FIR Report

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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. The FIR Program assists foresters and other resource management specialists in solving complex biological and management problems endemic to southwest Oregon. FIR specialists organize, coordinate, and conduct educational programs and research projects specifically tailored to meet the needs of this area.

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

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

For the FIR Staff,

Ole T. Helgerson
Reforestation Specialist

Inside

OREGON STATE UNIVERSITY EXTENSION SERVICE

FORESTRY INTENSIFIED RESEARCH

SERVING SOUTHWEST OREGON THROUGH RESEARCH AND EDUCATION

Adaptive FIR

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

Adaptive FIR

FIR SCIENTISTS OFFER ASSISTANCE TO FIRE REHABILITATION EFFORTS

Started by a lighting storm on August 30, 1987, 30 major fires (greater than 1000 acres) are estimated to have burned more than 400,000 acres of forest land in the Cascade and Klamath Mountains of southwest Oregon and northern California. The large magnitude of these fires has created land management problems that greatly exceed those normally encountered in more typical fire seasons. Foresters and resource managers must now allocate funds, personnel and other resources to salvage timber, protect watersheds, and to reforest these burned lands while also accomplishing normal management programs.

Site specific prescriptions will be required because of the variation in site conditions between and within the burned areas, and the interactions between harvesting, watershed protection and reforestation. For example, not all burned areas will be amenable to timber salvage, and on sites where timber is salvaged, harvesting methods and their timing can affect watershed protection and reforestation success. Grass is commonly seeded to protect watersheds after wildfire, but the need for seeding will vary depending on characteristics such as hydrophobicity, soil texture, soil infiltration capacity, canopy cover, litter left by the fire, precipitation, and compatibility with reforestation, among others.

Reforestation poses unique problems in addition to it's interactions with timber salvage and watershed protection. Urgent silvicultural questions focus on defining sites where reforestation is required; seedling availability and the transfer of seedlings within and between seed zones; stocktype suitability and site plantability; site productivity; and recovery of competing vegetation and the ability to control it.

To assist the reforestation effort, FIR scientists and others with expertise in watershed management, soils, genetics, vegetation management, seedling qualities, and other areas of forest science have been contacted to share their expertise with local foresters and resource managers. This will help ensure that site specific prescriptions lead to prompt reforestation that is congruent with timber salvage and watershed protection.

As a first step, FIR scientists from OSU and the PNW Research Station and local foresters and resource specialists visited major fire sites near Canyonville and Rogue River on October 8, and conferred at the office of the Medford District BLM the next day. This two-day session brought forth many ideas for dealing with the multifaceted reclamation efforts. These thoughts will also be organized and developed in the next issue of the FIR Report to help ensure their availability to all involved in fire rehabilitation.

OH

GOOD GROWTH AND HIGH SURVIVAL AFTER FIVE YEARS AT TIN PAN PEAK

Sites within the Interior Valley Zone of southwest Oregon are regarded as difficult to reforest because of their droughty character. Testing the reforestation potential of this zone is important because if artificial reforestation can be demonstrated to work on these types of sites, then a potential for reforestation can be considered to exist on other sites considered difficult-to-reforest, but which represent less xeric conditions.

The Tin Pan Peak study site falls within this zone. It was the first site installed in Adaptive FIR's Regeneration Potential study. Ponderosa pine and Douglas-fir (1+0 plugs and 2+0 bareroots) were planted to see whether either species or stocktype was important in reforesting these types of sites.

This study site faces west (35-percent slope, 1000 feet elevation) on Tin Pan Peak near Rogue River, OR. This area receives less than 30 inches of precipitation annually and less than 6 inches between May 1 and September 30. Soils are classified as a loamy-skeletal, mixed mesic Typic Haploxeralf (Beekman series), 60 to 90 centimeters deep. Natural vegetation in the area includes madrone, California black oak, greenleaf manzanita, wedgeleaf ceanothus, poison oak, and scattered large overstory ponderosa pine. The area burned as part of a 2400 acre wildfire during September 1981.

In the test plots, weeds (herbs and resprouting brush) were initially controlled with glyphosate and triclopyr ester. Because of the subsequent injunction on herbicide use, paper mulches (75 by 75 cm) were applied to individual seedlings during late winter, 1984. Non-conifer cover now consists of grass, with some native herbs, and occasional clumps of poison oak and weakly sprouting hardwood stumps.

At the end of the fifth growing season, survival averaged 98 percent for bareroots and 89 percent for plugs. While the difference is statistically significant, either survival rate would be very acceptable operationally. Average survival of the two species was nearly identical.

The high survival is due to vigorous planting stock, good planting, good weed control, and an absence of browsing by mammals. Under these conditions, high survival rates stabilized very quickly. Similarly good seedling survival has been reported for other reforestation studies within the region when these principles are adhered to.

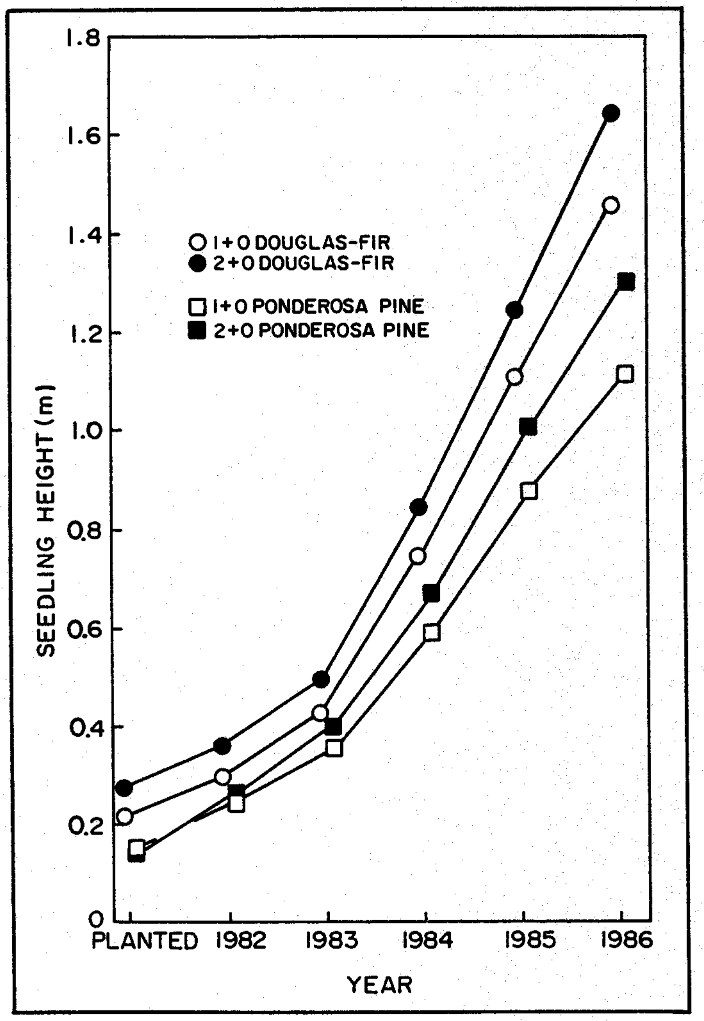

FIGURE 1.--Average seedling height at Tin Pan Peak.

