1500 5/21/92

United States
Department of
Agriculture

Forest Service

**Pacific Southwest
Research Station**

P.O. Box 245
Berkeley
California 94701

Research Note
PSW-RN-412
August 1991

Site Preparation + 1 Year: Effect on Plant Cover and Soil Properties

Raymond D. Ratliff **Renee G. Denton**

Ratliff, Raymond D.; Denton, Renee G. 1991. *Site preparation + 1 year: effect on plant cover and soil properties*. Res. Note PSW-RN-412. Berkeley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 5 p.

Preparing areas for planting conifer seedlings reduces competition for site resources but creates poor range conditions. Bare soil, low plant cover, and little forage do not support forest grazing programs. At Boyd Hill on the Modoc National Forest, in California, several regeneration sites were prepared in 1988. Early in 1989 they were planted with ponderosa pine *(Pinus ponderosa)* seedlings. On five plantations that summer, live plant cover averaged just 2.5 percent. Except for shrubs, which covered 1.4 percent of the surface, cover values for plant groups (perennial grasses, annual grasses, perennial forbs, and annual forbs) were less than 0.5 percent each. Non-plant area included 53 percent bare soil and 34 percent litter. Rock, wood, and gravel each occupied around 3.5 percent of the surface. For the surface layer, average soil properties on the plantations were: bulk density—1.05 g/cm^3, organic matter—11.7 percent, soil water—8.1 percent, and water absorption—0.98 min/cm.

Retrieval Terms: Modoc National Forest, Big Valley Ranger District, plantation, fire, herbaceous vegetation, soil

Biologists and forest managers are searching for practices that will maintain long-term productivity and ecological stability on commercial forest land. A frequent goal after fire or logging is to establish conifer plantations. Another goal is to establish a vegetative cover to minimize soil erosion and to establish a crop of desirable herbaceous species. Seeded herbaceous species may reduce growth of highly competitive species of plants—shrubs, for example. But herbaceous species, seeded or natural, are often a major problem to the forester because they usurp resources that conifer seedlings need.

Site preparation for planting conifer seedlings aims to reduce competing vegetation, lessen the chance of pests, and dispose of slash. Meeting those aims creates poor range conditions—bare soil with low plant cover and little forage. The conditions created are seldom reported, however. This note reports ground cover and soil properties on five regeneration sites, which are part of a larger study, the year after they were prepared for planting to ponderosa pine *(Pinus ponderosa)*.

Until conifer seedlings gain a competitive advantage, maintaining poor range condition is necessary. Herbaceous species can compete strongly, and competition within the space needed by conifer seedlings can negatively affect their growth.[1] Competition is for soil moisture and light;[2,3] increasing herbaceous cover reduces survival of conifer seedlings. Survival of planting stock in the eastside pine type of California was poorest in soil with a heavy vegetative cover.[4] Seedlings grew best where there was no grass.[3] Thus, site preparation which reduces plant cover helps promote a new stand of ponderosa pine.[5]

Removing existing plant cover helps assure adequate water for tree seedlings for 2 or 3 years, and using a bulldozer to do so has proved highly successful.[6] A bulldozer with the blade angled to create a furrow 15 to 30 cm deep effectively reduced competing vegetation for at least 2 years.[7] On burned areas of the Modoc National Forest, creating blade-width trenches at least 15 cm deep removed all competing vegetation.[8] Similarly, logging activities can significantly reduce understory vegetation. In northeastern California, logging reduced available forage the next year by about 19 percent.[9] Skidding removed vegetation and slash from 14 percent of the area, and slash covered another 24 percent. Tractor logging in eastern Oregon and Washington reduced shrubby and herbaceous vegetation by 47 percent compared with prelogging densities.[10]

METHODS

Source Data

The data reported are from pine plantations at Boyd Hill on the Big Valley Ranger District of the Modoc National Forest, California. Soils there are in the Lawyer and Elmore families.[11] Both families have loam to stony loam surface textures and clay loam to cobbly clay loam subsoil textures. They are well-drained, and permeability (saturated) is moderately slow—0.5 to 1.5 cm water/h. Effective rooting depths range from 50 cm to more than 100 cm over basalt bedrock. Hydrogen ion concentrations are in the slightly acid range—pH 6.1 to 6.5. The forest site class is 5, with potential productivity in the range of 3.5 m^3 to 5.9 m^3 per hectare per year (50 ft^3 to 85 ft^3/ac/yr).

