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A SUMMARY OF TWO SILVICULTURAL STUDIES CONDUCTED BY JAMES LINDQUIST ON JACKSON DEMONSTRATION STATE FOREST

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As part of the ongoing research program on Jackson Demonstration State Forest, a number of silvicultural studies funded through the Forest Resource Improvement Fund (FRIF described in Newsletter 29, March 1988) have been implemented over several years. This is a summary of two completed research projects presented to the Department. These reports are planned for publication in their entirety as California Forest Notes.

STUDY OF ADVANCED REGENERATION DAMAGE DURING A SECOND ENTRY

This research is germane to thousands of acres of partially cut stands both on the state forest and on other private forest lands. These stands vary widely in residual stocking levels, diameter classes, and species which presents a question of appropriate silviculture upon stand reentry.

Many stands have been partially cut with the original intent to create an uneven-aged structure. If however, a decision is

made to convert to even-aged management, the manager may desire to take advantage of established advanced regeneration. Under conventional harvesting practices, a significant amount of this regeneration may be damaged which may have long term stand development implications.

Coast redwood's well known ability to develop stump sprouts creates special opportunities and problems in managing this species. Is it better to leave stump sprouts from the earlier entry intact or would the stand development be better served by a deliberate removal of these trees? Observational evidence that new sprouting may be inhibited by advance sprouts growing from the same stump and possible reduced vigor of this advance regeneration may influence future stand development.

Study Objectives

Jim Lindquist's (retired PSW researcher) study was designed to address four specific questions:

1. How much advanced regeneration will survive the overstory logging planned for the area?
2. What effect would total removal of the advanced regeneration have on the rate of stand reestablishment?
3. Are there different rates of growth between the advance regeneration and new stock arising from this entry?
4. Does leaving advanced redwood regeneration affect the numbers of sprouts and rate of growth on new stumps?

The first objective was achieved within the framework of a completed research contract while the remaining three will require future monitoring and analysis to achieve.

Stand History and Description

The stand characteristics on this site result from clearcut logging in the late 1800's followed by a tractor logged partial cut of the resulting second growth stand in the early 1960's. The stand is on a northerly

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aspect slope in a tributary watershed to the North Fork of Caspar Creek. Average tree age was 90 years in 1987, and the site index for redwood was calculated to be 160 (Lindquist and Palley - Bulletin 796).

The stand, after each partial cut, was approximately 90 percent redwood both in basal area and by tree count. The first partial cut was a marked sale, while a fifteen inch lower diameter limit was used for the regeneration release cut. After this 1987 second harvest, the stand averaged 80 trees per acre and 33.5 square feet per acre basal area (BA) for trees >4.5".

Six inventory plots were randomly located and installed prior to tractor logging in the 1987 Middle Fork Caspar timber sale. All stumps and live stems were mapped within the plots. A sub-sample of trees were measured for height and diameter as the basis for computing local volume tables using the Redwood Cooperative Yield volume equations.

Damage To Regeneration

As Figure 1 indicates, the two most economically desirable species, redwood and Douglas-fir, account for just over 50 percent of the regeneration prior to logging. Redwood alone accounts for 20 percent overall and almost all of the regeneration over 2.5 inches in diameter. Many of the larger, older trees established prior to the first entry were of the intermediate and suppressed crown classes. The more vigorous advanced regeneration has resulted from sprouts and seedlings established after the first entry. The performance of these trees will be evaluated over time.

The post-logging survey (Fig. 2) and statistical analysis indicates a significant difference between before and after logging regeneration. Redwood and Douglas-fir increased to 65 percent of the total with most of that due to redwood sprouts. Redwood had a survival rate of 50 percent whereas the other conifer species had survival rates of only 20 to 30 percent. The size classes above the 4.5 foot height group