Survival of adjoining operationally-planted pine and Douglas-fir is 50 percent or less, seeming to depend on the amount and type of competing vegetation. These trees received less weed control because of budgetary constraints and are now surrounded by extensive stands of grass and brush. Surviving trees are also smaller than those in the test plots.

At the end of the fifth season, seedling heights for all stocktypes averaged 1.4 m, with the Douglas-fir bareroots nearly half again as tall as the ponderosa pine plugs (Figure 1). At planting, the diameters of Douglas-fir were greater than pine, but pine diameters exceeded those of Douglas-fir after the first growing season. Bareroots of both species remained larger than the plugs for all times of measurements.

This study further illustrates that good seedling survival on xeric sites is achievable with good quality planting stock, good planting practices, and control of weeds. After five years, both stocktypes and species perform similarly under these conditions. The cheaper 2-0 bareroots are suitable for reforestation on this type of site, and the 1-0 plugs can be used when bareroots are not available. Survival of adjoining operationally-planted seedlings adds support to the common observation that ponderosa pine suffers less mortality in competition with grass than does Douglas-fir, and suggests that deerbrush ceanothus may be a more severe competitor than grass. For previous results see FIR Report 8(4):2; 6(3):3; 5(4):4.

OH

FIFTH-YEAR SEEDLING GROWTH AT SILVERCAT SITE PREPARATION SITE

Machine site preparation treatments are being tested for reforestation of a plant community dominated by sclerophyll brush in the western Siskiyou Mountains about 25 miles west of Grants Pass. The treatments and third-year performance of seedlings on the Silvercat test site have been previously described in greater detail (FIR Report 6(4):5-6). After clearcut harvesting using designated skid trails, five treatments were installed: a control (no site preparation); scarify (remove slash and shrubs); scarify and till with rock rippers (seedlings planted in the rip furrows); soil removal (remove slash, all vegetation, and approximately 2 inches of soil); and soil removal and tilling.

Machine site preparation effectively controlled competing vegetation. After five years, vegetative cover averages 73, 23 16, 7, and 8 percent for the control, scarify, scarify and rip, soil removal, and soil removal and rip treatments, respectively. The soil removal treatments were particularly effective at removing the existing vegetation which was dominated by Sadler oak, pine-mat and greenleaf manzanitas, rhododendron, and beargrass. Grasses and forbs are practically nonexistent.

After five years, survival of 2-0 bareroot Douglas-fir seedlings for all machine site preparation treatments remains between 86 and 96 percent (not statistically different). Survival on the untreated control plots has decreased from 57 percent after the first summer to 40 percent, significantly lower ($p < 0.05$) than survival of seedlings planted on plots receiving machine site preparation.

Seedling growth after three years was extremely poor (Figure 1). Second year height increment was typically less than half of that of the first year, and that of the third year also failed to exceed the first year's increment. Several factors probably contribute to the poor seedling performance. These include poor quality of planting stock, late planting (May 18) because of a late winter snowpack, poor planting quality, an exposed high elevation (4,000 ft) planting site, and low soil fertility. In addition, six weeks of post-planting drought contributed to poor height increments in the second and third years because seedlings generally failed to break bud until July and August of the first summer; seedlings planted in 1984 with several precipitation events prior and for four weeks after planting did not show in a second year decline in increment (FIR Report 8(1):3-4).

Differences in seedling size are beginning to appear among treatments (Figure 1). Statistically significant differences ($p < 0.05$) among treatments were only found for the fifth year height and diameter increment and total height. The machine treatments tended to differ from the control, although there were no significant differences among machine treatments.

The most obvious trend in seedling growth is the continued slow growth of the control seedlings. These are of generally poor vigor with short, chlorotic needles. One-third have dead terminals (terminals were protected from browsing) and a few have no new buds. Vegetative cover on the control plots has increased three-fold since harvesting and currently overtops all seedlings. Few of the control seedlings are expected to become crop trees.

Seedlings on the scarify and soil removal plots are larger than seedlings on similarly treated plots that were also tilled. A plausible explanation for the size differences is that seedlings planted on the tilled plots were planted in the bottom of the rip furrows. Over the first two years, the furrows filled with sediment from surface erosion thereby elevating the soil surface from which height and diameter measurements are made. These differences were most pronounced during the second and third year, and growth trajectories appear more congruent after that.

Seedling growth is currently greatest on the soil removal plots. In the near future, seedlings on these plots should continue to grow well because of the slower recovery of competing vegetation. Whether the loss of surface soil will decrease long-term site productivity on these plots is uncertain. A possibility exists that the lack of competing vegetation during stand establishment may offset some losses in growth attributable to soil removal on this site for this rotation. Other effective methods of controlling competing vegetation that are less damaging to the soil could decrease any loss of soil productivity and possibly improve site productivity.

The fifth-year measurement of seedling growth concludes the first phase of this study. Seedlings planted on the soil removal treatment three years after the first planting to assess the effects of a different planting regime will be measured for another two years (FIR Report 8(1):3-4).