Wildfire burned the area in 1978. Preparation for planting in 1989 occurred during the summer and fall of 1988. Using a brushrake-equipped bulldozer, standing dead trees and shrubs were pushed into large piles and burned. The brushrake ripped the soil surface, upturning the grasses and forbs and bringing boulders to the surface. That treatment left the soil surface rough, i.e., in a primary tillage condition.[12] Nevertheless, the soil thus cultivated was loose and friable—much like newly plowed ground (*fig. 1*).

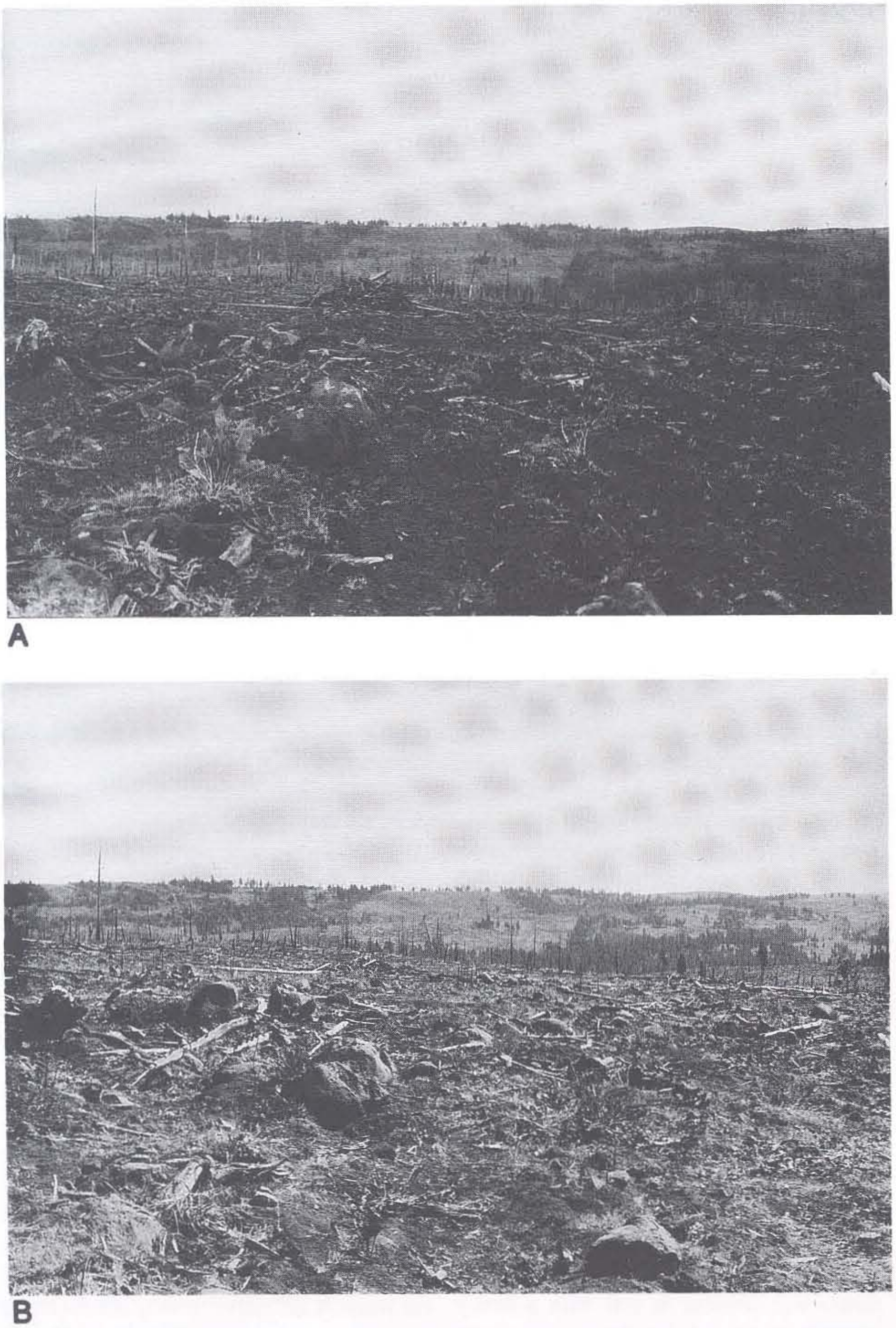

Figure 1—Standard site preparation on burned timber land—plot number one, Boyd Hill, Modoc National Forest—(A) August 1988, (B) September 1989. In (A) the piles are not burned and there is little herbaceous vegetation. In (B) the piles are burned, seedlings are planted, and herbaceous vegetation is recovering.

Design

Five regeneration sites were randomly selected for establishing 64-m by 128-m study plots. Placement of the plots within the regeneration sites avoided the burn piles. To provide a randomized complete block experimental design, each plot consisted of four experimental units (EU) each 32 m by 64 m. Treatments were assigned but not applied.

Plant cover and non-plant factor estimates were made in summer 1989. Soil properties were estimated that fall.

Sampling units (SU) were two 3-m by 60-m belt transects randomly located within each EU that were treated as one. The first 1.5 m bordering each EU formed a buffer for reducing side effects. Also, 1.5 m was the minimum distance allowed between the two transects. All responses were estimated within the belt, and sample placement was random.

Response units (RU) for plant groups (grasses, grasslike plants, forbs, shrubs, and pine seedlings) and non-plant factors (bare soil, gravel, rock, litter, wood, and animal waste) were one-meter long sub-transects. Perpendicular to the center line of the SU, 100 sub-transects were randomized in the left-hand, center, or right-hand meter of the transect. Plants and non-plant factors intercepted by each sub-transect were measured to the nearest millimeter. Plant intercepts were recorded by species, but analyzed by groups. Projected crown intercepts were recorded for tree seedlings and shrubs. Actual basal intercepts were recorded for all other characteristics. Gravel, litter, and bare soil were measured individually on every fifth sub-transect, and together as surface on all other sub-transects.