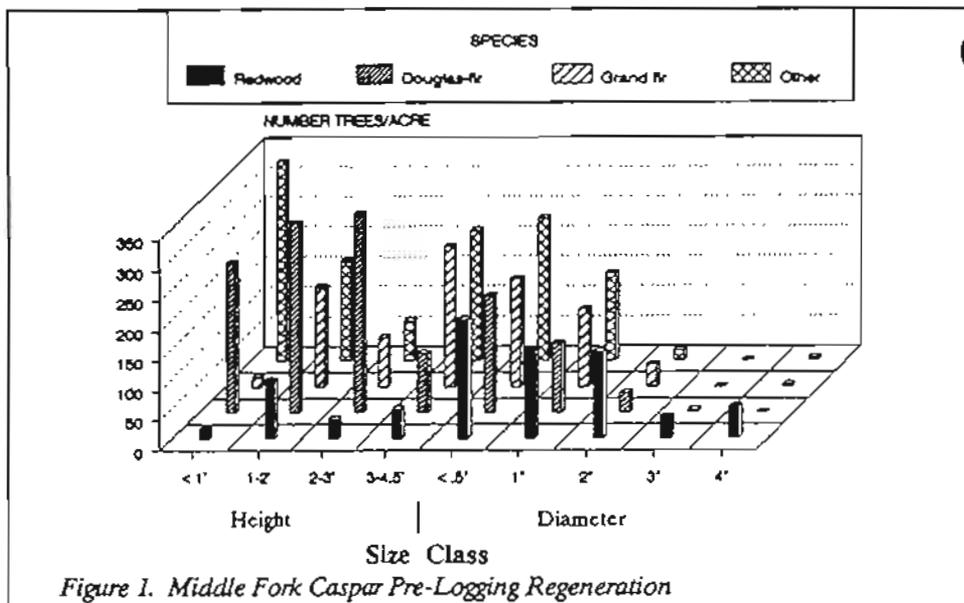


Figure 1. Middle Fork Caspar Pre-Logging Regeneration

performed better during the logging and increased their percentage share from 41 percent to 62 percent. Presumably the larger size classes, especially sprouts, are more resistant to skidding damage since operators can more easily see and avoid the larger sized regeneration.

the effects on future stand development of leaving or removing advanced regeneration.

COMMERCIAL THINNING AT WHISKEY SPRINGS 1970-1985

Future Monitoring

To address the last three objectives, Jim overlaid an additional treatment on the six sample plots. Half of each plot had the surviving advance regeneration removed. The development of regeneration on these plots will be followed to better understand

A long term cooperative silvicultural study involving Jackson Demonstration State Forest and the now disbanded silvicultural unit at the Pacific Southwest Experiment station (Redwood Sciences Lab) was initiated in 1970 at Whiskey Springs

