SERVING SOUTHWEST OREGON THROUGH ADAPTIVE RESEARCH AND EDUCATION

fir report

forestry intensified research

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"FIR REPORT" is a quarterly publicaiton containing information of interest to individuals concerned with forest management in southwest Oregon. It is mailed free on request. Requests should be sent to: FIR REPORT, 1301 Maple Grove Drive, Medford, Oregon 97501.

FIR REPORT communicates recent technological advances and adaptive research pertinent to southwest Oregon, and alerts area natural resource specialists to upcoming educational events. Comments and suggestions concerning the content of "FIR REPORT" are welcome and should be sent to the Maple Grove address.

The Southwest Oregon Forestry Intensified Research Program (FIR) is an Oregon State University, School of Forestry program designed to assist region foresters and other specialists in solving complex biological and management problems unique to southwest Oregon. FIR specialists organize, coordinate, and conduct educational programs and adaptive research projects specifically tailored to meet regional needs.

Established in October, 1978, the FIR project is a cooperative effort between Oregon State University, the Bureau of Land Management, U.S. Forest Service, O & C Counties, and southwest Oregon timber industries. It represents a determined effort by the southwest Oregon forestry community and county governments to find practical solutions to important forest management problems.

For the FIR Staff

David H. Lysne
Harvesting Specialist

inside...

Agriculture, Home Economics, 4-H Youth, Forestry, Community Development, and Marine Advisory Programs. Oregon State University, United States Department of Agriculture, and Oregon Counties Cooperating.

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current research

adaptive fir

COST AND EFFECTIVENESS OF SKIDDING TREE TOPS USING DESIGNATED SKID TRAILS

Site productivity reductions resulting from soil compaction are of concern to land managers. In the western U.S. significant growth losses have been documented in seedlings and trees growing in skid trails and in areas adjoining them. Ultimately, future stand growth losses are a function of the total area impacted by skidding, severity of the impact and duration of the impact. Conventional tractor skidding practices often compact 25 percent of the harvested area during each entry. Repeated entries using new trails each time may result in most of the land surface being compacted to some degree.

Growth losses from soil compaction may be reduced by the use of designated skid trails. Designated skid trails are located prior to falling and skidding, giving access to all merchantable timber within an area. Trees are felled to lead to make skidding easier. Skidding vehicles are then restricted to the designated skid trails and winch lines are pulled to the logs. This minimizes the area of compacted soil. However, the use of designated skid trails may result in problems with slash disposal. Machine piling of logging residue will partially negate the benefits of using the designated skid trails. One alternative is to remove unmerchantable tree tops as part of the skidding operation. However, the cost and effectiveness of reducing fuel loading by skidding unmerchantable material to designated skid trails is not known.

A new Adaptive FIR study has been initiated near Union in cooperation with the Prospect Ranger District, Rogue River National Forest, to fill this information gap.

The specific study objectives will be to:

1. determine the effects of skidding unmerchantable material to a landing upon net merchantable timber volume skidded per effective hour;

2. determine the amount of damage to the residual stand resulting from skidding the additional unmerchantable material; and

3. determine the impact of not removing unmerchantable materials upon the site fuel loading.

The study area is a relatively uniform, multi-storied, multi-species, old-growth stand located at 4,100 feet elevation on soils derived from pumice. The topography is virtually flat. The silvicultural prescription for the unit is best described as a combined improvement cutting and high-thinning. The objective is to remove the large, old-growth individuals, releasing the smaller, generally younger, true fir and Douglas-fir understory, which average about 16 inches d.b.h. The prescription requires minimum damage to the residual crop trees.

The sale has been made and logging should be finished by September 30. Post-logging damage and fuels inventories will follow immediately. Results of the study should be available early in 1982. For further information, contact Steve Tesch or Dave Lysne.

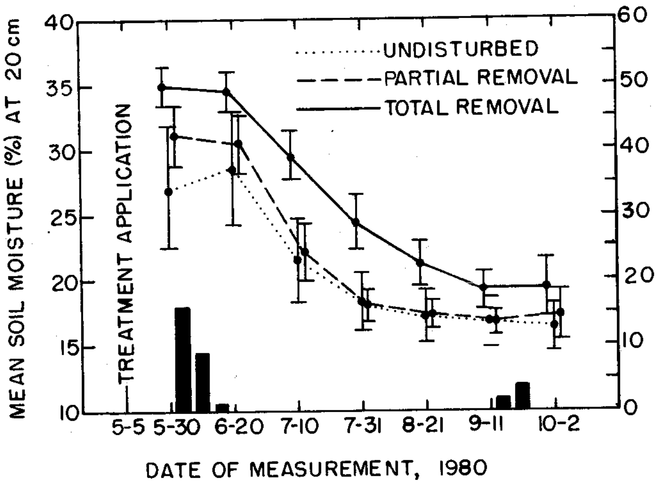
S. T.

