diminishing to the east and west. It does not occur in the two most western areas. It therefore is restricted to the more temperate environments of southwest Oregon. The environment is moderate to cool, with most precipitation occurring during winter months. Shasta red fir and Sadler oak indicate cooler habitats. Tanoak is characteristic of moderate available moisture, whereas codominance of Douglas-fir in the regeneration layer indicates low amounts of available moisture during the growing season. Port-Orford-cedar indicates frequent fog and/or high humidity during the growing season, hence reduced evapotranspiration rates. Sugar pine, ponderosa pine, and incense-cedar are common associates in the Series, as well as golden chinquapin, canyon live oak, Pacific madrone, and Pacific yew. Consequently, there is opportunity for commercial production of a variety of species.

Over 60 species of shrubs and 200 species of herbs were sampled in the Series. Baldhip rose, dwarf Oregongrape, creeping snowberry, and common prince's-pine are the most common shrubs. Vegetation management is a significant concern in the silvicultural treatment of these sites. Ceanothus and manzanita species and trailing blackberry are strong invaders and competitors and may require control under some management strategies.

Herbage and browse production are generally low, except in early seral stages of stand development. However, wildlife diversity is greater than expected, due primarily to vegetational and structural diversity. Large mammals benefit from thermal and hiding cover. Small mammals, rodents, and other fauna benefit from the large amounts of woody debris which are common in mid-seral to climax stands.

Summary

The White Fir Series is widespread and diverse. It represents the environmental middle of southwest Oregon. The ranges of many species overlap in this Series, thereby creating a diverse mosaic of associations. Management practices must be responsive to this diversity. The next FIR Report will continue with more detailed discussions of the White Fir Associations.

A list of the scientific names for any of the common plant names used in this article is available from the authors. If there are any questions or comments, please contact us at the Siskiyou National Forest, Grants Pass, OR 97526 (503) 479-5301 or at the Forestry Sciences Lab, 3200 Jefferson Way, Corvallis, OR 97331, (503) 757-4361.

David Wheeler, Siskiyou NF
Tom Atzet, Siskiyou NF
Brad Smith, OSU Forest Science Dept.
Jerry Franklin, PNW

CHARACTERISTICS OF SURFACE COARSE FRAGMENTS COVERING SKELETAL SOILS

The Fundamental FIR project "Nature and distribution of raveling soils in southwest Oregon" has made considerable progress towards understanding the nature and physical properties of "raveling" soils. Managing soils which have a surface mantle of coarse fragments can be difficult because of the poor growth medium properties and marginal stability on steep slopes.

We define these types of soils as those which have a natural surface made up primarily of gravel-sized or larger (>2 mm) soil particles (coarse fragments), with 50% or more of the particles larger than 12.7 mm. These surface coarse fragments may or may not be underlain by finer-textured soil material. This definition excludes areas where coarse surface debris is a result of road sidecast material, and steep areas with fine-textured soils that may experience fine soil "raveling" after severe burning.

Undisturbed forests with coarse fragment mantles often show evidence of recent or historic coarse fragment movement. Evidence for this movement includes: a build-up of coarse fragments behind obstructions, older understory seedlings with long "J" roots, and large quantities of partially decomposed organic matter buried within coarse fragment layers.

The mantle of coarse fragments often has a high organic matter content to a fairly great depth. Much of this organic matter is only partially decomposed. The organic matter may filter through the large pore spaces between fragments, be mixed by earthworm activity, or become mixed with the coarse fragments during surficial movement episodes.

Study Site Descriptions

To examine soil characteristics more closely, we located three study sites in different geologic formations and climate zones in southwest Oregon.

The Applegate River study site is a dry interior site on metamorphic bedrock (T40S R4W S13). The site is under Rogue River National Forest management, has a southwest aspect, elevation 670 m, slope 60-90%, and a mean annual precipitation of 890 mm. The forest stand was dominated by Douglas-fir, with a large component of madrone, canyon live oak, and Oregon white oak.