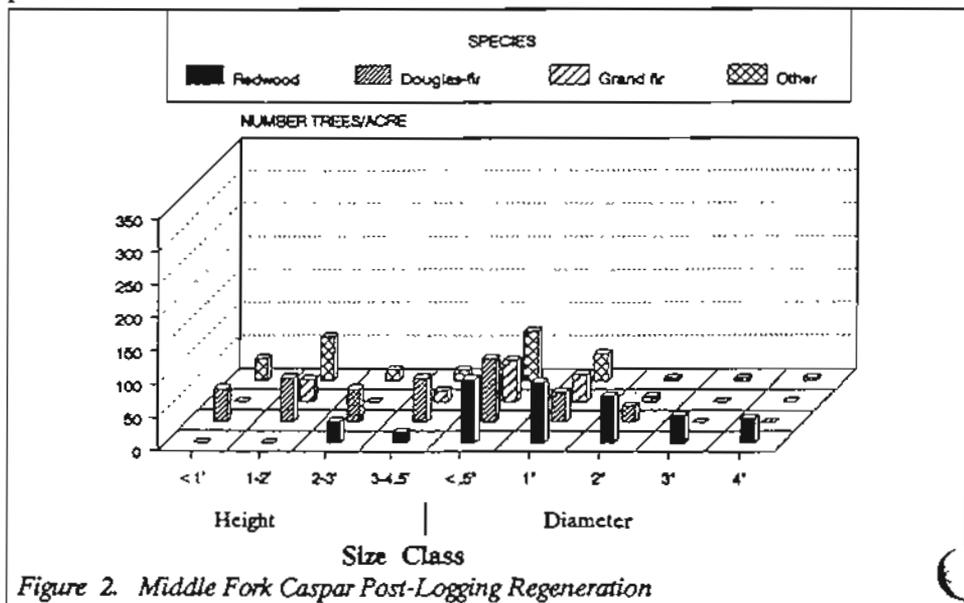


Figure 2. Middle Fork Caspar Post-Logging Regeneration

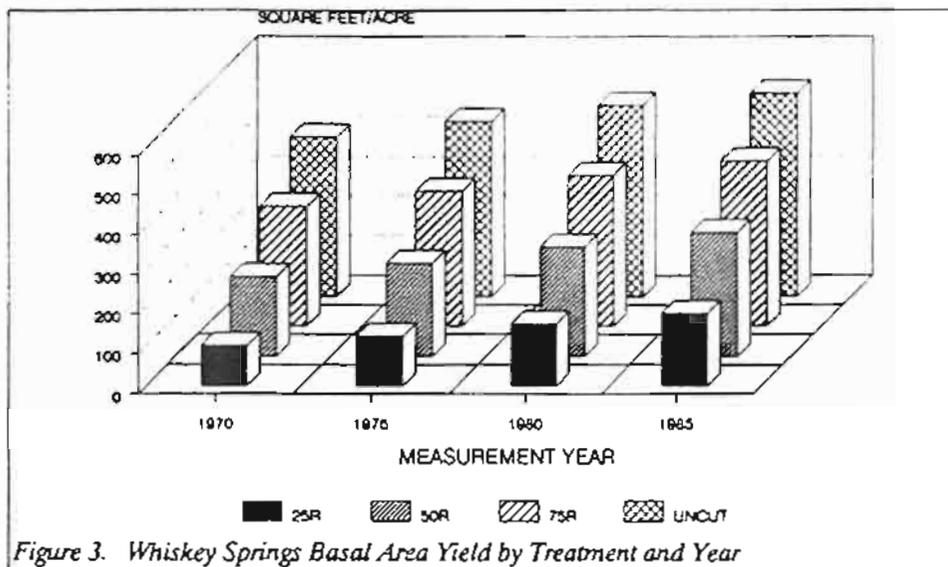


Figure 3. Whiskey Springs Basal Area Yield by Treatment and Year

(JDSF). Newsletter No. 9 (Dec. 1982) reported on the first 10 year growth and yield results.

Study Objectives

The original study objective was to determine the effect of thinning at various intensities on the long term growth and yield of a 40 year-old, high-site redwood stand. The initial study design, plot installation and inventory were done by now retired research forester Rudy Strothman.

The study design included two other locations (Humboldt and Del Norte counties) which had randomized block designs versus the fully randomized design at Whiskey Springs. Jim Lindquist continued this study and initiated sprout growth studies at this location. The data and analyses presented are based on the Whiskey Springs stand information.

In this study, stand basal area was cut to 25, 50, and 75 percent (25R, 50R, and 75R treatments) of the original basal area level for all trees greater than 4.5 inches in diameter.

Three replications of each treatments plus uncut controls (UN) were randomly assigned to the twelve 0.4-acre plot locations.

Initial Plot Condition

Statistical analysis (ANOVA) indicated pre-treatment basal area stocking uniformity in all plots with an average BA of 401 square feet per acre. Although no statistical difference was found, inventory data shows that the UN and 75R had only 10 trees per acre over 20 inches dbh while the 25R and 50R plot areas had 33 and 20 trees per acre respectively over 20 inches.

Basal Area Change

Results from fifteen years of monitoring (Fig. 3) show that there is no significant difference in the basal area growth between the control and treatment plots. This fifteen years of BA growth ranges from 83 sq ft /acre in the 25R to a tight grouping of 109-113 sq ft /acre for the UN, 50R and 75R treatments.

Number Of Trees, Average Diameter and Mortality

Although the pre-thinned stand was uniform in all respects statistically, the control plots, due to random selection, averaged 150 trees per acre more and a 1.5 inch smaller average diameter than the other nine treatment plots. Immediately after thinning, the average stand diameter in each treatment was statistically significant as was the radial growth in each 5 year period.