BRUSH REMOVAL STUDY

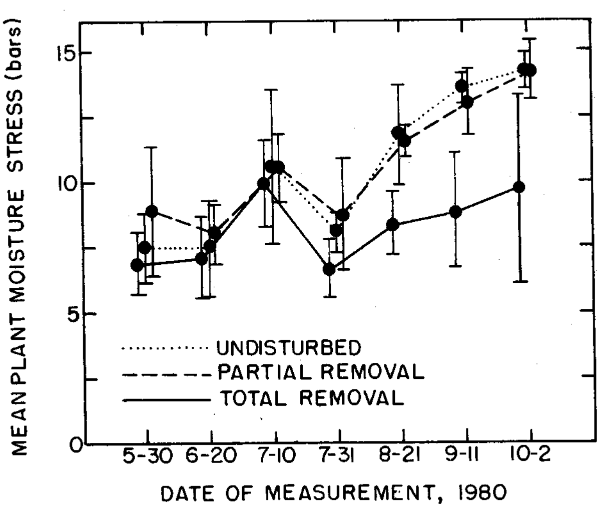
In May 1980, Adaptive FIR, in cooperation with the Medford District of the Bureau of Land Management, initiated a study to evaluate the impact of brush removal on soil moisture content and plant moisture stress in Douglas-fir saplings. The test site is located on the west side of Negro Ben Mountain at an elevation of 1,097 m and is approximately 10 km southwest of Ruch in the Siskiyou Mountains. The dominant vegetation on the test site is composed of canyon live oak and green manzanita with scattered Douglas-fir saplings. The soil is a skeletal Xerochrept with a surface mantle of ravel and an average slope of 66 percent.

Three treatments were applied to the test site on May 5, 1980. These were: (1) total brush removal, (2) partial brush removal, and (3) an undisturbed control. Brush removal was accomplished by handslashing with chainsaws. Approximately 38 percent of the brush basal area was removed in the partial removal treatment. Soil moisture at 20 cm was determined by measuring electrical resistance with Soiltest MC-310A soil moisture and temperature cells. Douglas-fir plant moisture stress was measured with a Pressure Bomb. Both the soil moisture and plant moisture stress data were collected every three weeks during the predawn hours.

Soil moisture, expressed as a dry weight percentage, was consistently higher where sclerophyll brush had been completely removed. By mid-July there was little difference in soil moisture between the undisturbed and partial removal treatments. Mean soil moisture levels with 95 percent confidence intervals, are shown in the figure below.



Mean predawn plant moisture stress in Douglas-fir saplings was substantially lower by mid-July where the brush had been totally removed. No difference in mean predawn moisture stress could be detected between the undisturbed and partial brush removal treatments. This relationship between treatments is depicted below.



On this test site, total brush removal was more effective in maintaining a higher level of soil moisture and thus lower plant moisture stress in Douglas-fir saplings than partial removal or no brush treatment. Interestingly, by mid-July there was little difference in soil moisture or Douglas-fir plant moisture stress between the partial removal and undisturbed treatments. Although not graphically illustrated in this article, mean predawn plant moisture stress in both canyon live oak and green manzanita was lower in the partial removal treatment than in the undisturbed treatment. It is evident that partial brush control did not benefit Douglas-fir saplings, but did improve conditions for the remaining brush. This study has shown that in a dry environment sclerophyll brush utilizes soil moisture that would otherwise be available to Douglas-fir.

S. H.

SEEDLING SURVIVAL UNDER A SHELTERWOOD

In 1979 a cooperative research project to compare survival and identify sources of mortality for natural and planted seedlings under a shelterwood was initiated between FIR and the Applegate District of the Rogue River National Forest. The site had moderately deep skeletal soils (45 to 60+ percent gravel and cobble), 55 to 80 percent slopes, a southwest aspect, and an elevation of 1,160 m (3,800 ft.). The regeneration cut in 1978 created 0.2 to 0.4 ha (0.08 to 0.16 a.) openings among the overstory trees. Broadcast burning for site preparation in the fall of 1978 controlled nearly all understory vegetation. Douglas-fir and ponderosa pine 2-0 seedlings were planted over part of the area the following spring. Abundant natural germinants of Douglas-fir and white fir also appeared then. The microsite occupied by each measured seedling was classified as being either shaded or exposed. Seedlings growing in shaded microsites were judged to be protected from environmental extremes by trees, rocks, logs or woody debris.

Survival of the natural seedlings was poor. After two years only 13 percent (9/70) of the Douglas-fir and 18 percent (13/71) of the white fir were alive. Heat and drought stress combined caused the most mortality for both species. Clipping by small mammals caused about three times more mortality for Douglas-fir than for white fir. Survival of shaded Douglas-fir and white fir natural germinants was significantly greater than unshaded seedlings as indicated by a chi-square test.

The probability of survival for the planted 2-0 seedlings was overall significantly greater than for the germinants. After two years, 86 percent (42/49) of the Douglas-fir and 60 percent (28/47) of the ponderosa pine were alive. The significantly greater survival of the planted Douglas-fir was probably associated with better seedling quality. Heat and drought stress again accounted for the majority of mortality among the planted seedlings. In comparison to the natural seedlings, however, survival was not enhanced by shading for either Douglas-fir or ponderosa pine. Shading also did not significantly affect height growth for either species after two years.

The very low survival rates of the natural germinants compared to the planted seedlings strongly suggests that natural seedlings will not provide prompt stand regeneration on similar difficult to regenerate sites in southwest Oregon. Although shading does significantly enhance survival of the natural seedlings, the shaded survival rate [7/25 (28%) for Douglas-fir and 12/29 (41%) for white fir] is still far below the worst survival rate for the planted seedlings (60 percent for ponderosa pine). For the nursery-grown seedlings, the lack of dependence on shading for survival implies strongly that planting in naturally shaded microsites under a shelterwood is unnecessary. The lack of shade effects and the observed differences in seedling quality also strongly suggest that seedling quality as determined by nursery practice is more important to seedling survival under a shelterwood than microsite shading.