The Sixes River study site is a wet coastal site on sedimentary bedrock (T32S R13W S35). The site is under Siskiyou National Forest management, with a south aspect, elevation 61 m, slope 70-100%, and a mean annual precipitation of 2540 mm. The forest stand was a windthrow-opened Douglas-fir forest, with a secondary stand of western hemlock.

The North Umpqua River site is an interior site on volcanic bedrock (T24S R1W S14). The site is under Roseburg BLM and private timber company management. The site has a south aspect, elevation 762 m, slope 50-90%, and a mean annual precipitation of 1905 mm. The forest was a mixed-conifer forest dominated by Douglas-fir, with sugar pine and incense cedar subdominant.

Soil Sampling

We took undisturbed soil samples from across each site, using a frozen core method we developed for these soils. Soil samples were taken to include all of the coarse fragment layer, plus some of the underlying fine-textured soil. When the coarse fragment layer was greater than 45-cm deep, only the coarse fragment layer to that depth was sampled. The frozen soil cores were transported back to Corvallis. Twenty-four samples were collected at the Applegate River site, 23 at the Sixes River site, and 17 at the North Umpqua site.

The volume of each sample was determined by encasing the sample in a plastic bag and applying a vacuum to tightly mold the plastic to the irregular surface of the sample. The sample was then immersed in water and the volume of water displaced was measured. This volume was used along with total weight to determine soil sample bulk density. When the coarse fragment mantle layer had a discrete lower boundary, the depth of the layer was recorded. The soil samples were thawed into 10 cm (4 in.) layers, starting at the surface. The 10 cm layers of soil were then wet-sieved to determine particle size distribution, and organic matter subsamples were taken. Organic matter was determined by the dry ash method (500°C for 3 hrs).

Results

Particle-size analyses of the soils confirms the coarse nature of the surface soil (Table 1). More than 85%, by weight, of the surface 10 cm of soil on all three sites is made up of gravel-sized or larger particles. More than 50% of the surface soil is made up of coarse gravel. The amount of coarse fragments decreases with depth to at least 30 cm on all sites. The change from the surface layer to finer-textured lower layers was visually evident on the Umpqua and Applegate River sites; the depth of the coarse fragment layer averaged 17 cm (ranging from 5 cm to 46 cm) and 22 cm (8 cm to 36 cm) on the two sites, respectively. A distinct, fine-textured layer underlying the coarse fragment layer was not evident in the Sixes River samples, but may exist at a greater depth than the soil was sampled.

TABLE 1.--Particle size analysis and organic matter content of soil samples from three sites with surface coarse fragment layers. Numbers are mean percent by weight of whole soil, with standard deviation in parentheses.

Site/Soil Characteristics	Depth 0-10 cm	10-20 cm	20-30 cm
	---- Percent of Whole Soil ----		
Applegate River			
coarse gravel (>12.7mm)	62.7 (27.0)	43.2 (26.7)	38.3 (21.2)
fine gravel (12.7-2mm)	25.5 (16.7)	28.7 (11.9)	28.8 (16.4)
fine soil (<2mm)	11.7 (15.0)	27.3 (23.1)	30.3 (22.0)
organic matter[1]	33.0 (21.1)	15.1 (13.3)	12.0 (10.3)
texture of fine soil	Sandy loam	Sandy loam	Sandy loam
Sixes River			
coarse gravel (>12.7mm)	53.4 (17.3)	51.2 (17.9)	49.5 (20.7)
fine gravel (12.7-2mm)	33.7 (14.2)	30.9 (13.2)	29.4 (12.6)
fine soil (<2mm)	12.1 (8.4)	17.5 (9.2)	20.5 (11.0)
organic matter	32.0 (14.7)	22.5 (9.4)	18.5 (5.2)
texture of fine soil	Loamy sand	Sandy loam	Sandy loam
North Umpqua River			
coarse gravel (>12.7mm)	72.4 (15.4)	67.5 (19.1)	56.1 (20.2)
fine gravel (12.7-2mm)	21.3 (14.3)	24.8 (15.9)	28.1 (14.3)
fine soil (<2mm)	5.1 (3.2)	7.4 (6.1)	15.5 (10.2)
organic matter	48.4 (19.3)	24.0 (12.4)	13.7 (6.9)
texture of fine soil	Sandy loam	Sandy loam	Sandy loam

[1] organic matter as a percent of fine soil only.