DM

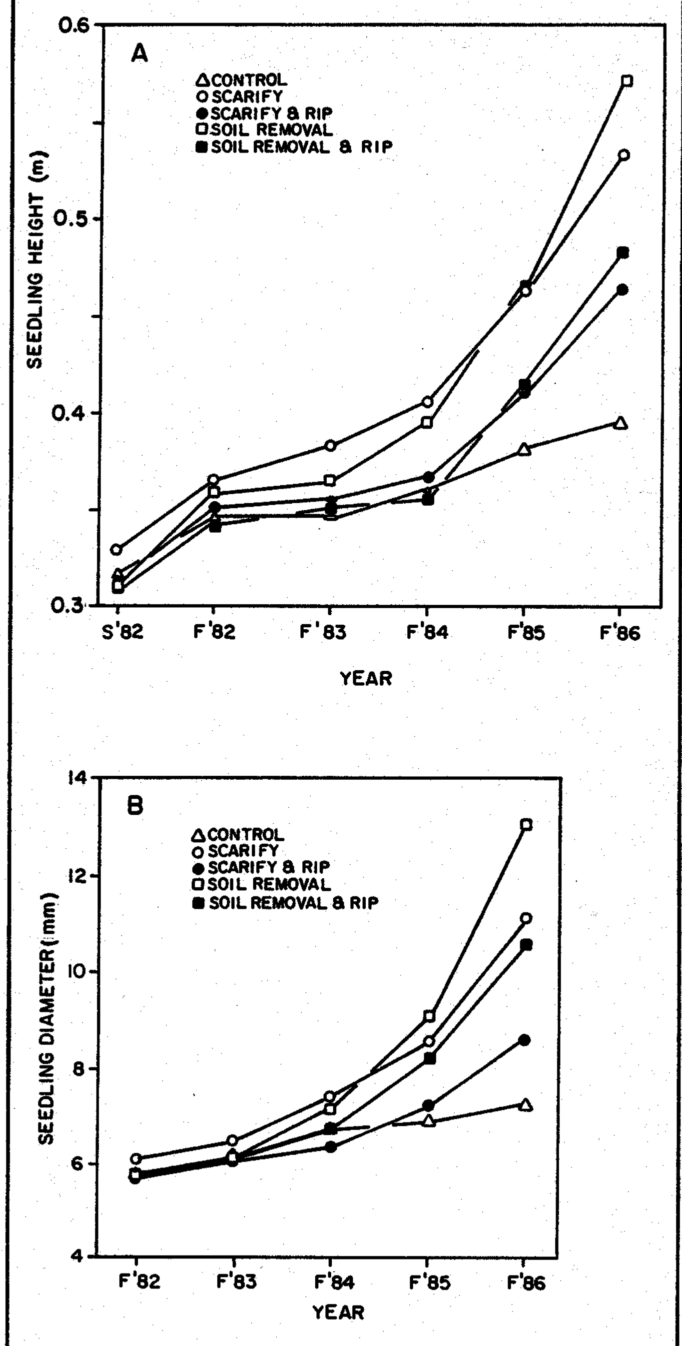

FIGURE 1.--Height (a) and diameter (b) of 2-0 bareroot Douglas-fir seedlings at Silvercat following clearcut harvesting and different intensities of machine site preparation.

MINIMIZING SHRUB COMPETITION ENHANCES DOUGLAS-FIR SEEDLING GROWTH

After four growing seasons, Douglas-fir seedlings planted in plots nearly free of competition from sclerophyll shrub sprouts averaged 10 times more stem volume than seedlings planted in plots containing greater levels of interference from sprouting shrubs.

This competition study, located on Negro Ben Mountain near Ruch, is studying the effects of different levels of canyon live oak and greenleaf manzanita sprouts on Douglas-fir seedling survival and growth. The study site is located at 1100 meters elevation on a 66-percent, west-facing slope. The soil is a skeletal Xerochrept with a mantle of scree. Douglas-fir seedlings were planted in March 1983, within plots containing the following treatments: Treatment 1, 2-year-old brush sprouts killed with herbicide 1 year before planting; Treatment 2, mature brush plants slashed with chainsaws just before planting and then allowed to sprout; and Treatment 3, third-year sprouts, untreated.

Seedling survival observed in fall 1986, changed little from that observed in 1985, despite a hot, dry summer in 1986 and the increasing cover of shrubs. Conifers planted in Treatment 1 continue to increase substantially faster in average height and diameter than seedlings planted in the treatments with more shrub cover (Table 1). The combined effects of increased height and diameter growth on aboveground volume are shown in Figure 1. Seedlings in Treatment 1 continued to show a strongly exponential increase in volume through the end of 1986, but volume in the two sprout treatments increased only slightly.

TABLE 1.--Douglas-fir seedling survival and size in 1986, 4 years after planting.

Treatment (Percent Cover of Shrubs in 1986)	Percent Survival	Height (cm)	Diameter (mm)
Treatment 1 (20%)	91	82.1	16.6
Treatment 2 (56%)	86	45.8	7.1
Treatment 3 (72%)	78	38.9	4.9

The results of this study continue to support the value of effective brush control at the time of planting in improving the growth of seedlings planted on harsh sites. Methods of vegetation management that enable treated brush to rapidly produce new sprouts will result in greatly reduced rates of seedling growth.

Survival and growth measurements for the fifth growing season will be completed in the fall of 1987. In December, seedlings will be excavated to determine the five-year effects of differential competition on root growth.

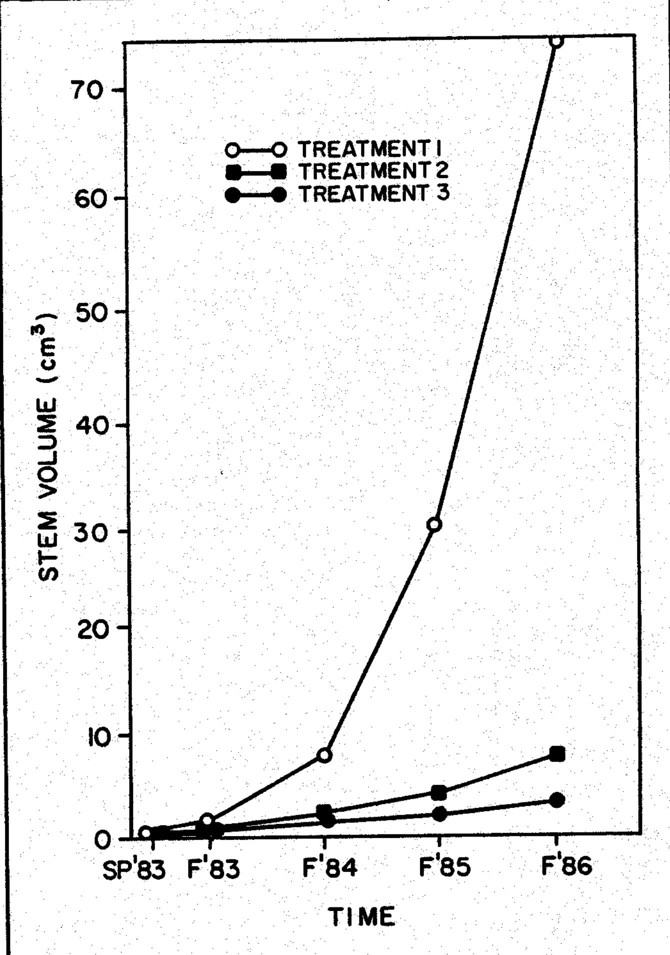

FIGURE 1.--Average Douglas-fir seedling stem volume in 1986.