HARDWOOD INJECTION AND DOUGLAS-FIR UNDERPLANTING STUDY

A large proportion of land in the Siskiyou Mountains of southwest Oregon is currently covered with low value hardwoods. Over 15,000 acres of hardwood stands are found in the Galice Resource Area of the Medford District of the Bureau of Land Management alone. These stands typically occur on south facing slopes and are composed primarily of tanoak, madrone and chinkapin. Stocking densities range from 300 to 400 square feet of basal area per acre with tree heights between 40 and 80 feet. Understories are typically open with little brush regeneration. These lands have a strong potential to support commercial conifer species as suggested by the presence of occasional large Douglas-fir and sugar pine - up to 50-inches d.b.h. - or as small scattered seedlings less than two feet tall. Intermediate size classes typically do not exist. Pure stands of conifers are, however, commonly found in draws adjacent to the hardwoods.

A stand conversion technique that offers good probability of success is to kill the hardwood overstory and underplant with Douglas-fir seedlings. Initial trials by the Josephine County Department of Forestry suggest that stem injection followed by underplanting is successful.

The effects of this method of stand conversion on seedling growth and survival compared to untreated hardwood stands have not been well quantified, nor have the effects of different stocktypes and planting methods been fully evaluated on these commonly dense soils.

To address these questions, a new Adaptive FIR study has been initiated with the Galice Resource Area of the Medford District, Bureau of Land Management. Specific objectives include:

1. assess the effects of dead and live hardwood overstories on Douglas-fir seedling survival, height and diameter growth;

2. compare survival and growth of Douglas-fir 1-0 plug seedlings and the larger 2-0 bare-root seedlings using both hoe and auger planting methods.

Plot layout and tree injection will be completed by the end of September, 1981, and planting and initial data collection is scheduled for 1982. First year results should be available by the end of 1982. Contact Ole Helgerson for further information.

O. H.

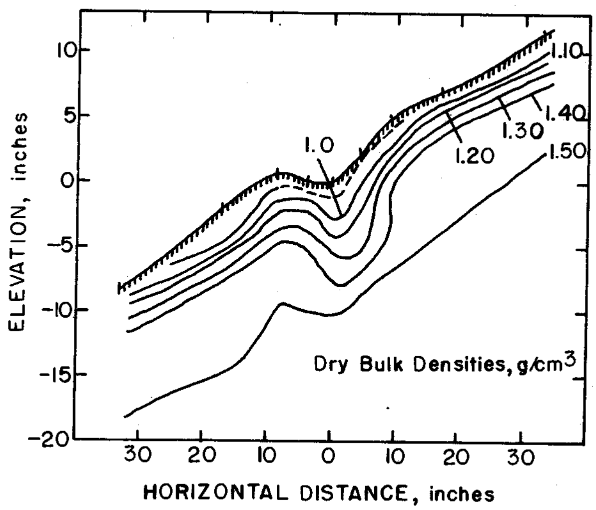
SOIL BULK DENSITIES ON SITES PREPARED BY TRACTOR

Adaptive FIR is studying the effects of ripping as a site preparation treatment on one of the nursery undercutting study outplanting sites (FIR Report, June 1980). The study area is located two miles northwest of Ruch on a southerly slope of approximately 30 percent. A stand predominantly composed of manzanita with scattered buckbrush, white oak and madrone had occupied the site since a wildfire in the late 1930's. This soil type is Vannoy, a fine-loamy, mixed, mesic Typic Haploxeralf.

Site preparation consisted of uprooting the brush and piling it into windrows with a D-6 class tractor. The work was done in July, so very little soil was carried into the windrows. Following clearing, the site was ripped on the contour to a depth of approximately one foot with a D-4 class tractor.

Bulk density was measured at two-inch depth intervals with a two-probe soil densitometer. Densities were measured in the center of the rip track and at 4, 9, 17, and 33 inches on either side of the rip. Eight density profiles were measured. Bulk density of an adjacent untreated site was also taken for comparison.

An averaged bulk density profile from the eight sample profiles shows ripping altered bulk densities to a depth of about one foot. The zone of reduced soil bulk densities expands upslope as a result of the ripper tooth traversing the site perpendicular to the slope. The zone of altered soil densities is broader at the base than is normally assumed, possibly the result of lateral movement of the ripper and slippage of the tractor on a 30 percent slope.



Bulk densities of undisturbed soil in the brush field is relatively high, averaging over 1.3 g/cm^3 between the three- and nine-inch depths. Soil below the two-inch depth was compacted as a result of site preparation. The increase in bulk density averaged about nine percent between the four- and eight-inch measurement depths.

Depth	Bulk Density		
	Midway Between Rips	Rip Track	Undisturbed Soil
inches	g/cm³		
2	1.24	1.06	1.27
4	1.47	1.19	1.35
6	1.49	1.28	1.37
8	1.47	1.35	1.34

Ripping reduced bulk density below densities of undisturbed soil in the brush field to a depth of 8 inches; however, the greatest change in bulk density was limited to the first 4 inches of soil. Because the brush clearing portion of the site preparation operation compacted the soil, ripping decreased bulk densities more and to a greater depth when compared to soils in the area between rips in the brush-raked portion of the study site than undisturbed soil in the brush field.

Depth	Changes in Bulk Density From Undisturbed Soil		
	Midway Between Rips	Rip Track	Total Change
inches	%		
2	-2.4	-16.5	-14.1
4	8.9	-11.9	-20.8
6	8.8	-6.6	-15.4
8	9.7	-0.7	-10.4

The significance of this data is that machine piling of brush compacts the soil independent of harvesting operations. In this case, the increase was about nine percent. Timber harvesting operations may increase bulk densities within skid trails more than site preparation; however, trails can be limited to less than ten percent of the unit area. Machine preparation compacts nearly all of the unit.