The organic matter content of these soils is quite high, as a percent by weight of the fine soil (Table 1). Because of the very low density of organic matter compared to mineral matter, the percent organic matter by volume would be much higher.

The bulk density of the soil samples at the Applegate River site averaged 1.23 g/cm³ (s=0.19), at the Sixes River site 0.94 g/cm³(s=0.10), and at the Umpqua River site 1.02 g/cm³(s=0.12).

Management Implications

There are a number of ways in which fine material can either be lost or displaced on steep, gravelly and cobbly slopes, especially because of the high percentage of fines which are organic matter. Some sifting of fines may occur in areas of localized logging disturbance. Broadcast burning as a method of site preparation could cause significant losses in the organic matter portion of the fine soil. The total amount lost would be a function of the intensity and duration of the slash fire. Loss of organic matter may reduce the amount of fine soil by up to one third or one half, with an even higher loss in nutrient and water storing capacity because of the higher storage capability of organic matter.

Planting bare-root stock on these gravelly sites may have some inherent drawbacks. When a hole is dug in this coarse-textured material, the fines sift away and primarily gravel is replaced around the roots. This provides little root contact with moist soil and nutrients. Nursery-grown seedlings may also have a disadvantage compared to natural seedlings because of the lack of a tap root. A tree with a tap root would be most likely to reach deeper, fine-textured soil material sooner, thereby increasing its chances of survival and growth. On the North Umpqua River site, at least two plantings of nursery stock have failed, but natural seedlings are fairly common.

Scraping off the coarse fragment layer and creating a horizontal bench in mineral soil before planting seedlings may work in some situations, especially where the coarse fragment layer is distinct and shallow. The Sixes River site, however, does not have a distinct layer, and benching would increase the probability of seedling burial. Digging through the coarse fragment layer may destabilize the layer above the planting spot.

We have little direct knowledge about what factors determine the stability of the surface layers, although we have made some observations. Organic matter, roots and fungal hyphae have provided considerable strength to our soil samples. Destruction of this network may destabilize the coarse fragment layer.

The extreme variability in particle size distribution within management units creates difficulties in land management planning. The eight-hectare study areas sampled are small compared to many timber harvest units, yet the variation in soil properties suggests different management techniques on this scale. For instance, on the Applegate River site, a planting technique successful in an area with a coarse fragment mantle of only 5 cm may not work where the layer is 45-cm deep. The manager may choose to manage for the worst conditions, vary the management within a unit, or accept uneven stocking.

Sites with a surface mantle of coarse fragments overlying skeletal soil are some of the most difficult sites to regenerate in southwest Oregon. Successful regeneration has been obtained on some of these sites, but many other attempts have failed. Alternatives to planting nursery stock on sites with deep coarse fragment mantles should be explored more thoroughly. When artificial regeneration practices are used, techniques which minimize the loss of fine soil material and avoid destabilizing the coarse fragment layers should be promoted.

Don Miles, OSU Forest Engineering Dept.
Hank Froehlich, OSU Forest Engineering Dept.

PREDICTING BIOMASS OF WHITELEAF MANZANITA, DEERBRUSH, AND SNOWBRUSH

Equations have been developed to predict aboveground biomass and leaf area of snowbrush (Ceanothus velutinus var. laevigatus), deerbrush (Ceanothus integerrimus), and whiteleaf manzanita (Arctostaphylos viscida). They are based on data collected from a wide range of sites being managed for conifer wood production in southwest Oregon and northern California (Table 1). The main objectives of this study are to provide foresters with a means of quantifying the occupancy of these species on sites where they occur and to determine the rate of site occupancy as measured by leaf area and biomass production.