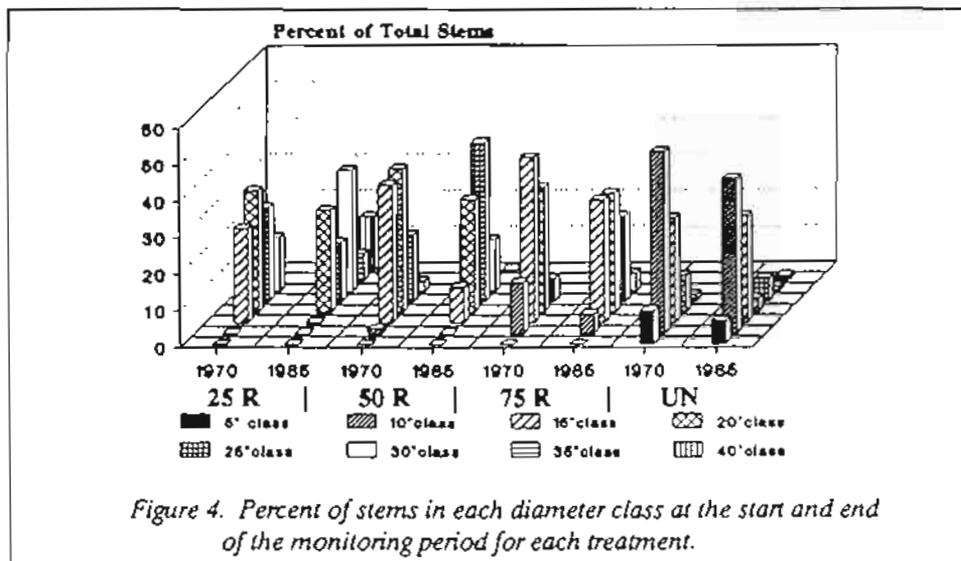
The 25R thinning reduced the stand to 45 trees per acre with an average diameter of 20.2 inches while 117 trees per acre were left on the 50R with an average diameter of 17.7 inches. The 75R leave treatment resulted in 205 trees being left with a 15.9 inch average dbh and the uncut plots had 240 trees averaging 14.7 inches dbh. The resulting diameter growth differences over the 15 year period illustrates one major reason to thin - to transfer the diameter growth onto selected crop trees. The movement in diameter classes shown in Figure 4 generally reflects the trend set by the 25R stand which has four times more diameter growth than the uncut stand (7.1 versus 1.7 inches for the period) in the strata of trees over 10.5 inches dbh.

While the uncut plots had 6% mortality in stem count versus none in the 25R and 50R, the dead tree diameters averaged only 6 inches and did not significantly effect volume yield of the uncut stand.

Volume Growth and Yield

The gross growth and yield values of the various treatments were not statistically significant different at the end of the 15 year period, however the 15 year net growth of the 25R treatment was significantly less than the 75R. This would indicate that the 25R stocking was reduced too much for effective use of the site potential during this time period. Although not analyzed as part of this study, varying degrees of sprouting and subsequent growth resulting from the thinning may have some competitive influence on the overstory crop trees response in the various treatments. In addition, the initial stand structural differences and the possible influence from the untreated stands adjacent to the 20 foot wide plot buffers has made it difficult to conclusively evaluate the thinning response at this point in time.

The uncut stands, prior to thinning, averaged about 12000 board-feet (bf) per acre less than the next lowest group (50R) as shown in Table 1. Thinning reduced this treatment and the 25R to volume levels below the uncut. Significant differences in



stand volumes were created by the various thinning treatments. There has been no culmination of mean annual increment (MAI) in any of the treatments. For example, the gross MAI on the 25R plots was 1240 bf per acre before thinning at age 40 (the time of harvest) and after thinning has steadily increased to 1377 bf/acre/year in 1985. The 25R has the highest gross growth for the period (56864 bf) despite having the lowest five year periodic growth (26500 bf) indicating that stocking probably was reduced too much for effective use of the site during this time period.

Recommendations

The inference from the lack of statistically different responses to the various thinning

regimes for the 15 year period is that implementing a commercial thinning at this age may have to be based on other objectives in addition to stand yield considerations. Jim Lindquist's comparison of treatments in table one is an attempt to equilibrate the stands and show some trends which have occurred during the period. For example, the uncut had the lowest gross yield but when expressed as a percentage comparing the initial volume to final yield, it was highest for the period. This may be partially a result of ingrowth into board foot classes occurring in this period and not necessarily extrapolative to future periods as the competition increases in the uncut stand.

An economic analysis was not part of study so we cannot make conclusions based on calculated present net worth

Table 1. Summary of stand growth and yield under three thinning levels with comparison to the uncut stand.