Increased survival and growth of seedlings planted in the rip tracks remain the ultimate test of the benefits of ripping soil as a part of site preparation. These benefits cannot be evaluated until the trees planted on the site are older.

D. M.

OVERSTORY REMOVAL STUDY - FURTHER RESULTS

Further analyses of the overstory removal study data have been completed. Dave Lysne described the study in detail in the last "FIR Report" (Vol. 3, No. 2). If you recall, skyline logging was used to make the final harvest on a steep unit which had been shelterwood cut. Part of the unit was uphill yarded, part downhill yarded. Natural regeneration had been established beneath the shelterwood. The main objective of the study was to quantify the impact of the logging operation on seedling survival. Of particular interest were the relationships of seedling height and lateral slope to seedling survival. Lateral slope is the slope measured perpendicular to the skyline corridor.

Plots were originally established on a 4.27 x 4.27 m (14.0 ft.) grid throughout the unit. If a seedling was encountered within a 1-m radius circular plot, then the seedling was observed for logging damage. If no seedling was present, then a thin metal survey pin was inserted into the ground to represent a seedling. For the uphill yarded area, seedling mortality was isolated as a result of falling and yarding. On the downhill yarded area, seedling mortality was recorded only after logging was complete, so no falling data is available.

Dave's article presented results based on the combined seedling and pin population. Tests since then have established a very poor correlation between seedling mortality and pin "mortality." As a result of that analysis, all results presented here are based solely on the actual seedling population.

A careful review of the seedling population did indicate that seedlings were reasonably well distributed throughout the entire study area and that the desired range of seedling heights and lateral slope classes were adequately represented. To further reduce possible error, any seedling whose outcome was uncertain was eliminated.

Uphill Logged Area

Seedling survival following falling was 78 percent. A chi-square test further indicated that falling survival was independent of seedling height ($\alpha = .05$).

For seedlings which survived falling, 71 percent survived uphill yarding. According to another chi-square test, seedling survival of yarding is also independent of tree height ($\alpha = .05$). However, if seedling survival is plotted as a function of seedling height class (20 cm height classes unless otherwise noted) an interesting pattern emerges (Figure 1).

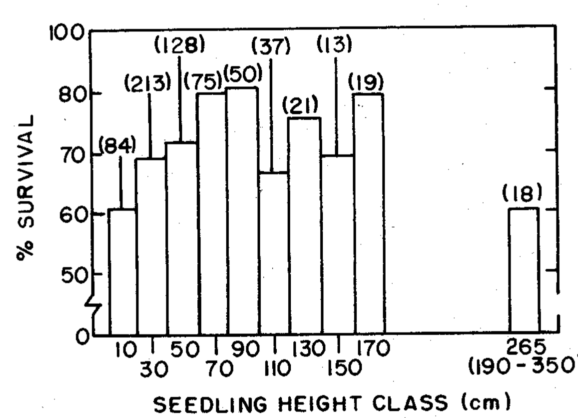


Figure 1. Seedling survival by height class after uphill yarding. Values in parentheses indicate number of seedlings in class.

Seedling survival increases in an almost linear fashion as height class increases from 10 to 90 cm. Beyond the 90 cm height class survival generally drops, but increases again in the 170 cm height class.

Seedling survival following uphill yarding was not independent of lateral slope class ($\alpha = 0.05$). While no functional relationship is obvious when the values in Table 1 are plotted, seedling survival generally does increase with increasing steepness of the lateral slope.

Table 1. Seedling survival after uphill yarding by lateral slope class.

Lateral Slope Class	Survival (%)	n
0-15% (1)	64	137
16-30% (2)	54	48
31-45% (3)	77	56
46-60% (4)	75	199
61-75% (5)	75	222

Using seedlings only, this trend is much different from that presented by Dave Lysne's article in the previous FIR Report using trees and the pin analogs.

When logging was complete, 59 percent of the seedlings clearly survived the combined impacts of falling and yarding. If the unit had been 100 percent stocks with seedlings of a similar height distribution and if the unstocked portion of the unit contained a similar distribution of lateral slope classes, then one could anticipate about 60 percent stocking following the removal of an overstory of similar characteristics, logged in the same fashion.

Following yarding, 33 seedlings classified as dead after falling recovered and survived. These were seedlings which had been covered by slash or brush after falling and uncovered during yarding. In this case, the yarding reduced the total mortality expected from logging if falling and yarding mortality were considered as additive.

Downhill Logged Area

Falling and yarding mortality cannot be isolated for the downhill logged area. Survival following logging was 57 percent. Seedling survival was independent of tree height ($\alpha = .05$), but for the downhill logged unit, seedlings in the 90 cm height class had the highest rate of survival (77%).

Uphill versus Downhill Yarding

No survival data is available for downhill yarding to enable a direct comparison with uphill yarding. However, if one assumes that the rate of falling mortality is similar for the uphill and downhill logged portions of the timber sale, then any differences in seedling survival rate after logging may be attributable to differences in yarding direction. A chi-square test indicates that seedling survival is independent of logging unit ($\alpha = .05$). Therefore, if our assumptions hold, there is no difference in yarding mortality between uphill and downhill yarding in this particular case.

The same assumptions can be made to enable comparison of seedling survival by lateral slope class for uphill and downhill yarding. Only yarding is affected by lateral slope, not falling.