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

ST

HEIGHT GROWTH OF ADVANCE REGENERATION IN SOUTHWEST OREGON AFTER OVERSTORY REMOVAL

Forest managers in southwest Oregon frequently face decisions regarding the management or disposition of advance regeneration, which is typically scattered and somewhat clumpy in distribution. Such trees have often been removed through burning or mechanical site preparation on the assumption that an even-aged, well-distributed stand could then be planted. But because of costs of planting and weed control, forest managers are now re-evaluating silvicultural alternatives regarding the management of advance regeneration. To help these decision-makers, a study was initiated to determine the height growth of advance Douglas-fir and white fir regeneration after overstory removal. Effects of overstory density, understory competition, and site characteristics on release are also being examined. Results should be useful in determining how quickly and how well understory seedlings and saplings respond to overstory removal by changes in height growth.

Height growth response was measured by stem analysis. Study sites offering at least 10 years of release were selected; many sites offered 20 to 30 years of release. Most sites were old clearcuts containing advance regeneration. Site quality classes III, IV, and V were examined over a range of aspects and elevations across southwest Oregon (Table 1). The average age and height of the Douglas-fir sample trees at the time of release were 22 years and 10 feet, respectively. White fir averaged 25 years of age and 9 feet tall at release.

TABLE 1.--Distribution of stem analysis sample trees by species, site class, and geographic area.

	Number of Sample Trees					
	Douglas-fir Site Class			White Fir Site Class		
Geographic Area	III	IV	V	III	IV	V
Applegate				50		
Butte Falls (East)	11	16			9	
Butte Falls (West)	23	25	26	41	39	32
Canyonville		25			2	
Galice		17	13		17	36
Glendale		37	35			
Grants Pass	20	16	48	23	24	39
Jacksonville		24	25		34	
Total	54	160	147	114	125	107

Summarization of the data into five-year growth periods shows a substantial increase in the rate of height growth over a 20-year period after overstory removal (Figure 1). Within 10 years, mean periodic annual height growth tripled for both species, compared to the increment observed in the 5-year pre-release period. The improved height growth appears to level off at about 2.0 feet per year at age 20 (not shown on figure). After that age, the trend is toward a slight decline in height growth rate, perhaps because of competition, but our sample size begins to shrink rapidly and this observation needs further analysis.

When sample trees were stratified on the basis of the landowner's site quality classification, tree response was associated with site quality class. Trees of both species responded more quickly on better sites and were growing faster after 20 years than those on poorer sites, even though trees in all three site classes had similar pre-release increments.

Sample trees of both species from site V areas responded well over a 20-year release period. Douglas-fir periodic annual height growth was 3.6 times the 5-year pre-release increment and white fir growth was nearly 6 times. However, these trees responded only 30-50 percent as much in the first five-year increment after release as did trees from site classes III and IV. The difference did decrease over time, as the periodic annual height growth for years 16-20 was only

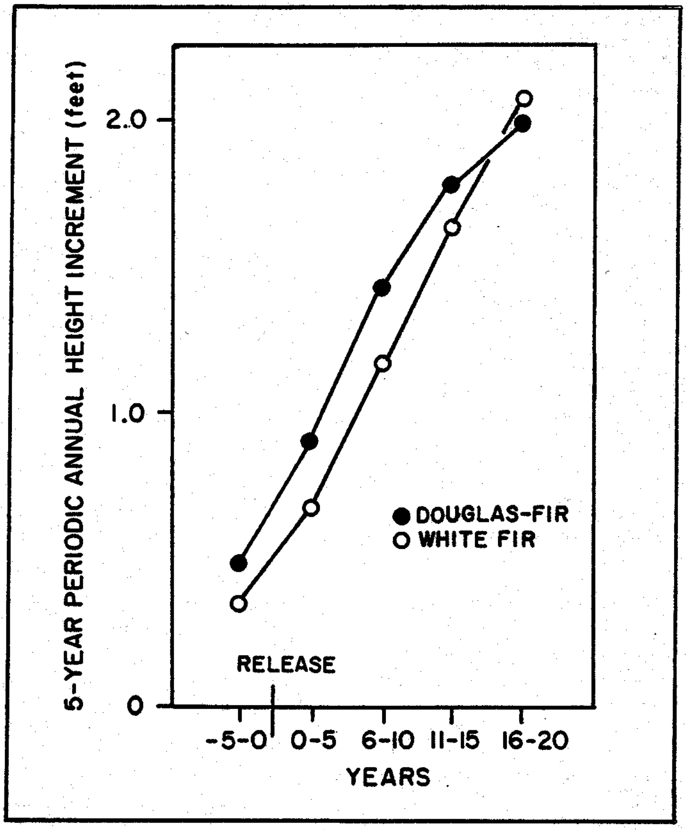

FIGURE 1.--Mean pre-and post-release annual height growth (±S.E.) of Douglas-fir and white fir sample trees, all sites combined by five-year increments.

23 percent less than site III and 13 percent less than site IV for Douglas-fir, and for white fir, 14 percent and 4 percent, respectively.

Prediction equations to estimate growth potential of individual trees have not been completed. Preliminary correlation analyses indicate the best predictor of post-release height growth is 5-year pre-release height growth.

Live crown ratio does not appear to be a useful prediction variable in this data set because of the long release period. We found that the base of the live crown moved substantially up the tree in many cases, as a result of tree and shrub competition. This precludes meaningful estimation of live crown length at the time of release 20 - 30 years ago.

We will continue to analyze the data and ultimately provide a comparison of hypothetical stands originating from advance regeneration versus stands originating as a result of site preparation and planting.

ST

ASSESSING SEEDLING RECOVERY FROM OVERSTORY REMOVAL DAMAGE

Douglas-fir seedlings that were less than 30 cm tall when damaged by removal of the overstory have suffered 42 percent mortality 3 years later. Damaged seedlings between 31 and 61 cm have suffered 15 percent mortality. Larger reproduction up to 457 cm tall has suffered between 5 and 10 percent mortality.

Foresters need to understand how well Douglas-fir seedlings recover from damage caused by logging injuries in order to include reproduction with a good chance of recovery in their postharvest stocking surveys and to avoid replanting of marginally stocked lands.

This study was initiated in 1984 to monitor regeneration after overstory removal. Fifteen transects were established in 1984 and four in 1985 on six sites where the shelterwood overstory had been removed. A total of 550 seedlings were selected for observation and classified by their height at the time of overstory removal and the type of damage they had received. Seedlings with no visually apparent damage were classified as undamaged. This article compares mortality of all damaged seedlings with those classed as undamaged.