Item	Treatment			
	Uncut	25R	50R	75R
Precut vol (bf)	35210	49254	47440	51893
Percent of uncut	100.0%	139.9%	129.7%	147.4%
Vol. cut 1970 (bf)	0	30367	14733	5191
Post-thinned vol.	35210	18887	30928	46895
Volume 1985 (bf)	71229	46384	66134	86900
15 year net growth	36019	26497	35206	40205
Gross growth (bf)	36019	56864	49939	45396
Gross yield (bf)	71229	76751	82686	92091
Percent of uncut	100.0%	106.3%	113.5%	129.3%
15 year MAI	4.51%	5.97%	4.83%	4.01%
Gross yield/precut	202.3%	153.8%	174.1%	177.6%

values. A comprehensive economic evaluation by the landowner, however, should estimate various management costs such as timber harvest plan development, harvesting and site preparation costs and weigh them against the projected revenues from the thinning and final harvest. Specifically since this treatment was done as a low thinning, there is a question of at what level of thinning the material removed would generate a net revenue. While the 25R should generate the most thinning revenue, it apparently reduced the growing stock below that which could be fully utilized by the site. If thinning is desired, the 50R seems an acceptable compromise between revenue and residual stocking levels, especially if the stand rotation will be considerably longer. The 75R thinning did not result in the trees releasing due to the low thinning and light intensity of cut.

Other considerations involved in the thinning decision may include the desirability of growing fewer but larger diameter trees more quickly and the ultimate silvicultural system desired. The first consideration has implications for harvesting cost and stumpage value. Based on average log size, the final harvest cost should be lower and depending on rotation length, log grade considerations may influence the stumpage values especially as this volume is all redwood. The second factor relates to whether the thinning is to be regarded as an intermediate entry prior to a final harvest cut or as transition cut towards converting the stand for unevenaged management. Protection of the sprout regeneration during the final harvest becomes important if it is regarded as advance regeneration under an evenaged system. This may influence the rotation length so as to grow these to a size where they are less susceptible to logging damage. As discussed in the first study in this newsletter, in developing an unevenaged system, the protection of stump sprouts becomes important in this context as these sprouts would constitute the new lower diameter replacement classes. The added advantage is the expectation that this advance regeneration should have sufficient crown development to respond quickly to any release having grown under increased spacing initially.

Timber Sales on Jackson State Forest - A Summary of Activity 1987 - 90.

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Forestry Assistant I

The State Forest system was formed for the purpose of demonstrating economical forest management. Management is defined in PRC Section 4639 as the application of practices designed to achieve "maximum sustained production of high quality forest products while giving consideration to values relating to recreation, watershed, wildlife, range and forage, fisheries, and aesthetic enjoyment." A recap of the 1987 - 1990 forest management activities will help illustrate how well Jackson Demonstration State Forest did in achieving this management goal.

Active Sales 1990

The Bear Gulch '89 sale incorporated clearcutting and seed tree, seed step (even-aged) silvicultural systems. A total of 128 acres were harvested with 65 acres of tractor and 63 acres of high-lead cable yarding. This sale was completed October 1990. The sale price was \$313.78 /Mbf (Dollars per thousand board feet).

The Caspar East '89 sale is part of the Caspar Creek Watershed Study and incorporated clearcutting (even-aged) silviculture. A total of 138 acres were harvested with 16 acres tractor and 122 acres high-lead cable yarded. This sale was completed September 1990. The sale price was \$201.72 /Mbf.

The Noyo '89 sale incorporated a combination of shelterwood - removal step and commercial thinning to 75 square feet of basal area per acre. A total of 412 acres were harvested with 290 acres of tractor

and 122 of high-lead cable yarding. This sale was completed August 1990. The sale price was \$191.58 /Mbf.

Rice '90 forms the second phase of the clearcutting-cumulative effects evaluation in the Caspar Creek Watershed Study. A total of 194 acres are scheduled to be harvested with 51 acres of tractor and 143 acres of high-lead cable yarding. This sale is in progress with 4,488,910 bf (board feet) harvested as of Dec. '90. The sale price was \$312.97 /Mbf.

Clearcutting and shelterwood, seed step methods are combined in the Berry Gulch '90 sale. A total of 255 acres are scheduled to be harvested with 30 acres of tractor and the remainder cable yarded. Harvesting has not started on this sale. The sale price was \$251.32 /Mbf.

Bids were opened on the Volcano '90 sale Jan. 1991 at a sale price of \$221.10 /Mbf. The sale constitutes 355 acres of transition from even-aged timber to uneven-aged management by removing 30 % of the stand volume. Sixty acres are scheduled for tractor yarding and with the remaining 295 acres cable yarded. Operations should commence Summer 1991.