TABLE 1.--Characteristics of the sites where snowbrush, deerbrush, and whiteleaf manzanita data were collected.

Species	Elev. (m)	Aspects	Slope (%)	Dry Season Precip. (cm)[1]	Soil Texture[2]	% Rock (0-60cm)	Site Index (m at 100 yr)[3]
Snowbrush	200-1480	N,NE,E, SE,SSE, S,SW	5-55	10-25	SL,L,CL, SiL,LS	4-73	25-52
Deerbrush	420-1170	NE,E,SE, SSE,S,W, NW	11-56	10-25	SL,L,SiL	6-76	25-43
Manzanita	490-1000	SE,SSE,S, SSW,SW, WSW	10-60	9-14	NA	NA	25-37

[1] Froehlich, H.A., McNabb, D.H. and Gaweda, F. OSU Ext. Serv. misc. pub. EM 82:20.

[2] Soil texture abbreviations: SL - sandy loam, L - loam, CL - clay loam, SiL - silt loam, LS - loamy sand.

[3] McArdle, R.E., W.H. Meyer, and D. Bruce. USDA Tech. Bull. 201.

A total of 75 stems were sampled from 13 snowbrush sites where shrubs ranged in age from 2-17 years, 46 stems from 14 deerbrush sites where shrubs ranged in age from 4-20 years, and 60 whole bushes from 9 manzanita sites, with bushes ranging in age from 2-16 years. Regression analysis was used to develop species-specific equations for predicting the various live biomass components associated with a particular stem diameter. Examples of equations for each species are presented in Table 2. Logarithmic transformations of dependent variables (biomass) and the independent variable (stem diameter) resulted in the most precise estimates for the three species.

These equations were applied to whole plot data to compute stand leaf area and biomass. Although basal area was found to be the best independent variable, it is difficult to measure. Instead we focused on independent variables for which data could be quickly and easily obtained in the field. Stand age appears to be a good estimator of manzanita leaf area and biomass, while average stem height provides reasonable estimates for snowbrush and deerbrush. Equations and minimum density requirements are given in Table 3.

TABLE 2.--Linear regressions predicting total biomass(y) (g) of whiteleaf manzanita, snowbrush, and deerbrush as a function of stem diameter.

Species	Basal Diameter Range	Equation[1]	r^2	sy.x
Whiteleaf Manzanita	2-140 mm	(ln)y=-1.41-2.01(ln)x	.98	0.3667
Snowbrush	3-85 mm	(ln)y=-1.91+2.53(ln)x	.99	0.2302
Deerbrush	3-65 mm	(ln)y=-2.18+2.53(ln)x	.97	0.3376

[1] x is stem diameter (mm) measured 2 cm above ground on the main stem for whole whiteleaf manzanita bushes, and 8 cm aboveground for individual stems of snowbrush and deerbrush.

TABLE 3.--Regression equations for estimating total biomass(y) (g/m^2) for whiteleaf manzanita, snowbrush, and deerbrush communities.

Species	Independent Variable (x)	Equation	r^2	sy.x	n
Whiteleaf Manzanita[1]	age (years)	y=-165.54+214.33x	.82	409.6	52
Snowbrush[2]	height(cm)	y=142.76+1778.89x	.76	1260.8	54
Deerbrush[3]	height(cm)	y=-129.89+1393.19x	.74	633.1	57

[1] Minimum bush density for equation to be valid: stands <10 years old - 2 bushes/m^2; stands ≥10 years old - 1 bush/m^2.

[2] Minimum stem density: stands <8 years old - 8 stems/m^2; stands ≥8 years old - 2 stems/m^2.

[3] Minimum stem density: stands <11 years old - 8 stems/m^2; stands ≥11 years old - 2 stems/m^2.