In the fall of 1985, seedling mortality was tallied on all transects. Of damaged seedlings less than 30 cm tall, 31 percent died, while 11 percent of the undamaged seedlings in the same size class died (Figure 1).

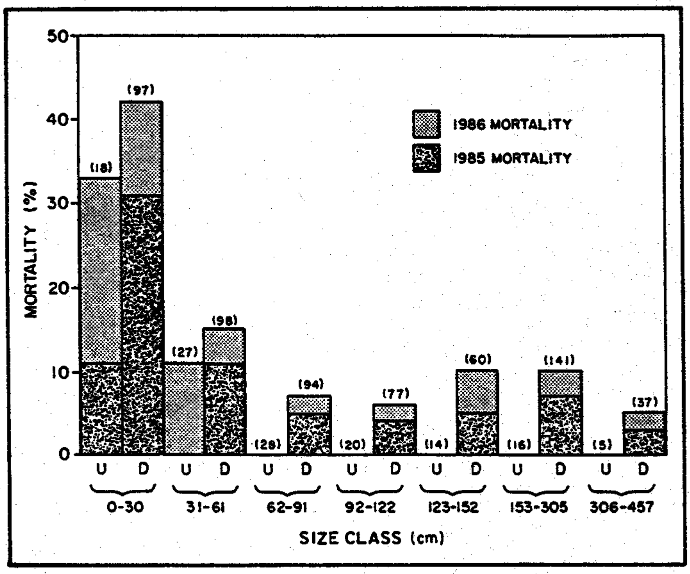

FIGURE 1.--Mortality of damaged (D) and undamaged (U) trees after 1986 growing season. Numbers on bars represent numbers of seedlings.

Of the damaged seedlings between 31 and 61 cm tall, 11 percent died, but undamaged seedlings the same size incurred virtually no mortality. Approximately 5 percent of all damaged seedlings died in larger size classes.

The seedlings were observed again in 1986. Of the damaged seedlings smaller than 30 cm tall, an additional 11 percent had died, bringing two-year mortality to 42 percent. An additional 22 percent of undamaged seedlings of the same size also had died, increasing that total to 33 percent.

Of the damaged seedlings within the 31 to 61 cm height interval, another 4 percent had died, bringing the total to 15 percent, and 11 percent of the undamaged seedling had died, representing the only mortality for this class. For all larger damaged seedlings, cumulative mortality is 10 percent or less after two years, and no undamaged seedlings have died.

These results support our preliminary hypothesis that very small seedlings do not survive overstory removal well, and that when damaged, do not recover well. The continued death of small, apparently undamaged seedlings may have been caused by their lack of adequate establishment and their susceptibility to hot, dry summers and competing vegetation. It could also partially result from invisible internal or below-ground damage to these smaller, more flexible seedlings.

These results have not yet been stratified by injury type and crop tree status, but overall, at least 85 percent of damaged trees taller than 31 cm have survived overstory removal injuries after several growing seasons.

Annual observations of mortality will continue through the 1988 growing season. After that, sample seedlings will be rephotographed and work will begin on a regeneration recovery photo guide. The 1988 date represents a 1-year extension to allow for 5 complete seasons of recovery on most transects before recovery photographs are taken.

ST

Fundamental FIR

BIOGEOGRAPHICAL LIMITS OF DOUGLAS-FIR IN SOUTHWESTERN OREGON

In some areas of southwestern Oregon, Douglas-fir has many of the characteristics of a species near its adaptational limits - difficult regeneration, a distribution influenced by topography, and all-aged stands in a species that, in the central part of its range, is commonly represented by even-aged stands. In these areas, Douglas-fir sometimes encounters conditions in which it cannot reproduce. When this occurs, it has reached an internal "species edge" far within the boundaries of the species range. Before the edge is reached, however, there exists a zone in which a special relationship between individuals and their environments cause unusual difficulty in natural regeneration. It therefore would be helpful to estimate a margin, near the edge, in which this special relationship can be expected. The relationship might help account for the difficulties with artificial regeneration in parts of southwestern Oregon.

A procedure has been developed for estimating the position of a tree or stand within this margin. Because the special relationship depends intrinsically on genetic adaptation, the procedure uses information about genetic variation between and among populations of Douglas-fir in southwestern Oregon. It is based on the probability of matching genotypes with environments in which they can survive and reproduce. Douglas-fir is highly variable in many traits affecting the conditions and resources necessary for survival and growth to maturity. Each population consists of individuals with requirements that vary around an average requirement. The conditions and resources that constitute the environment of southwestern Oregon are also highly variable and change along complex gradients. Furthermore, at any place on the gradient, variation in soil color, soil depth, organic matter, stoniness, shade and surface roughness can create a mosaic of microsites with different conditions and resources. As conditions deteriorate along a gradient approaching the species edge, most elements in the mosaic of microsites become less favorable for seedling survival and growth.

Unlike animals, plants cannot migrate to suitable microsites, so establishment of a plant depends on the chance matching of an individual with a microsite that can satisfy its requirements for survival and growth. This chance varies within the margin near the species edge. At the outer edge only the especially hardy individuals can survive and then only in the most favorable of microsites. At the edge near the central population most individuals can survive in most microsites. The procedure for estimating position within the margin is based on a model that assumes a margin in which the proportion of seedlings adapted to available microsites becomes smaller and smaller as the species edge is approached.

The procedure predicted that the species edge is approached only in the southeastern part of the region at low elevations. At low elevations in the eastern parts of the region, the "distance" of populations from the edge increases rapidly from the border of California north to Prospect and beyond. In western parts, the distance to the edge does not change much from north to south. Conditions are neither as severe as in the southeast nor as mild as in the northeast. In all parts of the region, an increase in elevation up to 920 meters means a steady retreat from the species edge.

Records of stem basal area and numbers of Douglas-fir in temporary sample plots scattered throughout southwestern Oregon were consistent with predictions by the procedure; i.e., they agreed whether a present stand was near the species edge or well within the species margin. The procedure, however, suggested that many locations that presently do not support Douglas-fir stands were well within the species margin. Given appropriate site preparation and seed source, these locations should sustain productive forests of Douglas-fir.