Class 1 Sales are located throughout the forest and consist primarily of firewood permits, but also include salvage logs, split products, burls, poles, redwood bark, ferns, and mushrooms. A total of 734 permits for these products were issued (Jan. through Nov. '90) generating a total taxable revenue of \$30864.

Previous Sales

These sales were completed prior to the 1990 calendar year. This sales summary covers the period from our

last timber sales report (Newsletter 28, Jan 1988).

The South Fork Hare Creek '88 sale incorporated clearcutting and selection silvicultural systems. A total of 431 acres were harvested with 299 acres of tractor and 132 acres of high-lead cable yarding. The sale price was \$150.96 /Mbf.

Noyo Incline '88 incorporated clearcutting, shelterwood, and selection silvicultural systems. A total of 200 acres were harvested with 125 acres of tractor and 75 acres of high-lead cable yarding. The sale price was \$165.01 /Mbf.

A series of small 5-acre clearcuts comprised the Fourteen Gulch '88 sale. A total of 173 acres were harvested with 118 acres of tractor and 55 acres of high-lead cable yarding. The sale price was \$102.79 /Mbf.

The Stone '87 sale was created as part of an asymmetric growth model research project which measured the response of residual trees after commercial thinning. A total of 52 acres were harvested by tractor yarding. The sale price was \$125.32 /Mbf.

Also sold as part of an optimum commercial thinning density study, Whiskey Springs '87 resulted in 40 acres of harvesting by tractor. The sale price was \$102.15 /Mbf.

Peterson Gulch '87 incorporated clearcutting and selection silvicultural systems. A total of 184 acres were harvested with 66 acres of tractor and 118 acres of high-lead cable yarding. Bid prices were split out for different species with a sale price of \$183 /Mbf for redwood and \$46 /Mbf for Douglas-fir and whitewoods.

The Deadman's Trestle '87 sale incorporated clearcutting, shelter-

wood - removal step, and selection silvicultural systems. A total of 223 acres were harvested with 155 acres of tractor and 68 acres of cable yarding. The sale price was \$99.52 /Mbf.

Clearcutting and shelterwood - removal step systems were incorporated in the Middle Fork Caspar Creek '87 sale. A total of 298 acres were harvested with 226 acres of tractor and 72 acres of high-lead cable yarding. The sale price was \$120.31 /Mbf.

Prospective Sales

The following sales are scheduled for the 1991 calendar year. The sales are in various stages of preparation.

The Pacific Gas and Electric high voltage power line Right-of-way which transects the State Forest will undergo hazard tree removal operations. This will include 741 acres adjacent to the lines and has an estimated harvest volume of 820 Mbf.

Tramway '91 is scheduled to be the final harvest for the Caspar Creek Watershed Study. Approximately 8 to 10 million board feet will be clear-cut harvested from 124 acres. Bid opening is anticipated in Spring 1991.

Located in one of our uneven-age management units, the Parlin Creek '91 even-aged stand will be transition cut with a 30 % volume removal goal. This sale is currently being prepared. It will cover about 516 acres and volume estimates should come in between 8 and 10 million board feet. Bid opening is tentatively scheduled for late Spring 1991.

The Bunker Gulch '91 sale is in the preliminary stages of layout. The silviculture will combine seed tree, seed step and commercial thinning systems. Estimates of acreage or volume have not yet been determined.

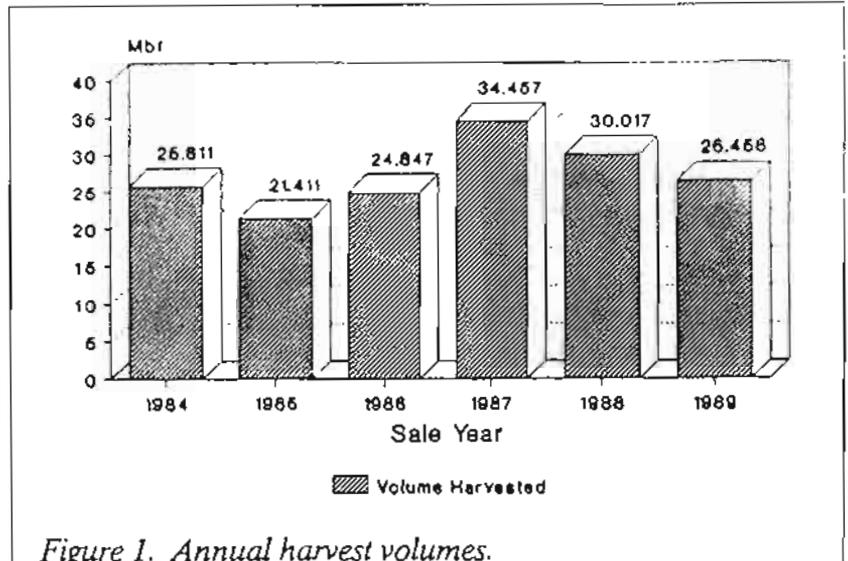


Figure 1. Annual harvest volumes.