These equations are valuable for forestry personnel who are responsible for assessing regeneration problems. The equations provide a means of quantifying present brush competition and projecting future conditions. This information can greatly aid in stand treatment decisions. Results from this study should also be of interest to fire management personnel and others charged with brushfield conversion, for estimating fuel loads on areas where these species are predominant.

For further information, please contact Tom Hughes (503-754-2384) or John Tappeiner (503-754-4215), College of Forestry, Oregon State University, Corvallis, OR 97331.

Tom Hughes
OSU Forest Science Dept.

Continuing Education

ADAPTIVE FIR SOUTHWEST OREGON REFORESTATION WORKSHOP

September 18, 1986. Best Western Conference Center, Best Western Riverside Motel, Grants Pass, OR. For foresters and others concerned with reforestation. This program will present research updates on reforestation technology and regional reforestation issues. Attendance is limited to 100. Fee: $40 U.S. Accreditation for SAF-CFE program, and Oregon and California pesticide licensing. For further information, CONTACT: Ole T. Helgerson, Workshop Director, or Lenore Lantzsch, Secretary, Adaptive FIR, (503) 776-7116.

Of Interest

REFORESTATION WITH WHITE FIR IN NORTHERN CALIFORNIA

The True Fir Management Cooperative was rejuvenated in Northern California in 1979 and began Phase I of a 3 phase program in 1980. The primary objective of the project is to find a cost-effective and successful way to artificially regenerate white fir in Northern California.

Phase I of the project examined the relationship between 3 seedling vigor indexes (frost hardiness (FR), dormancy release (DR), and root growth capacity (RGC)) and various growing regimes, lift dates, storage periods, and stocktypes. Results from this phase are summarized in Table 1 and Figure 1. The seedling vigor line on the figure represents a conceptual summation of the three indexes and clearly shows a peak in midwinter.

TABLE 1.--Vigor index values for white fir from Phase I.

Vigor Index	Value Ranges
RGC[1]	50-260 cm.
Dormancy release[2]	14-28 days
Frost resistance[3]	-11°C to -30°C

[1]Average total root elongation >2.5 cm per seedling, after 28 days in a growth chamber.

[2]Mean number of days to terminal budbreak for sample of seedlings placed in growth chamber.

[3]Temperature at which 50 percent of seedlings in a sample are killed after 2 hours of exposure.

Phase II of the project started in 1984 and will continue through 1987. In this phase of research, field survival and performance are being correlated with the vigor indexes developed in Phase I. Eight outplanting sites, with approximately 24 treatments (100 seedlings per treatment) covering a variety of nurseries, stocktypes, freezer and cold storage regimes and facilities, and seedling sizes have been planted over the last 2 years on a range of sites from the Central Sierra to north of Mount Shasta. Eight more installations are planned over the next 2 years.

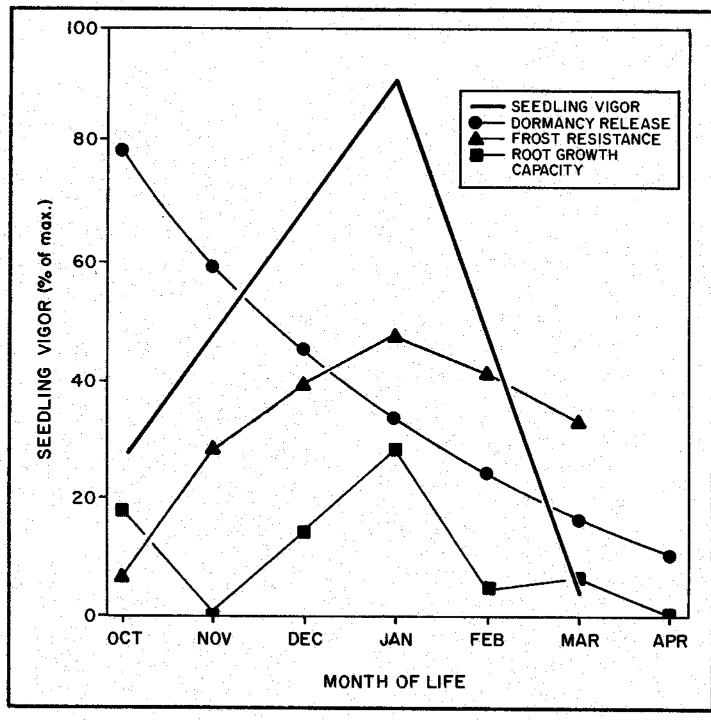

FIGURE 1--Seedling vigor and RGC, FR, and DR versus Month of Lift.