Soil properties assessed were bulk density, soil water, and soil organic matter in the top 10 cm, and water absorption. For the first three properties, the RU was a 10-cm long core with a diameter of 4.7 cm (volume = 173.5 cm^3). The RU for water absorption was a 2.54-cm head of water. Ten cores were extracted and ten tests of water absorption were made at randomly selected points in the SU.

Each soil core was sealed in a plastic container to prevent water loss. In the laboratory it was weighed wet, dried at 105° C for 48 hours, and weighed dry to estimate soil water and bulk density. The core was crushed, oven dried in a crucible, weighed, held at 600° C for 6 hours, and weighed to estimate the amount of organic matter lost. This procedure is rapid and provides an estimate of the amount of soil organic matter that is useful for treatment comparisons.

To estimate water absorption we used the tin can infiltrometer (a 907-g coffee can) and improvised baffle.[13] After removing all litter and vegetation and setting the can into the soil 7.5 to 10 cm, we poured water on the baffle and recorded the time. A test was complete when the water film disappeared from the soil surface.

Analyses

The mean values and 95 percent confidence intervals (CI) for plant cover and non-plant variables and soil properties were computed using the mean square error for study plots from analysis of variance. Standard analysis of variance for the randomized complete block was used. Analyses of cover values, however, were for unbalanced data, because a number of sub-transect values were missing. The numbers of soil property samples for all EUs were equal; therefore, analyses were for balanced data.

RESULTS AND DISCUSSION

Plant Cover

One year after site preparation bare soil made up about 53 percent of the area not covered by plants *(table 1)*. Litter made up about 35 percent. Cover estimates from 18 ponderosa pine-bunchgrass sites 40 km south of Boyd Hill[14] suggest that litter may have been reduced by site preparation. In that study, bare soil averaged 16 percent and litter 60 percent.

Compared with the situation immediately after site preparation, herbaceous cover 1 year later had improved *(fig. 1)*.

