United States
Department of
Agriculture

Forest Service

**Pacific Southwest
Research Station**

Research Paper
PSW-RP-215

Vegetative Trends in a Young Conifer Plantation After 10 Years of Grazing by Sheep

Philip M. McDonald Gary O. Fiddler

McDonald, Philip M.; Fiddler, Gary O. 1993. **Vegetative trends in a young conifer plantation after 10 years of grazing by sheep**. Res. Paper PSW-RP-215. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 9 p.

An 11-year-old ponderosa pine (*Pinus ponderosa* Dougl. ex Laws. var. *ponderosa*) plantation in northern California was grazed annually in summer by 600-1150 dry (nonlactating) ewes in an attempt to reduce competing vegetation and increase growth of pine seedlings. The sheep also provided an opportunity to evaluate density and developmental trends in the pine, shrub, grass, thistle, and forb components of the plant community. A manual release and a deer-only treatment provided contrast to the effects of grazing by sheep. In general, stem diameter and foliar cover of ponderosa pines, rarely damaged by sheep or deer, were significantly greater in manually grubbed areas, but only after 8 years. Pines in grazed areas never differed significantly in height, stem diameter, or foliar cover from control areas. Density, cover, and height of deerbrush (*Ceanothus integerrimus* H. & A.) were generally fewer and lower if grubbed and grazed, but grass and bull thistle (*Cirsium vulgare* [Savi] Ten.) were larger and more numerous in these treatments. Forb cover was highest in the grubbed treatment. In general, average density, cover, and height of deerbrush, bull thistle, grasses, and forbs did not differ significantly among treatments grazed by deer or sheep—suggesting that sheep did not have a deleterious effect on deer in terms of forage availability.

Retrieval Terms: pines, shrubs, forbs, grasses, survival, growth, grazing

The Authors:

Philip M. McDonald is a research forester assigned to the Station's Vegetation Management Research Unit, with headquarters at Redding, Calif. **Gary O. Fiddler** is a silviculturist assigned to the Timber Resource Planning and Silviculture Unit, Pacific Southwest Region, USDA Forest Service, with headquarters in San Francisco, and stationed at Redding, Calif.

Publisher:

Pacific Southwest Research Station
Albany, California

(Mailing address: P.O. Box 245, Berkeley, California 94701-0245
Telephone: 510-559-6300)

February 1993

Vegetative Trends in a Young Conifer Plantation After 10 Years of Grazing by Sheep

Philip M. McDonald Gary O. Fiddler

Contents

In Brief . . .

McDonald, Philip M.; Fiddler, Gary O. 1993. **Vegetative trends in a young conifer plantation after 10 years of grazing by sheep.** Res. Paper PSW-RP-215. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 9 p.

Retrieval Terms: pines, shrubs, forbs, grasses, survival, growth, grazing

A current major development in managing natural resources is the broadening emphasis on ecosystems and the many species in the plant community. This is manifest in the need to know more about "the little plants"—the forbs and grasses that currently have no recognized value. Key to this need is the realization that each species has intrinsic worth, not necessarily for wood or wood products, but as food for wildlife, to fulfill the variety and contrast requirements of pleasing scenery, or as components in ecosystems that the manager wishes to sustain or enhance. This northern California study provides some knowledge on the species composition and early development of a pine plantation and the plant community that ensues after burning. An untreated control, manual grubbing, and a deer-only treatment provide contrast to grazing by sheep.

The early plant community that resulted after the various treatments (including the control) was dominated by planted ponderosa pines and native deerbrush. At the end of the study in 1991, an average of 20 species with more than 21,400 plants per acre and a foliar cover of more than 84 percent were present in grazed areas. After 10 years of grazing, the range is in good shape and, if anything, has been underutilized with regard to forage.

Some practical findings have resulted from the study: (a) grazing by 600 to 1150 dry ewes each summer for 10 years greatly reduced deerbrush cover relative to the control; (b) in spite of this reduction, grazing never provided a significant increase in pine diameter, foliar cover, or height; (c) manual grubbing 2 years after planting eventually (after 8 years) led to a significantly larger pine diameter and cover; (d) manual grubbing greatly reduced deerbrush density and cover, increased thistle density and cover, and increased forb cover and grass height; (e) browsing by deer was relatively minor and never significantly affected any parameter of any category of plants relative to the control; (f) similarly, grazing by sheep did not significantly affect the amount or development of forage available for deer.

Introduction

A major concern today is the effect of treatments that affect the ecology of a given area. The effect of grazing on the plant community that develops in young conifer plantations is of increasing interest. Some of the questions being asked are: in addition to the planted conifer seedlings, what other plant species are present, in what numbers, and how do they develop over time in a treated and natural state?

Heightened public concern and increased restrictions on use of herbicides have caused natural resource managers to look for other methods to manipulate unwanted vegetation in young conifer plantations. Often these young plantations contain palatable shrubs and herbaceous plants, which provide forage for grazing animals until the tree crowns close and shade out the lower vegetation. Utilization of this forage, or transitory range as it sometimes is called, is increasing worldwide (Oregon State University 1983). Providing wood and forage constitutes a joint production strategy that emphasizes different outputs at different stages of the timber rotation and can increase the yield from the land (Ritters and others 1982). Sheep often are the grazing animals selected. In general, they are well suited to the dry, rough, and often shrub-inhabited terrain typical of conifer plantations in the western United States. And weight gains, at least for yearlings and dry ewes, have been satisfactory (Hall and others 1959, Sharrow and Rhodes 1983).