Initial results show some surprising trends:

1) Survival is extremely variable and does not correlate well with average RGC (Figure 2);

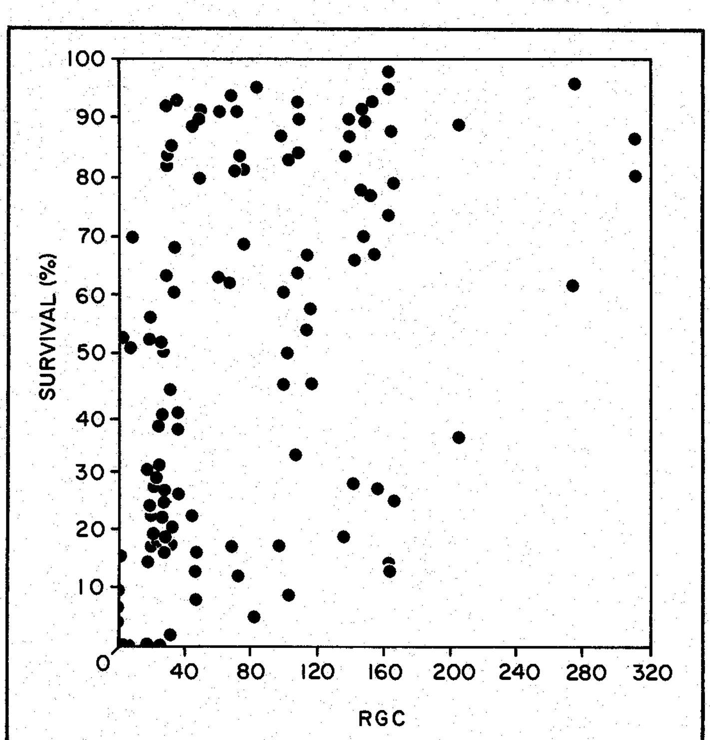

FIGURE 2--RGC and field survival from 8 outplanting sites.

2) Non-tree competition, especially grasses and forbs, presumably leading to water stress, appears to be the primary cause of seedling mortality;

3) Second-year fall down was greater in container (22%) than bareroot stock (8%);

4) White fir appears to be very sensitive to hexazinone, particularly if it is container stock. On one site that received a fall pre-plant application, 12% of the bareroot and 50% of the container mortality was attributed to hexazinone; and,

5) Soil temperatures under which the seedlings are grown appear to have a strong influence on RGC. Warm soils or a warm interruption in January result in a decrease in RGC.

Future work will include further study of, 1) freezer vs. cold storage; 2) nursery soil temperature regimes; 3) lift date and storage length; 4) nurseries and stocktypes; 5) the apparent ability of fall application of Subdue II to ameliorate the detrimental effects of cold storage on RGC; and, 6) the use of view boxes to nondestructively observe root growth before and after bud break.

We will also focus on a different approach of analyzing root performance with respect to field performance. The concept of threshold root growth (TRG) will be used in conjunction with root/shoot (R/S) ratios. TRG uses the percentage of a seedling test population that meets or exceeds a certain root growth performance dictated by the site to assess outplanting performance. For example, a moderate site may require 40 cm. of root growth for a seedling to survive. If 60% of the test population exceeds this threshold, then we can expect 60% survival. A harsher site would require more root growth (e.g., 80 cm.), which a lower percentage of the test population could achieve, leading to lower survival. Initial regression analysis along this line looks good, especially when R/S ratio is also factored in.