Nevertheless, over all plots, only 2.5 percent of the surface was covered by vegetation *(table 1)*. Of that, shrubs comprised 57 percent, forbs 24 percent, and grasses 18 percent. As was expected the year of planting, mean cover by ponderosa pine seedlings was low—just 2 percent of the total plant cover.

Other than conifer seedlings, 46 species were found on or around the study plots *(table 2)*: endemics (74 percent), perennials (59 percent), forbs (67 percent), grasses (24 percent), grasslike plants (2 percent), and shrubs (7 percent). Seven species had cover values of 0.1 percent or more: cheatgrass brome *(Bromus tectorum)*, squawcarpet *(Ceanothus prostratus)*, Douglas rabbitbrush *(Chrysothamnus viscidiflorus)*, Anderson thistle *(Cirsium andersonii)*, low gayophytum *(Gayophytum humile)*, California needlegrass *(Stipa californica)*, and mountain mule-ears *(Wyethia mollis)*. Together, they comprised 87.3 percent of the plant cover.

Results for shrubs suggested differences in species response to site preparation. Before site preparation, study plots 3 and 5 had dense stands of rabbitbrush *(Chrysothamnus* spp.) *(fig. 2)*. The major shrub on plots 2 and 4 was squawcarpet. In 1989 shrub cover was lowest on plots 3 (0.3 percent) and 5 (0.5 percent) and comprised rabbitbrush (30 percent) and squawcarpet (70 percent). Shrub cover, all squawcarpet, was highest on plots 2 (3.0 percent) and 4 (2.8 percent).

Poor range condition often equates to low forage volumes; it does not necessarily equate to poor forage quality. During 1989 the study plots at Boyd Hill were grazed by cattle and deer. The ratio of 1 unit of animal waste to 5.5 units of grasses and forbs *(table 1)* suggests that the scant forage produced was highly palatable to herbivores.

Soil Properties

Cultivation through site preparation aims to break up compacted soil and lower bulk density and thereby promote root penetration and seedling growth. Negative effects of site preparation on bulk density, if any, were biologically insignificant. Average bulk density was higher on our plots *(table 3)*, however, than for surface soil of similar origin (basaltic parent materials) under a 175-year-old forest in Washington.[19] Also, two soils, compacted because of logging operations in Oregon, had bulk densities approaching that of our plots.[20] Nevertheless, loam to clay loam soils with bulk densities of 1.03 g/cm³ to 1.07 g/cm³ should not inhibit growth of conifer seedling roots.

Soils on the plots at Boyd Hill had 10 times the recommended minimum content of organic matter (1.2 percent in the first 15 cm) for planting ponderosa pine.[21] Though derived by different methods, the estimated content of organic matter was similar to that reported for soil of the 175-year-old forest,[19] suggesting that our estimates were not higher than reasonably expected.

Site preparation may increase the rate of water absorption, suggesting a positive effect on compaction and bulk density. Soil on the plots absorbed a centimeter of water an average of 0.63 minutes sooner than on the ponderosa pine-bunchgrass sites south of Boyd Hill.[14] There the soil was undisturbed for several years, and water absorption measured by the tin can infiltrometer averaged 1.6 min/cm. Again, the soils were of basaltic origin.

Even under drought conditions, site preparation may conserve soil water. In fall 1965 soil water averaged 9.0 percent in the top 7.5 cm of the ponderosa pine-bunchgrass sites south of Boyd Hill.[14] That percentage was within the 95 percent confidence interval for soil water on our plots. June-through-August precipitation (averaged for Alturas, Adin/Bieber, and Susanville) was 10.4 cm in 1965 but only 3.1 cm in 1989.[22,23]

Table 1—*Means, standard errors (SE), and 95 percent confidence intervals (CI) for plant cover[1] by species group and non-plant factors 1 year after site preparation, Boyd Hill, Modoc National Forest, 1989*

Group/factor	Mean	SE	CI
	Percent cover		
Tree seedlings	0.043	0.014	0.005-0.081
Shrubs	1.445	0.593	-0.202-3.091
Perennial grasses	0.214	0.058	0.054-0.375
Annual grasses	0.232	0.054	0.081-0.383
Perennial forbs	0.443	0.072	0.244-0.641
Annual forbs	0.164	0.039	0.055-0.272
Non-plant	97.454	0.697	95.519-99.389
Animal waste	0.193	0.059	0.029-0.356
Rock	3.181	1.562	-1.154-7.516
Wood	3.633	0.685	1.730-5.535
Surface	90.449[2]	2.373	83.861-97.037
Gravel	3.718	0.658	1.890-5.546
Litter	33.777	2.239	27.560-39.994
Bare soil	52.990	4.179	41.390-64.590

[1]Cover values for tree seedlings and shrubs were based on projected crown intercepts.