Table 2 presents survival rates for seedlings after logging by lateral slope class. For both uphill and downhill logging, survival is associated with lateral slope. It is interesting to note that, while magnitudes of differences in survival are not really great, the patterns do reverse themselves for uphill and downhill logging. The zero percent survival for lateral slope class 5 should probably be viewed cautiously as it represents only 9 observations, although the seedlings do represent the entire range of height classes.

Table 2. Seedling survival after logging by lateral slope class.

Lateral Slope Class	Uphill Yarding		Downhill Yarding	
	Survival (%)	n	Survival (%)	n
0-15% (1)	52	176	63	78
16-30% (2)	46	69	64	66
31-45% (3)	56	78	57	74
46-60% (4)	62	260	55	89
61-75% (5)	64	277	0	9

These results ought to generate some discussion. Several trends obviously contradict popular notions. I can't find any glaring errors in our logic and our sample size is very large. Let us know if you have any explanations!

S. T.

continuing education

REFORESTATION OF SKELETAL SOILS

November 18-19, 1981. Southwest Oregon Forestry Intensified Research Program (FIR), Medford, Oregon. This two-day workshop will cover the nuts and bolts of reforesting sites in southwest Oregon with rocky soils, particularly in steep terrain. Seventeen speakers will present subjects ranging across soil interpretation, genetic adaptation, site preparation strategies, and stocktype selection. The workshop will be held at the Medford Holiday Inn. Enrollment is limited. CONTACT: Steve Hobbs or Ole Helgerson, FIR.

YOUNG PLANTATION MANAGEMENT

December 15-17, 1981. Oregon State University, Corvallis. A silvicultural research update with primary emphasis on the influence of land manager objectives and economics on commercial thinning options will be presented. The workshop will focus on forests on the west side of the Cascade Mountains, although some references from the east side will also be included. Enrollment is limited. CONTACT: Conference Assistant, School of Forestry, Oregon State University, Corvallis, OR 97331, (503)754-3709.

MANAGING THE IMPACTS OF SOIL COMPACTION ON FOREST LAND

February 9-10, 1982. Oregon State University, Corvallis. The program, designed for forest land managers, forest engineers and soil scientists, will cover such topics as recognizing and measuring compaction, the impact of compaction on soil properties and seedlings, logging equipment alternatives to limit compaction, and soil tillage to recover from the effects of compaction. CONTACT: Conference Assistant, School of Forestry, Oregon State University, Corvallis, OR 97331, (503)754-3709.

FOREST VEGETATION MANAGEMENT

March 2-4, 1982. Oregon State University, Corvallis. A technical workshop for forest managers addressing the use of herbicides is planned. Specific topics to be covered include herbicide prescriptions for various vegetation problems, pre- and post-treatment evaluations and herbicide application technology. CONTACT: Conference Assistant, School of Forestry, Oregon State University, Corvallis, OR 97331, (503)754-3709.

# of interest

MIXED STAND GROWTH PREDICTIONS FROM PROGRAMMABLE POCKET CALCULATORS

Programs developed by John Henshaw and Jerry Westfall of the Tahoe National Forest for HP-41C and TI-59 pocket calculators will predict 10-year growth of mixed conifer stands. Both programs calculate present basal areas and volumes (cubic feet) and 10-year basal area and volume growth for Douglas-fir, ponderosa and Jeffrey pine, sugar pine, white fir, incense cedar and red fir, and expand the data to a per acre basis. The program for the HP-41C will also calculate 10-year growth, the present basal area ratio, and annual volume growth in percent for these species.

The input required for each tree is: d.b.h. (inches), total height (feet), age (years) and the length of the last 10-year radial increment in 20ths of an inch. The tree volume equations are based on "Softwood Tree Volume Equations for Major California Species," PNW-266, 1976. One user commented, however, that the height growth equations work best on mature dominant trees between approximately 70 and 120 years old.

O. H.

ADVANCE REGENERATION RELEASE

Since arriving in southwest Oregon, I've been asked several times about the release potential of advance regeneration when an overstory is removed. A recent Forest Science article by Dennis Ferguson and David Adams addresses the release of grand fir [*Abies grandis* (Dougl.) Lindl.] in northern Idaho. Much of their discussion may be pertinent in southwestern Oregon, at least in principle.

A study was initiated to determine under what conditions advance growth should be retained as a component of the next stand. Stem analysis techniques were used to measure annual leader growth on 250 advance regeneration grand fir released by past silvicultural treatments. At the time of release, trees had to be at least five years old but not greater than 3.0 inches d.b.h.

Height increment following overstory removal was felt to be the most important variable to study in releasing regeneration-size trees. A mathematical model predicting annual height increment for the first ten years following release was developed. Many variables were tested using step-wise regression analysis, with the final model including 5-year height increment prior to release, age of tree at release, logging damage, habitat type, slope, aspect, residual basal area, number of other competitors, and time since release. The model explained 35 percent of the variation in annual height growth, suggesting important sources of variation remain unexplained.

The five-year height increment prior to release was the best predictor of height increment after release. Slow height growth before logging generally meant slow height growth after release. Younger trees adjusted most quickly to the change in environmental conditions following release. Older trees did release, but took longer to respond. Ferguson and Adams recommended not releasing trees older than 30 years. All other things being equal, taller trees responded less than shorter trees.

Potential for release was greatest on the best sites. Ten years after release the influence of slopes and aspect also became noticeable. In northern Idaho the optimum aspect azimuth for release was 20 degrees.

Increasing slopes on northerly aspects aided release, increasing slopes on southerly aspects hindered release.