For further information on this cooperative research effort, feel free to contact me or any other cooperator.

Charlie Brown
Fruit Growers Supply Co.
Star Route 440
Hilt, CA 96044
(916) 475-3453

RELEASING DOUGLAS-FIR SEEDLINGS FROM DEERBRUSH CEANOTHUS

Phil McDonald and Gary Fiddler, with the PSW Experiment Station in Redding, shared a draft manuscript describing 1984 results of a deerbrush ceanothus - Douglas-fir competition study located on an intensely burned area on the Salmon River District of the Klamath National Forest. The Hog Fire burned a well-stocked stand of young-growth Douglas-fir in August 1977. Two-year-old Douglas-fir seedlings were hand planted in March 1978, with the area nearly devoid of all vegetation because of the hot burn. The site III area was rapidly occupied by germinating deerbrush ceanothus seedlings.

The study was initiated in 1980 to compare various methods of releasing the Douglas-fir seedlings. Treatments included 2 chemical treatments, 3 manual treatments and a control. Each treatment was replicated 3 times using 1/7-acre plots. Within each replicate 30 to 40 "crop tree" quality seedlings were flagged; from this population, five were randomly selected for growth measurements.

Manual treatments consisted of grubbing shrub and herbaceous seedlings and snipping hardwood sprouts within 2-, 4-, and 6-foot radii around crop trees. The initial release was done in August 1980; the second release was done in May 1983. The herbicide treatments utilized 2,4-D (3 lb. a.e./acre). One treatment was a directed spray, covering a 3-foot radius around each conifer; the second was a broadcast application to the whole replication area. The first of two applications was made in June, 1981 and the second in May, 1983.

The authors provided production and cost information in the manuscript (Table 1). Dollars refer to labor costs only and do not include overhead, chemical costs, or costs associated with bagging trees to protect them during spraying. Clearly, grubbing costs are expensive and increase rapidly as the radius of the scalp increases.

TABLE 1.--Treatment costs and production information.

Treatment	Production Time (person hours per acre)	Cost ($/acre)
2-ft scalp	35	264
4-ft scalp	73	549
6-ft scalp	82	617
3-ft spray	8	60
Broadcast spray	6	46

Four years after the first treatment, reductions in height growth with increasing competition were visually apparent, but not statistically different (Table 2). The only significant difference in stem caliper was between the broadcast herbicide application and the untreated control.

McDonald and Fiddler grouped least intensive treatments (2-foot manual, 4-foot manual, 3-foot chemical) and most intensive treatments (6-foot manual, broadcast chemical) and found survival significantly better when the groups were compared with the control, but not with each other. Stem caliper was significantly greater in the most intensive treatments than in the least intensive treatments and the control, but the least intensive treatments were not different from the control.

In 1980, two years after planting, survival in all treatments was at least 80 percent, probably a result of "good" site preparation, quality planting stock and a good job of planting. However, without release, survival dropped substantially in the control area by 1984 and was at least 30 percent less than in the smallest radius scalp or spray treatments.

TABLE 2.--Douglas-fir seedling survival, height, and caliper in 1984.

Treatment	Survival (%)	Height (ft)	Caliper (in)
2-ft scalp	77	4.53	0.94
4-ft scalp	89	4.91	1.06
6-ft scalp	89	5.78	1.27
3-ft spray	73	5.38	1.20
Broadcast spray	88	5.62	1.49
Control	42	4.79	0.80

Small radius scalps or chemical applications (least intensive treatments) were useful in improving survival, but not growth. When treatments are initially applied two years after "site preparation," it appears that encroaching root competition from deerbrush plants located within 4 feet of the conifer seedlings is sufficient to reduce diameter growth to levels comparable to untreated conditions. In this case, it doesn't seem to matter whether vegetation control was accomplished by chemicals or manually; radius of controlled area is the key factor.