The practical reason for estimating the species margin was to indicate areas in which regeneration and growth problems may be largely caused by poor genetic adaptation of species to site. In the species margin, many poorly adapted seedlings may exist even in the seedlot from the indigenous stand. In this case, natural regeneration may be very slow and uncertain. Artificial regeneration may be faster and more predictable, but this advantage may be gained at a considerable cost. For example, the model on which the procedure was based suggests that planting more seedlings per hectare will increase the probability that a seedling is planted in a compatible microsite. The number to be planted will vary depending on the position of the plantation within the margin and on other factors such as expected success in regeneration and number of crop trees desired. The model provides a method for calculating the theoretical number of seedlings needed in each case. Predicted numbers are not prescriptions, but they do indicate the relative difficulties expected in regenerating sites within the margin. The calculations suggest that regeneration costs will expand greatly near the species edge. Near the edge, regimes that ensure early establishment are especially important and especially difficult to achieve. Regeneration and growth-enhancing treatment sufficing in the inner half of the margin may not be cost-effective in the outer half.

Copies of the report on which this note is based can be obtained at the Pacific Northwest Research Station, Forest Service, U.S.D.A., 3200 Jefferson Way, Corvallis, OR 97330.

Robert K. Campbell

SEEDLING DROUGHT STRESS STUDIED IN RELATION TO MYCORRHIZAE AND ROOT REGENERATION

The objectives of these Fundamental FIR studies are to evaluate different fungi and determine the mechanisms whereby mycorrhizal fungi reduce seedling response to soil drought; to determine conditions to optimize formation of mycorrhizae; and to develop the technology to enhance root regeneration on transplanted seedlings by prior treatment with mycorrhizal fungi and/or rhizobacteria or exogenous sources of rooting hormones.

Procedures for evaluating ectomycorrhizal fungi for their capacity to reduce Douglas-fir seedling response to soil drought have been fine-tuned by studies that demonstrated that mycorrhiza formation was enhanced by NH_4 nitrogen sources (compared to NO_3 source) and by maintenance of root temperature at 20°C (inhibition occurred at 27°C). Preliminary results indicate that mycorrhization can be optimized by strategic placement of the inoculum where new roots would readily contact it and thereby reduce the time for formation of an effective symbiosis. Tests have also been initiated to determine if an exogenous supply of rooting hormones and water-retention gels will enhance root regeneration on transplanted seedlings. Future tests will be conducted to measure levels of endogenous rooting hormones resulting from exogenous application of hormones as well as inoculation with selected ectomycorrhizal fungi and/or rhizobacteria in relation to root regeneration.

Detailed comparisons of mycorrhizal and nonmycorrhizal Douglas-fir seedlings under soil moisture-limiting conditions indicated that different fungi differently modified photosynthetic rate, stomatal conductance, and tissue water potential. Analysis of these data will provide critical clues as to the mechanisms involved in reduction of drought stress on seedlings with mycorrhizae.

For more information, contact me at USDA-ARS, Oregon State University, Corvallis, OR. (503) 757-4544.

Robert Linderman

RESEARCH UPDATE ON SOUTHWEST OREGON FOREST SITE PRODUCTIVITY

OSU College of Forestry graduate students Jeff Borchers and Greg Koerper have measured soil N (total and mineralizable) on 20 sites in southwestern Oregon: 5 clearcut and burned, 5 clearcut and not burned, and on 10 adjacent undisturbed forest stands. The clearcuts were all approximately 5 years old. Analyses have been completed for mineralizable N (min N), an index of nitrogen availability that has proven to be related to forest productivity.

In the top 5 cm of soil, min N was consistently lower in burned clearcuts than in adjacent forest, with an average decrease of 24.3 micrograms N/gram of soil, or about a 37 percent decrease. The pattern was different in the lower soil layer (5 cm to 15 cm). Here, burned clearcuts averaged 6.7 micrograms/gram greater than adjacent forest - a 40 percent increase - apparently caused by a downward migration of substrates for N mineralization. The gain in the lower soil, however, does not make up for the lower rates in the upper soil, and overall, the burned sites appear to have less available N.

The story is different on unburned clearcuts. Compared to adjacent forest, the top 5 cm of soil in the clearcuts has 11.4 micrograms/gram more min N (18 percent increase) and the 5 cm to 15 cm layer has 5.5 micrograms/gram more (29 percent increase) than in the equivalent soil layers in the adjoining undisturbed forest. The difference between the burned and unburned clearcuts is almost certainly related to consumption of organic matter with high N contents during burns, recognizing that factors such as soil bulk densities, coarse fragment content and the entire microbial environment can also affect measurement of min N. Without further study, it is difficult to say what effect lower available N will have on long-term productivity of burned sites. But, on the H.J. Andrews Experimental Forest, less available N lowered the growth efficiency (stem volume per unit leaf area) of 20-year-old stands of Douglas-fir by approximately 5 percent per year in a two-year study. If compounded over a rotation, the volume losses are substantial.

Other nutrients, however, such as Ca, limit tree response to N on some sites in the H.J. Andrews Experimental forest, and similar responses will likely be found in southwest Oregon. Because of this, predictions of tree growth from models that are based solely on tree responses to N (e.g. Forsite) are likely less reliable than previously thought. This is not to say that large enough losses of N will not cause growth losses - they definitely will, either in the short or long term. But quantifying those losses with greater certainty won't be possible until we do more on-the-ground experimentation to determine the entire suite of soil factors that influence tree growth and how these vary with site.

For more information, contact me at the Department of Forest Science, Oregon State University, Corvallis, OR 97331, (503) 754-2244.

Dave Perry

OSMOTIC CONCENTRATION OF XYLEM SAP AS A PREDICTOR OF DOUGLAS-FIR SEEDLING QUALITY

High quality seedlings are required for reforestation, and a fast, reliable technique to predict seedling performance is needed. This project assessed osmotic concentration of xylem sap as a predictor of field performance of Douglas-fir seedlings.

A range of vigor conditions was created among the seedlings by applying a series of freezing and drying treatments. The resulting quality of the seedlings was evaluated by root growth potential, growth chamber performance, and field performance. Growth room and field survival were regressed on the osmotic concentration of xylem sap at the time of planting to determine its predictive ability. The results indicate that this method alone cannot identify all types of injury that reduce seedling quality. However, the osmotic concentration of xylem sap can detect freezing damage to seedlings and should prove valuable in conjunction with other methods of quality assessment.

For more information, contact us in the Department of Forest Science, Oregon State University, Corvallis, OR 97331, (503) 754-2244.