If saving the advance regeneration is considered important, the authors suggest slowly opening the overstory in two or more cuttings, waiting two to five years between cuttings. Avoiding sudden exposure of trees reduces moisture stress as the conversion is made from shade-adapted needles to sun-adapted needles. However, this slow overstory removal will lead to additional logging damage and may not be logistically or economically expedient in many cases. While the model coefficients should not be used in this area, the fundamental principles discussed may provide good guidelines here for grand fir as well as for other coniferous species.

The formal citation for this article is: Ferguson, D. E. and D. L. Adams. 1980. Response of advance grand fir regeneration to overstory removal in northern Idaho. Forest Science 26(4):537-545.

S. T.

THE LOG DRIVE

Skyline Logging Damage, Continued

Lynn Burditt, currently Forest Logging Engineer for the Flathead National Forest in Montana, recently graduated from Oregon State University with a Master of Forestry degree in Forest Engineering. Her paper, Damage to the Residual Stand Due to Skyline Yarding, explored the effect of variables identifiable during timber sale unit layout that cause residual stand damage. Data was collected from 78 uphill and 13 downhill yarding corridors with ten different skyline machines rigged in standing, running and live skyline configurations. The data was collected within the West Side Zone of the Forest Service's Northern Region in northwestern Montana and northern Idaho from 1975 through 1979. Independent variables include span length, external yarding distance, chord slope, tailblock height, maximum lateral yarding distance, deflection, landing dimensions, number of cut trees per acre, number of leave trees per acre, cut volume per acre, logs per Mbf, brush descriptors and footing descriptors. Regression analysis was used to relate the independent variables to residual stand bole damage.

Lynn analyzed uphill yarding separately from downhill yarding and analyzed each yarding configuration separately, allowing independent variables to enter each regression equation without consideration of other equations. Therefore, generalizations about the damage resulting from differences in yarding direction and yarding configuration are not apparent. She found, however, that damage to the residual stand increased with increasing chord slope, increasing leave trees per acre and decreasing cut trees per acre. The remainder of the independent variables were not reliable predictors of damage to a residual stand.

Feller-Buncher at Butte Falls

A feller-buncher is in operation with good results in a commercial thinning on the Butte Falls Ranger District, Rogue River National Forest. The machine is being used in a prebunch and swing operation with the feller-buncher used as the prebunch machine. The feller-buncher cutting head is mounted on the front of a D-5-sized tracked loader. Because the severed tree is supported by the closed shears and is held firmly by closed clamps above the shears, falling direction is controlled. Therefore, stand openings may be used to avoid falling hang-ups and to minimize residual stand damage from both falling and skidding. Residual stand damage is further held to a minimum by the machine's narrow 74-inch overall width. Severed stump heights are less than four inches above ground, measured on the uphill side. Fracturing of the severed end of the log is less than two inches because the shears are kept sharp. Falling production is estimated to be at least three times greater than a single chainsaw faller's production, but the cost per unit volume of felled timber is estimated to be the same for both falling methods.

The machine is limited to slopes less than 15 percent, a maximum 22-inch diameter stump and non-rocky areas. Because falling is done by a shearing falling head, falling may continue with a "D" Fire Precaution Class, a time when use of chainsaws in the woods is not permitted.

D. L.

STAND HISTORY AFFECTS SEEDLING MYCORRHIZAE

Research by Michele Meyer for Dave Perry at the Forest Research Lab at O.S.U. assessed the effects of natural and human-caused disturbances on total and mycorrhizal root tips of Douglas-fir and western hemlock. The root response of Douglas-fir and the shade tolerant hemlock offer potential insights into regeneration problems in southwest Oregon. Seedlings of the two species were grown in a greenhouse on soils collected from a variety of old and young, burned and unburned adjacent forest stands located on a steep, southeast-facing slope in the west-central Cascades.

Douglas-fir had the greatest number of total ectomycorrhizal root tips when grown in soils from an unburned clearcut. Fewest tips were associated with soils from a 20-year-old Douglas-fir plantation and a 100+ year-old stand. Soils from a 40-year-old regenerated natural burn, another 100+ year-old forest, and a recently broadcast burned clearcut were intermediate in total and mycorrhizal root production.

Hemlock differed, however, from Douglas-fir. Soils from stands without a recent fire history (unburned clearcut, 40-year-old natural burn, and the two old-growth stands) produced equivalent numbers of total and mycorrhizal root tips. Combined root tip formation was less in soils from the recent clearcut and burn than from the young plantation.

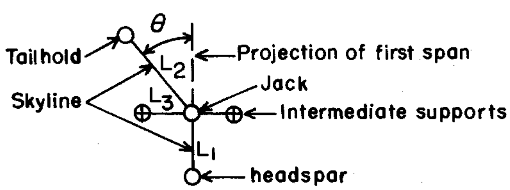
Root dry weight, total mycorrhizal tips and occurrence of *Cerrococcum geophilum* Fr. (a mycorrhizae species) were highly positively correlated with total soil nitrogen, carbon, and moisture for both Douglas-fir and western hemlock.

O. H.

NEW RESEARCH ON MULTI-SPAN LOGGING

Multi-span skyline logging is becoming increasingly popular in southwest Oregon as a means of improving skyline deflection and increasing haul road spacing. Bill Fodge, who is assigned to the Forest Srvice's Regional Office in Portland, recently completed his Master of Forestry research on that subject at O.S.U. Bill's paper, Engineering Analysis of Forces Created in Two Tree Intermediate Supports During Multi-Span Logging, examines, among other topics, two very important multi-span logging issues: (1) determining the maximum horizontal angle that the second span of a multi-span skyline setting can deflect from the projection of the first span, and (2) determining the maximum tension that the intermediate support line will experience.