While few significant treatment differences were observed in 1984, the authors suggest that treatment effects will become increasingly apparent in the next 5 years. They suggest that by delaying initial treatments until shrub germinants are three years old, it may take as long as 7 more years before some treatment benefits are realized.

ST

ERROR IN NEW CUBIC FOOT VOLUME PUBLICATION

David Hann at OSU reports an error in the following publication:

Walters, David K., David W. Hann and Merlise A. Clyde. 1985. Equations and tables predicting gross total stem volumes in cubic feet for six major conifers of southwest Oregon. Forest Research Laboratory, Oregon State University, Corvallis. Research Bulletin 50. 36 p.

In Table 7 all regression coefficients in the columns labeled F_2 and F_3 have been reversed and should be transposed (i.e., F_2 should be changed to F_3 and vice versa).

ST

Recent Publications

For copies of these publications, mail your request to Forestry Business Office, College of Forestry, Oregon State University, Corvallis, OR 97331.

DAMAGE TO REGENERATION DURING SHELTERWOOD OVERSTORY REMOVAL ON STEEP TERRAIN: A CASE STUDY. by S.D. Tesch, D.H. Lysne, J.W. Mann, and O.T. Helgerson. 1986. Forest Research Laboratory, Res. Note 79, Oregon State University, Corvallis. A case study was initiated in southwest Oregon to identify seedling characteristics and harvesting factors influencing seedling survival during removal of a shelterwood overstory. From a pre-harvest population of planted and natural Douglas-fir and ponderosa pine seedlings ranging from 5 to 400 cm in height, those between 40 and 100 cm high survived falling and yarding best. Most site disturbance and seedling mortality occurred within skyline corridors, which increased in width as skyline cross slope increased. However, even narrow (<2-m-wide) corridors on cross slopes <15 percent resulted in high mortality when they converged on a landing. Wide (10- to 12-m) corridors, occurring on skyline cross slopes >45 percent, also resulted in high mortality, but wide spacing between such corridors left many seedlings alive. Interplanting after logging would be necessary to ensure adequate stocking, with most of the seedlings required in areas where skyline corridors converge and in wide corridors on steep cross slopes.

EQUATIONS FOR PREDICTING BASAL AREA INCREMENT IN DOUGLAS-FIR AND GRAND FIR by M.W. Ritchie and D.W. Hann. 1985. Forest Research Laboratory, Res. Bulletin 51, Oregon State University, Corvallis. Equations are presented for predicting basal area increment for individual Douglas-fir and grand fir trees in the east-central Coast Range of Oregon. Final parameter estimates were obtained using weighted nonlinear regression analysis of a simple exponential model. Two equations are presented for each species: one has site index, and the other has predicted height growth as independent variables in the model. The other variables used are diameter, crown ratio, crown competition factor in larger trees on the sample point, and stand basal area. Techniques for predicting future diameters from these equations are also presented. A number of methods of expressing stand density or structure are compared for the log-linear model of basal area growth.

PREDICTING MERCHANTABLE VOLUME IN CUBIC FEET TO A VARIABLE TOP AND IN SCRIBNER BOARD FEET TO A 6-INCH TOP FOR SIX MAJOR CONIFERS OF SOUTHWEST OREGON by D.K. Walters and D.W. Hann. 1986. Forest Research Laboratory, Res. Bulletin 52, Oregon State University, Corvallis. A volume ratio approach is used to predict volume in cubic feet from breast height to any top diameter inside bark from zero to 6 inches. In addition to total height and diameter outside bark at breast height, crown ratio can be an independent variable for predicting merchantable volume in cubic feet for Douglas-fir and grand of white fir. An equation, which assumes that the true shape of the lower bole is a neiloid frustrum, is presented to estimate volume from breast height to any lower stump height. Equations are included for predicting volume in Scribner board feet to a 6-inch top diameter inside bark for 16- and 32-foot log lengths. Appended tables show volume in cubic feet and in Scribner board feet for various top diameters inside bark of six major conifers.

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