[2]Surface = (gravel + litter + bare soil). The difference between the mean value of "Surface" and the sum of the mean values of gravel, litter, and bare soil is due to sampling intensity—N for surface = 5 times that for the components.

Future Range Condition

High survival of conifer seedlings with rapid growth is desirable. So, also, is an improving range condition. Treatments started in 1990 aim to tell whether specialized grazing management can promote survival and growth of conifer seedlings and better range condition (greater cover of desirable forage and browse species) than protection or season-long grazing.

Table 2—*Names, habits, and botanical compositions of understory plants found 1 year after site preparation, Boyd Hill, Modoc National Forest, 1989*

Name[1]			Botanical composition
Scientific	Common	Habit[2]	Pct.
Achillea millefolium	Common yarrow	EN-PE-FO	0.15
Agoseris retrorsa	Spearleaf agoseris	EN-PE-FO	—[3]
Agropyron intermedium	Intermediate wheatgrass	EX-PE-GR	1.72
Brassica campestris	Field mustard	EX-AN-FO	—
Briza maxima	Big quakinggrass	EX-AN-GR	—
Bromus carinatus	California brome	EN-PE-GR	0.40
B. japonicus	Japanese brome	EX-AN-GR	0.24
B. tectorum	Cheatgrass brome	EX-AN-GR	8.97
Calystegia occidentalis	Western morning glory	EN-PE-FO	0.07
Carex rossii	Ross sedge	EN-PE-GL	—
Ceanothus prostratus	Squawcarpet	EN-PE-SH	50.28
Chrysothamnus nauseosus	Rubber rabbitbrush	EN-PE-SH	0.82
C. viscidiflorus	Douglas rabbitbrush	EN-PE-SH	5.70
Cirsium andersonii	Anderson thistle	EN-PE-FO	2.02
C. pastoris	Snowy thistle	EN-PE-FO	0.12
Cryptantha ambigua	Wilkes cryptantha	EN-AN-FO	1.00
Dactylis glomerata	Orchardgrass	EX-PE-GR	0.01
Descurainia pinnata	Pinnate tansymustard	EN-AN-FO	—
Eriophyllum lanatum	Woolly eriophyllum	EN-PE-FO	0.04
Euphorbia serpyllifolia	Thymeleaf spurge	EN-AN-FO	—
Gayophytum humile	Low gayophytum	EN-AN-FO	2.95
Lactuca serriola	Prickly lettuce	EX-AN-FO	0.49
Lagophylla ramosissima	Comman hareleaf	EN-AN-FO	0.07
Lathyrus nevadensis	Nevada peavine	EN-PE-FO	0.50
Lepidium nitidum	Tongue pepperweed	EN-AN-FO	0.06
Lupinus caudatus	Tailcup lupine	EN-PE-FO	0.01
Madia glomerata	Cluster tarweed	EN-AN-FO	0.17
Malva neglecta	Common mallow	EX-BI-FO	—
Microsteris gracilis	Small star	EN-AN-FO	1.64
Monardella odoratissima	Pacific monardella	EN-PE-FO	—
Montia chamissoi	Chamisso minerslettuce	EN-PE-FO	0.03
Navarretia species	Navarretia	EN-AN-FO	0.02
Nicotiana attenuata	Coyote tobacco	EN-AN-FO	—
Phacelia heterophylla	Varileaf phacelia	EN-PE-FO	0.64
Poa bulbosa	Bulbous bluegrass	EX-PE-GR	0.01
Polygonum douglasii	Douglas knotweed	EN-AN-FO	—
Scutellaria nana	Dwarf skullcap	EN-PE-FO	—
Sidalcea oregana	Oregon checkermallow	EN-PE-FO	—
Sitanion hystrix	Bottlebrush squirreltail	EN-PE-GR	0.64
Stipa californica	California needlegrass	EN-PE-GR	4.70
S. elemeri	Elmer needlegrass	EN-PE-GR	0.38
S. thurberiana	Thurber needlegrass	EN-PE-GR	0.51
Taeniatherum caput-medusae	Meduesahead	EX-AN-GR	—
Taraxacum officinale	Common dandelion	EX-PE-FO	—
Verbascum thapsus	Flannel mullein	EX-PE-FO	1.25
Wyethia mollis	Mountain mule-ears	EN-PE-FO	12.69