Summary

Table 1 summarizes the timber sales totals for 1987 through 1990 sales. Revenues generated from a given timber sale may be divided between several calendar years, depending upon when the timber is actually harvested. After taxes and operational expenses, revenues from sales are used in part to fund the California Forest Improvement Program (CFIP). This is a cost-sharing program offered by CDF to assist small landowners throughout the state with planning, site preparation, planting, pre-commercial thinning, and habitat and land conservation practices on non-industrial sized forestland.

Our annual allowable harvest target is estimated at 28,000 Mbf. The allowable cut is designed to provide sustained-yield, which limits our annual harvest volume to the equivalent annual growth for the forest. Sales are scheduled in advance, matching timber volumes prepared each year to our annual target. Compared to an average volume of 27,165 Mbf harvested over the last six complete sale years (Fig. 1), the State Forest is operating close to our goal. Annual growth estimates are revised as up-

dated forest inventory data is processed, keeping us on target with our sustained-yield objective. These figures illustrate that economical forest management under a sustained-yield practice is alive and well at Jackson Demonstration State Forest.

STAFF NOTES

JDSF's new Assistant Forest Manager is Tess Albin-Smith. Tess came on board in August, filling the role of Administrative Officer and directing the Recreation program for the State Forest. Her educational background includes receiving a B.S. in Renewable Natural Resources, 1974 and a M.S. in Range Management, 1978 from U.C. Davis, and she became a Registered Professional Forester (RPF) in 1983. She transferred from Sacramento Headquarters where she has been with CDF eleven years: six years as the first program coordinator for the California Forest Improvement Program; and the last five years as the program coordinator/evaluator for the Vegetation Management Program. Tess is an outstanding addition to the State Forest staff and her

experience, insight, and sense of humor will prove invaluable in helping us fulfill the State Forest mission.

JDSF is proving to be a valuable source of forestry expertise, unfortunately, resulting in the recent transfer of a number of outstanding personnel. Pete Cafferata has promoted to Forester II and is now working out of Sacramento as CDF's statewide Hydrologist. His integrity, experience, hard work, and dedication will be missed on JDSF and will be a definite asset to Sacramento. We wish him the best of luck in his new position and await his visit when the Caspar Creek watershed is raging.

JDSF Forest Patrolman Rich Elliot has moved into the Assistant Forest Manager position at the new Soquel Demonstration State Forest. His assignment should prove easier to patrol (3000 acres), but he will

shoulder increased responsibilities in timber management, wildlife, administration, and recreation. JDSF's loss will be more than compensated by Soquel's gain.

Rich's move created an immediate promotional opportunity for Tom Larsen. Tom was hired in October to fill one of the new recreation Forest Technician positions on JDSF and within two weeks promoted into the Forest Patrolman slot. Tom is a 1985 graduate of Humboldt State with a B.S. in Forestry and he is a RPF with several years of industry experience. While working for American Forest Products out of Martell, Ca., he performed harvest preparation and was the field supervisor for their permanent plot inventory.

Many other staff changes have occurred since our last "Notes". Janice Tompkins has retired after being the

JDSF secretary and office manager for over 23 years. Her efficiency, organizational skills, and knowledge of how to keep this place running are sorely missed. Malcolm Tonkin returned to Australia having completed his year as an exchange forester, and Walt Decker is now back at JDSF. The exchange program was considered to be a great success and we hope to see more exchanges in the future. Another returnee is our accountant Lisa Jensen, who gave birth to a baby daughter (Cassie Lee) in September. Lisa and new recruit Robln Malavasic are job sharing the Accounting position. We would also like to welcome Pam Linstedt and Robert Byers to the JDSF staff. As our new recreation techs, they will be implementing our forest-wide recreation plan starting in February. Good to have you aboard!

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