Keith R. Forry
Joe B. Zaerr

UPTAKE AND DISSIPATION OF TRICLOPYR HERBICIDE FROM DEPOSITS ON LEAVES AND GLASS SLIDES IN THE DARK

A phase of the Fundamental FIR study "Photodegradation and Dissipation of Triclopyr ([3,5,6-trichloro-2-pyridinyl]oxyacetic acid) Herbicide from Leaf and Glass Slide Surfaces" has been completed. The objective of this study is to determine the short-term environmental fate of the butoxyethyl ester of triclopyr (Garlon 4 herbicide, Dow Chemical) from fresh spray deposits in forest environments.

Single drops of spray solution representing spray droplets (5 microliters) were applied to excised leaves of Pacific madrone and golden chinquapin, and glass microscope slides (controls). After the water evaporated from all deposits, the leaves and slides were placed in a dark, controlled temperature cabinet at three temperature regimes (10°, 25°, and 40° C) and replicated three times. Seven leaves of each species and 3 slides were randomly selected and removed at 0, 14, 27, 41, 54, and 68 hours. The leaves and glass slides were rinsed with acetone, and the rinsate analyzed for triclopyr. Leaves were analyzed to determine the amount of triclopyr penetration into tissues.

The table below summarizes the findings in units of nanomoles (10^{-9}) per surface (1 nanomole of triclopyr weighs about 0.25 micrograms). All values are the means of three replications.

The droplets spread over different size areas on each surface type. Mean droplet areas (cm squared) and standard deviations were 0.56 ± 0.01, 0.10 ± 0.01, and 0.30 ± 0.01 for glass slides, madrone leaves and chinquapin leaves, respectively. These values reflect differences in surface morphology and chemistry that interact with the spray solution. A given quantity of a substance will dissipate more rapidly from a larger area deposit than from a smaller one.

Analyses of madrone and chinquapin leaf tissue show that substantial differences exist in the ability of sclerophyll plants to absorb triclopyr from spray deposits. These differences become more pronounced with increasing temperature. Chinquapin absorbs a larger quantity of triclopyr at higher temperatures, although the total tissue weight is typically less than half that of madrone leaves.

Temperature	Hours	Glass Slides	Madrone Leaves	Madrone Rinses	Chinquapin Leaves	Chinquapin Rinses
		nM				
	0	106.11	1.48	104.62	1.95	104.15
	14	96.98	2.32	86.58	3.06	100.77
10 C	27	100.38	4.23	83.25	3.71	100.26
	41	107.63	2.43	103.02	5.64	97.75
	54	106.95	4.54	89.62	8.20	106.29
	68	98.95	7.39	108.32	7.16	108.18
	0	106.11	1.03	105.10	1.34	93.26
	14	11D.72	7.74	92.28	20.08	83.68
25 C	27	95.37	13.04	85.40	31.71	89.44
	41	107.05	14.82	71.88	39.93	69.53
	54	97.83	14.50	77.44	42.94	60.46
	68	94.54	17.79	63.64	45.39	58.67
	0	106.11	2.12	103.99	3.37	102.73
	14	98.23	11.08	65.89	50.84	22.41
40 C	27	69.32	14.7D	51.99	46.30	12.68
	41	62.63	15.79	46.49	50.46	8.39
	54	85.33	15.93	50.85	56.68	8.63
	68	67.26	15.75	49.86	59.32	9.41

Glass slide recoveries show that at higher temperatures, triclopyr is lost at a greater rate. Because triclopyr cannot penetrate into glass slides, the decreasing recoveries observed on slides show the losses of triclopyr into the atmosphere from volatilization. Triclopyr recoveries are essentially the same at 10° and 25° C. However, between 25° and 40° C the rate of loss from volatilization appears to increase substantially. When the total recovered triclopyr is calculated for chinquapin and madrone leaves, a similar trend is found with higher quantities of triclopyr being lost at higher temperatures.

These results suggest that spray application should be performed when there will be warm dry weather following treatment, to maximize the dose received by weeds. Some off-site movement of triclopyr vapor will occur from 1 - 3 day old deposits when temperatures approximately exceed 30°C.

The next phase of this study will repeat these same treatments with artificial sunlight to determine the role that light plays in the degradation and dissipation of triclopyr. Triclopyr deposits on glass slides, and madrone and chinquapin leaves will also be weathered outdoors to evaluate the representativeness of the laboratory results, and the effect that environmental fluctuations have on triclopyr dissipation.

For additional information, contact us at the Department of Forest Science, Oregon State University, Corvallis, OR 97331, (503) 754-2244.

Kenneth P. Bentson
Logan A. Norris

FINANCIAL ANALYSIS OF EARLY STAND TREATMENTS IN SOUTHWEST OREGON

We analyzed the effect of early stand treatments (initial stand density, precommercial thinning, fertilization) on the financial returns from management of Douglas-fir in southwest Oregon. The results show how early stand treatments might be varied to obtain the maximum discounted financial return over a rotation. Different management situations were analyzed, representing a cross-section of assumptions about forest management in the area. These scenarios included no reforestation requirement; minimum reforestation requirements; and even-flow constraints.

For each management situation, a lower initial stand density always gave greater financial return than higher stand densities. In most cases, it paid to precommercially thin to obtain the low stand density. Fertilization as soon as possible after the juvenile growth stage always increased the financial return. But, costly management practices may not be financially justified under unfavorable investment conditions.

A minimum reforestation requirement may cause the forest manager to harvest fewer stands, or plant more trees per acre, or both, but it will not alter the financial attractiveness of discretionary silvicultural investments. An even-flow constraint can cause an increase in the financial attractiveness of discretionary investments that increase growth.

For more information, contact us through the Department of Forest Management, Oregon State University, Corvallis, OR, 97331. (503) 754-4951.

Helge Eng, Forest Managment
Norman Johnson, Forest Management
Roger Fight, PNW

Of Interest

DEER REPELLENTS: HINTS AND PRECAUTIONS

Biologists at Olympia's Forest Animal Damage Research Station have found a way of improving repellency of Big Game Repellent-Powder (BGR-P). They also have a word of caution to foresters trying "Ro-Pel" as a deer repellent on Douglas-fir.

For background, winter and summer browsing damage to Douglas-fir by black-tailed deer is a widespread problem in coastal Washington and Oregon. Summer browsing is more common in many areas; it starts shortly after spring bud burst and continues into late summer.

A variety of repellents are available to reduce browsing damage by deer. BGR-P - a 36 percent inedible egg solids concentrate in powder form - has been used for several years and has generally proven to be more effective than "Deer-Away" (liquid BGR) or other putrescent materials. "Ro-Pel", on the other hand, is a newcomer to the Pacific Northwest with relatively little data on its efficacy against black-tailed deer; it is an extremely bitter, liquid repellent. Regardless of the material, the recommended use during the growing season is to apply deer repellents to new growth immediately after bud burst.