[1]Names: scientific follow reference 15; common follow references 16, 17, and/or 18.

[2]Habit: EN = endemic, EX = exotic, AN = annual, BI = biennial, PE = perennial, FO = forb, GL = grasslike, GR = grass, SH = shrub.

[3]Species was found but not intercepted.

Table 3—*Means, standard errors (SE), and 95 percent confidence intervals (CI) of soil properties 1 year after site preparation, Boyd Hill, Modoc National Forest, 1989*

Soil property	Mean	SE	CI
Bulk density (g/cm^3)	1.049	0.0084	1.026-1.073
Organic matter (pct.)	11.737	0.2579	11.021-12.453
Soil water (pct.)	8.137	0.4201	6.971-9.303
Water absorption (min/cm)	0.985	0.1204	0.650-1.319

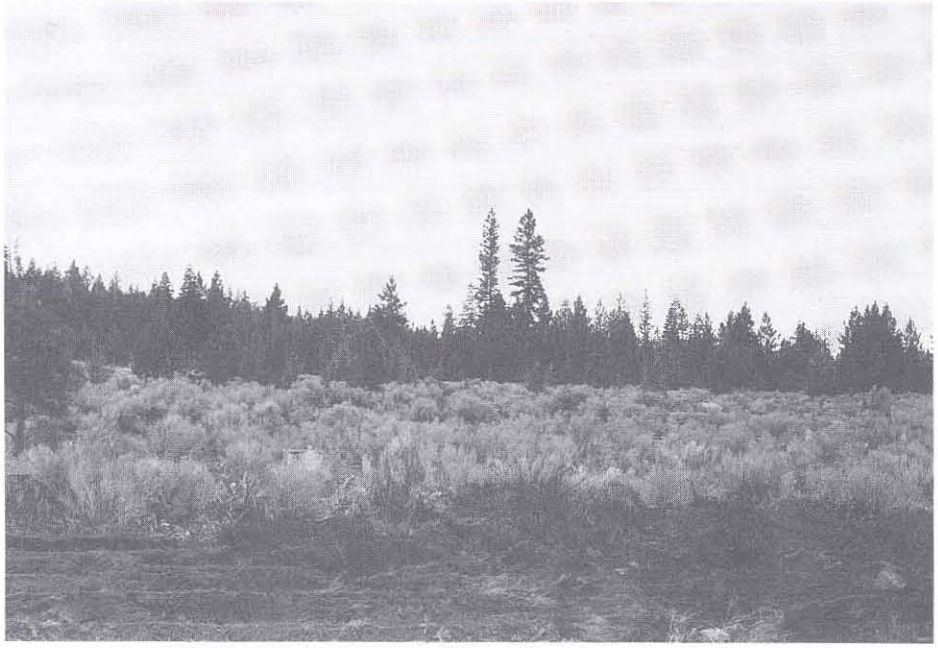

Figure 2—Site preparation at plot number three—Boyd Hill, Modoc National Forest, August 1988. Note the stand of rabbitbrush *(Chrysothamnus* spp.)

ACKNOWLEDGMENTS:

We thank Big Valley Ranger District employees for their help in establishing this study.

END NOTES AND REFERENCES

[1]McDonald, Philip M.; Fiddler, Gary O. 1989. *Competing vegetation in ponderosa pine plantations: ecology and control.* Gen. Tech. Rep. PSW-113. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 26 p.

[2]Embry, Robert S. 1971. *Soil water availability in an Arizona mixed conifer clearcutting.* Res. Note RM-206. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 4 p.