Bill's analysis of spans that are not colinear is based on the limiting conditions of either the mainline rubbing against a support tree when the carriage is at the tailhold, or the support jack swinging toward a support tree sufficiently to allow the carriage to impact the support tree during loaded inhaul. The limiting condition of the mainline rubbing against a support tree would be experienced when the span furthest from the headspar is significantly longer than the span closest to the headspar. The geometry may be diagrammed:



The following equation may be derived from the properties of similar triangles:

$$L_2(\sin\theta - \frac{L_3\cos\theta}{L_1}) - L_3 = 0$$

Iteratively solving for the deflection angle, θ, the feet horizontal offset from colinearity may be determined if the mainline rubbing against a support tree is limiting.

Sufficient lateral movement of the support jack to allow the carriage to impact a support tree during inhaul is likely to occur if the span furthest from the headspar is not significantly longer than the span closest to the headspar. This situation must be analyzed using Bill's computer program. As an example, it was found that the limiting deflection angle was 3.2 degrees (or a horizontal deflection from colinearity of 13.4 feet) for the multi-span setting at the O.S.U. Harvesting Lab. The Harvesting Lab setting is characterized by two short spans (270 and 239 feet), a relatively slack skyline, light turn loads, and high support line deflection. The calculated limiting deflection angle for the situation in which the mainline rubs against the support tree is 4.4 degrees.

The maximum intermediate support line tension is a function of:

1. the carriage plus log weights,

2. the skyline forces acting on the jack with the skyline tensioned at or near the pretension required to obtain the desired ground clearance, and

3. the mainline forces acting through the carriage.

Bill's computer program is again needed to incorporate the mainline effect on the support line tension. The calculated support line tension for a system composed of two 500-foot skyline spans, a constant 30 percent chord slope in the first span with 6 percent deflection, varying chord slopes in the second span, a one and one-eighth-inch skyline a three-quarter-inch mainline, and a 25 degree angle between the support line and the horizontal is shown in the following table:

Chord Slope %		
Span 1	Span 2	Support Line Tension, lbs.
30	30	10,650
30	34	10,785
30	38	10,915
30	42	11,040
30	45	11,135
30	50	12,280
30	55	11,415
30	60	11,540

The results obtained by the program may overestimate the actual intermediate support line tension as a result of the assumptions required to perform the analysis using equations of static equilibrium. The "Oregon Occupational Safety and Health Code," Division 80, "Logging," requires that the support line be at least one-eighth-inch larger than the skidding line. In this case, a seven-eighths-inch support line would be required with a safe working load of 26,500 pounds for a safety factor of three. Although the support line tension would increase with longer spans and flatter chord slopes in the first span, the seven-eighths-inch support line would certainly be adequate.

D. L.

recent publications

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1 Publications
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PROCEEDINGS FOREST FERTILIZATION CONFERENCE, edited by S. P. Gessel, R. M. Kenady, and W. A. Atkinson. 1979. Institute of Forest Resources Contribution No. 40, College of Forest Resources, University of Washington. The proceedings of the Forest Fertilization Conference sponsored by the College of Forest Resources, University of Washington, and the U.S.D.A. Forest Service Pacific Northwest Forest and Range Experiment Station held September, 1979, is now available. General subject areas covered include the principles of soil fertility and fertilization, current information on fertilizer response, nitrogen fertilizers, operational fertilization, predicting fertilizer response, economics and management, and long-term maintenance of productivity. The proceedings is the most comprehensive source of information related to forest fertilization in the Pacific Northwest that is available today.

3

EFFECTS OF CONTROLLED-RELEASE FERTILIZERS ON THE SHOOT AND ROOT DEVELOPMENT OF DOUGLAS-FIR SEEDLINGS, by W. C. Carlson and C. L. Preisig. Can. J. For. Res. 11(2):230-242. Two controlled-release fertilizers, Osmocote mixture and Agriform forest starter pellets, were used with 1-0 container-grown Douglas-fir seedlings at the time of planting in northwest Oregon. The fertilizers were either placed directly in the planting holes or buried in a three-inch deep hole one inch upslope from the seedling. All fertilizer treatments stimulated shoot and root development beyond that of unfertilized seedlings. Fertilizer effects were still evident two years after planting.

4

EFFECTS OF SKID ROADS ON DIAMETER, HEIGHT, AND VOLUME GROWTH IN DOUGLAS-FIR, by S. Wert and B. R. Thomas. 1981. Soil Sci. Soc., Am. J. 45:629-632. This study was conducted to measure the effects of tractor logging which occurred in 1947 upon the productivity of the subsequent stand of Douglas-fir and to assess the degree and extent of residual soil compaction. The 4.33-ha study area was categorized into skid roads, transition zones (three m on each side of the skid roads), and undisturbed areas. Volume of every tree over five cm (d.b.h.) was estimated by the tariff method. Growth reductions in the skid roads and transition zones resulted in an overall volume loss of 11.8 percent for the total area. There was no significant difference in the slope of tree height-age regression lines for each of the three categories; however, there was a highly significant difference in the adjusted height means between trees from skid roads and those in the other two categories. After 32 years, 25 percent of the entire study area was still heavily compacted. Recovery from compaction had occurred in the surface 15 cm.