A field trial in western Washington in 1986, however, showed that black-tailed deer could be conditioned to leave Douglas-fir new growth alone when BGR-P was applied before bud burst. The key was to first tie a 12-inch strip of plastic flagging to seedlings just below the terminal bud and then dust wetted seedlings (and flags) with BGR-P as directed on the label. [NOTE: the flagging should be applied loosely enough to not girdle the terminal--ed.] Results for the entire May through August growing season damage period were:

* Seedlings with flagging and BGR-P .... 0.0% browsing damage
* Seedlings with BGR-P alone .... 13.5% browsing damage
* Untreated control seedlings .... 66.7% browsing damage

Results of a recently completed 1987 pen test on dormant Douglas-fir seedlings were also favorable for BGR-P but discouraging for "Ro-Pel." In this test, BGR-P was dusted on wet seedlings before planting and "Ro-Pel" applied to dry seedlings, allowed to dry and then reapplied before planting. Terminals browsed by black-tailed deer at the end of the 28-day test were: BGR-P seedlings, 0 percent; "Ro-Pel" seedlings, 88 percent; untreated controls, 82 percent. In other words, "Ro-Pel" was no better than no treatment at all, whereas BGR-P gave complete protection. Furthermore, all "Ro-Pel" treated seedlings showed some burning of dormant needles suggesting that the compound could be quite phytotoxic if applied to new growth.

The bottom line is (1) tie a yellow (or blue or red) ribbon around the ol' Douglas-fir tree before applying BGR-P to maximize repellency and (2) watch out for phytotoxicity if you are trying "Ro-Pel" on new growth Douglas-fir.

For more information, contact us at USDA-APHIS-ADC, 3625 93rd Ave., SW, Olympia, WA 98502 or call (206) 753-9450/FTS: 434-9450.

Dan Campbell
Jim Evans

COMPARISON OF TREATMENTS TO CONTROL BIGLEAF MAPLE SPROUT CLUMPS

First-year results from a study conducted by Oregon State University's CRAFTS Cooperative illustrate the efficacy of various treatments in controlling bigleaf maple sprout clumps in young Douglas-fir plantations. The study was installed in 1985 and 1986 on six sites in Oregon and Washington. Six herbicides (Garlon 4®, Garlon 3A®, Roundup®, Arsenal® and Weedone 170®), were applied at three times of the year, February, June and August by four methods: 1) foliar spray, 2) basal spray, 3) thinline (applied in a thin stream directly to the bark), and 4) cut-surface (applied to the cambium of a freshly cut stem). Manual cutting at three times of the year was also included.

The percent change in effective crown volume or ECV (physical crown volume x percent foliage cover) from pretreatment size was used to measure treatment efficacy. The most effective treatments (Arsenal® foliage sprays; Garlon 4® thinline; dormant 3 percent Garlon 4® basal spray; late foliar and dormant Weedone 170® basal spray, and manual cutting with Roundup® and Garlon 3A® stump applications) reduced ECV more than 90 percent.

Basal sprays of 3 percent Garlon 4® in diesel oil were significantly less effective when applied during the growing season than when clumps were dormant. Full-strength Garlon 4® thinline treatments, however, showed little difference in effectiveness with season of application. A five-fold larger dose of triclopyr with the thinline treatment, relative to the 3 percent basal spray, probably compensated for the sensitivity of clumps to the timing of applications. Foliage sprays of Garlon 4® alone or Garlon 4® and Roundup® mixtures were not effective. Foliage sprays of Escort®, a new herbicide product, also were relatively ineffective.

All clumps that were manually cut sprouted vigorously in the first season after cutting, regaining over one-half of their pretreatment crown volume and about 75 percent of their original height. No differences in effectiveness were found among the June, August, or February cutting times, suggesting that a season of vulnerability, similar to that sometimes observed for red alder, may not exist for bigleaf maple sprout clumps.

For more information, contact me at CRAFTS Cooperative, Department of Forest Science, Oregon State University, Corvallis, OR, (503) 754-2244.

Bob Wagner

Continuing Education

FOREST VEGETATION MANAGEMENT - DOING WITHOUT?

January 19-21, 1988, Oregon State University. This year's course will explore consequences and alternatives to the continuing limitations on the use of many vegetation management tools. Speakers will discuss results of site preparation and release. A special session will feature new developments in forest vegetation management. The first day will review the basics of vegetation management principles, tools and techniques. This session should be useful for forest managers, foresters, and others who work in vegetation management planning and execution. CONTACT: Pam Henderson, Conference Assistant, Oregon State University, Corvallis, OR 97331. (503) 754-2004.

REFORESTATION RESEARCH ADVANCES IN SOUTHWEST OREGON

March 23, 1988. Southern Oregon State College. Held in conjunction with the 1988 Annual Meeting of the Northwest Science Association. This one day session will focus on current knowledge; related changes in the reforestation and management of southwest Oregon forests that have occurred in the last ten years; and future challenges. Workshop directors: Ole T. Helgerson, Dave McNabb and Steve Tesch. CONTACT: Lenore Lantzsch, Adaptive FIR, (503) 776-7116.

REFORESTATION METHODS WORKSHOP

March 29-31, 1988, Corvallis, OR. This workshop will review the principle components necessary for a successful reforestation program west of the Cascades. Speakers will discuss the latest practices regarding planning, site preparation, seedlings, and planting. Major emphasis will be given to the problem of meeting biological requirements of seedlings in a time of reduced budgets, and also how and when to plan for natural regeneration. The use of personal computers to plan and track reforestation operations will be demonstrated. Of interest to practicing silviculturists, regeneration specialists, and others involved in the regeneration process. Ample time for discussion, information exchange, and hands-on computer exercises will be allowed. CONTACT: Pam Henderson, Conference Assistant, Oregon State University, Corvallis, OR 97331. (503) 754-2004.

VARIABLE PROBABILITY SAMPLING: VARIABLE PLOT AND THREE-P

April 4-8, 1988. Oregon State University. This course offers in-depth instruction in Variable Plot and Three-P sampling, including: basics of sampling theory and techniques; computation techniques with hand-held calculators and microcomputers; field techniques, including actual field exercises; and a special problem-solving session where participants can get in-depth answers to questions and problems they bring. CONTACT: Pam Henderson, College of Forestry, Oregon State University, Corvallis, OR 97331. (503) 754-2004.

CALL FOR PAPERS AND POSTERS: INTERNATIONAL MOUNTAIN LOGGING AND PACIFIC NORTHWEST SKYLINE SYMPOSIUM

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

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