[3]Larson, M. M.; Schubert, Gilbert H. 1969. *Root competition between ponderosa pine seedlings and grass.* Res. Paper RM-54. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 12 p.

[4]Roy, Douglass F. 1953. *Effects of ground cover and class of planting stock on survival of transplants in the eastside pine type of California.* Res. Note 87. Berkeley, CA: California Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 6 p.

[5]Tackel, D.; Roy, Douglass F. 1953. *Site preparation as related to ground cover density in natural regeneration of ponderosa pine.* Tech. Paper 4. Berkeley, CA: California Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 13 p.

[6]Stone, Edward C.; Benseler, Rolf W. 1962. *Planting ponderosa pine in the California pine region.* Journal of Forestry 60(7):462-466.

[7]Shaner, Bruce A. 1959. *Site preparation for reforestation, using a D-7 crawler tractor with angle dozer.* Journal of Forestry 57(12):915-916.

[8]Buck, J. M. 1960. *Site preparation for forest regeneration in California.* Misc. Pub. San Francisco: California Region, Forest Service, U.S. Department of Agriculture; 26 p.

[9]Hormay, A. L. 1940. *The effect of logging on forage.* Chronica Botanica 6(1):6-7.

[10]Garrison, George A.; Rummell, Robert S. 1951. *First-year effects of logging on ponderosa pine forest range lands of Oregon and Washington.* Journal of Forestry 49(10):708-713.

[11]Luckow, Kenneth R. 1985. *Soil survey of Modoc National Forest, California: Parts of Modoc, Siskiyou, and Lassen Counties.* Forest Service, U.S. Department of Agriculture. Alturas, CA. Unpublished draft on file with Modoc National Forest, Alturas, CA.

[12]Moehring, D. H. 1970. *Forest soil improvement through cultivation.* Journal of Forestry 68(6):328-331.

[13]Evanko, A. B. 1950. *A tin can infiltrometer with improvised baffle.* Res. Note 76. Missoula, MT: Northern Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 2 p.

[14]Reppert, Jack N.; Ratliff, Raymond D. 1968. *Evaluation of rest-rotation grazing on the Harvey Valley allotment (an in-service report).* Unpublished draft supplied by author.

[15]Soil Conservation Service. 1984. *National list of scientific plant names, Vols. 1 and 2.* SCS-TP-159. Washington, DC: Soil Conservation Service, U.S. Department of Agriculture; 416 p. and 438 p.

[16]Beetle, Alan A. 1970. *Recommended plant names.* Res. Jour. 31. Laramie, WY: Agricultural Experiment Station, Univ. of Wyoming; 124 p.

[17]Weeden, Norman F. 1975. *A Sierra Nevada flora.* Berkeley: Wilderness Press; 406 p.

[18]Niehaus, Theodore F.; Ripper, Charles L. 1976. *A field guide to Pacific States wildflowers.* Boston: Houghton Mifflin Co.; 432 p.

[19]Wooldridge, David D. 1965. *Soil properties related to erosion of wild-land soils in central Washington.* In: Youngberg, Chester T., ed. Forest-soil relationships in North America. Corvallis, OR: Oregon State University Press; 141-152.

[20]Dyrness, C. T. 1965. *Soil surface condition following tractor and high-lead logging in the Oregon Cascades.* Journal of Forestry 63(4):272-275.

[21]Wilde, S. A. 1958. *Forest soils, their properties and relation to silviculture.* New York: Ronald Press Co.; 537 p.

[22]U.S. Department of Commerce, National Climatic Data Center. 1989. *Hourly precipitation data, California.* ISSN 0364-6092. Asheville, NC: U.S. Department of Commerce, National Climatic Data Center; 39(6,7,8).

[23]U.S. Department of Commerce, Weather Bureau. 1965. *Climatological data, California.* Asheville, NC: U.S. Department of Commerce, Weather Bureau; 69(6,7,8).

The Authors:

RAYMOND D. RATLIFF, a range scientist, and **RENEE G. DENTON**, a range conservationist, are assigned to the Pacific Southwest Research Station's Wildlife, Monitoring and Range Research Unit, headquartered at 2081 East Sierra Avenue, Fresno, CA 93710.