5

MEASURING FOREST SOIL BULK DENSITY USING IRREGULAR HOLE, PARAFFIN CLOD, AND AIR PERMEABILITY, by R. F. Howard and M. J. Singer. 1981. For. Sci. 27:316-322. Three methods of assessing soil compaction were compared using 14 northern California soils. The irregular-hole method uses a level point sampling device. The paraffin clod and irregular-hole bulk density methods were significantly correlated ($r = .958$, $n = 13$), although the irregular-hole procedure gave uniformly lower bulk densities. Standard deviations of the means for the two methods were not significantly different. Air permeability was not correlated with bulk density, but did show significant differences between compacted and non-compacted areas.

6

EVALUATION OF A SMALL DIAMETER BAFFLED CULVERT FOR PASSING JUVENILE SALMONIDS, by M. D. Bryant. 1981. USDA Forest Service Research Note PNW-384. Pacific Northwest Forest and Range Experiment Station, Portland. Road crossings of small streams can block upstream movement of juvenile salmonids unless culverts with gradients generally less than one percent or bridges are used. Baffled culverts may facilitate fish passage. Coho salmon, Dolly Varden char, and cutthroat trout, less than 120-mm fork length, were able to move up a 90-cm-diameter by 9-m-length culvert set at a ten percent gradient with off-set baffles in one artificial stream channel.

1

PROCEEDINGS OF INTERMOUNTAIN NURSERYMAN'S ASSOCIATION AND WESTERN FOREST NURSERY ASSOCIATION COMBINED MEETING, August 12-14, 1980, Boise, Idaho, by USDA Forest Service. 1981. USDA Forest Service General Technical Report INT-109. Intermountain Forest and Range Experiment Station, Ogden, Utah. 148 p. This publication contains papers which address a variety of reforestation-related topics including seed procurement, seedling production and planting. Much of the information will have direct relevance to southwest Oregon. Several of the papers address the issue of quality control, with specific suggestions for seed processing, nursery irrigation, and field handling care.

2

MOISTURE CONTENT CALCULATIONS FOR 1,000-HOUR TIMELAG FUELS, by M. A. Fosberg, R. C. Rothermel, and P. L. Andrews. 1981. For. Sci. 27:19-26. Techniques to calculate 1,000-hour timelag fuel moistures were developed from theory of water movement in wood. The 1,000-hour timelag fuel moisture is computed from mean daily temperatures and humidities and precipitation duration. A "least squares" regression equation also was developed to determine the seasonal starting value of the 1,000-hour timelag fuel moisture based on monthly climatological summaries.

7

POSTPLANTING SPRAYS OF DALAPON AND ATRAZINE TO AID CONIFER ESTABLISHMENT, by E. J. Dimock II, and E. B. Collard. 1981. USDA Forest Service Research Paper PNW-280. Pacific Northwest Forest and Range Experiment Station, Portland. 16 p. Dalapon and atrazine were applied separately and in combination to covered and exposed newly planted Douglas-fir and ponderosa pine seedlings in eastern Oregon. Dalapon combined with atrazine consistently controlled grasses and forbs more effectively than either herbicide used separately. Height growth in Douglas-fir and ponderosa pine was significantly greater with this treatment at one of the test sites when the seedlings were protected from the spray.

1

TREE GROWTH ON SKIDROADS ON STEEP SLOPES LOGGED AFTER WILDFIRES IN CENTRAL AND SOUTHEASTERN BRITISH COLUMBIA, by R. B. Smith and E. F. Wass. 1980. Canadian Forestry Service, Pacific Forest Research Centre. 28 p. Growth differences between trees growing within constructed skidroads and areas between skidroads are compared. The growth losses (15 examples) or growth gains (8 examples) are prorated over the entire logged area. Higher tree densities between skidroads may have favored tree growth on the skidroad surfaces. Average Douglas-fir growth loss, prorated over the entire logged area with 32.3 percent of the area in constructed skidroads, is 8.9 percent. Growth impacts were also measured for Engelmann spruce, subalpine fir, western larch, and lodgepole pine. The constructed skidroads were found to regenerate naturally more slowly than areas between skidroads. A rating scheme for predicting growth response of trees growing on skidroad surfaces is presented based on soil acidity, soil texture and depth, and climate.

1

LIFTING AND SKIDDING FORCES FOR SKYLINE LOGGING, by R. W. Mifflin and C. N. Mann. 1980. Journal of Logging, September, 1980. The authors used assumptions of the location of log center of gravity and choker attachment point to present a graph whereby the lifting and skidding forces for a partially-suspended log of known weight may be calculated. The graph shows the effect of ground slope and log support angle on the lifting and skidding forces. As an example, the required skidding force increases with increasing clearance of the leading end of the log. Therefore, keeping the leading end of the log in close proximity to the ground when downhill yarding will help reduce the tendency of the log to overrun the carriage.

1

TREE DAMAGE FROM SKYLINE LOGGING IN A WESTERN LARCH/DOUGLAS-FIR STAND, by R. E. Benson and M. J. Gonsior. 1981. USDA Forest Service Research Paper INT-268. Intermountain Forest and Range Experiment Station, Ogden, Utah. 15 p. Tree damage after logging was examined for six cutting units skyline logged to various utilization specifications. Using both uphill and downhill yarding, unit prescriptions included shelterwood, group selection, and clearcuts. Logging damage was assessed on both residual crop trees in shelterwood units and smaller understory trees in shelterwood and clearcut units. About 23 percent of the leave trees in the two shelterwood cutting units were killed in logging. In the clearcuts about 40 percent of the understory trees were killed. Benson and Gonsior conclude damage was directly related to slope steepness and cross-slope angle to the skyline, and inversely related to the load capacity of the skyline setting. They also suggest that small trees survived better than the less resilient large trees. However, be aware that these conclusions are not strongly supported by the data analysis.

2

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