Increasing evidence shows that, to be effective, release from competing vegetation must take place when conifer seedlings are 1 or 2 years old (McDonald 1982, McDonald and Fiddler 1986, Newton and Preest 1988). But young seedlings are vulnerable to browsing, and damage by sheep has been reported (Fullmer 1987, Hall and others 1959, Hill 1917, Logan 1983, Winward and Rudeen 1980). Skepticism remains that the risk of damage outweighs the gains from utilizing the forage. Some evidence is available, however, which shows the net effect of grazing by sheep to be positive. In a study in the Oregon Coast Range, for example, conifer seedlings grew better when competing vegetation was reduced by sheep, probably because more soil moisture was available (Sharrow and Leininger 1983). Diameters of Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) seedlings increased by 7 to 14 percent in grazed areas as compared to ungrazed controls.

This paper documents grazing over a 10-year period and shows the effects of it and other treatments on various components of the plant community. A control provides contrast by depicting plant density and development in an untreated condition.

Study Location and Environment

The study area was located in part of a 2,000-acre burn on the Tahoe National Forest in northern California *(fig. 1)*. A grazing allotment (Cap) encompassed the burn and adjacent area. Site quality rated as III (average [Biging and Wensel 1984]) for growing timber with deep and moderately well-drained soils. Slopes ranged from 10 to 50 percent on a southwest aspect. Elevation averaged 4,900 feet, and precipitation ranged from 60 to 80 inches with most falling as snow.

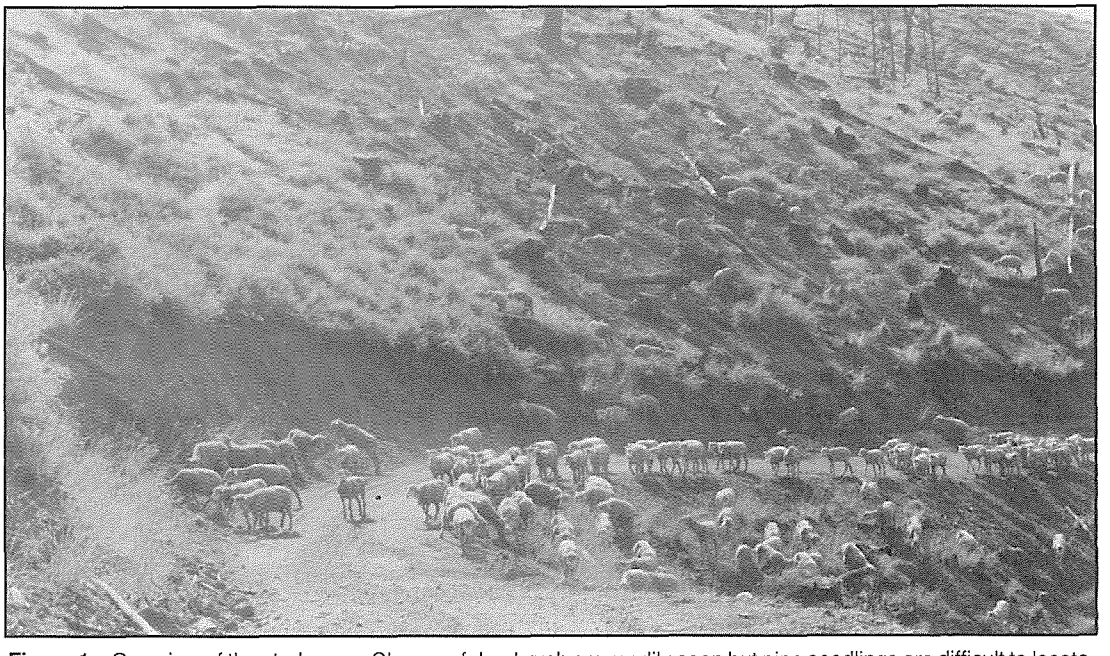


Figure 1—Overview of the study area. Clumps of deerbrush are readily seen but pine seedlings are difficult to locate.

The study area burned by wildfire in 1978, was logged in 1979, had slash broadcast-burned in 1980, and was planted with ponderosa pine (*Pinus ponderosa* Dougl. ex Laws. var. *ponderosa*) seedlings at an 8- by 8-foot spacing in 1981.

After the broadcast burn, deerbrush from dormant seeds in the soil was the most abundant vegetation. In addition, 13 forbs and 3 grasses were present when the study began. Among the forbs were bull thistle (*Cirsium vulgare* [Savi] Ten.), prickly lettuce (*Lactuca serriola* L.), gumweed madia (*Madia gracilis* [Sm.] Keck), bindweed (*Convolvulus* L. spp.), grand mountain dandelion (*Agoseris* Raf. spp.), goat's beard (*Tragopogon dubius* Scop.), and willow herb (*Epilobium* L. spp.). The grasses, all perennials, were from the genera *Bromus, Stipa*, and *Elymus*. The herbaceous vegetation tended to be scattered and patchy, except for bull thistle, which was fairly abundant and well distributed. To prevent erosion, a mixture of grasses was seeded along roads by Tahoe National Forest employees. Orchardgrass (*Dactylis glomerata* L.) was the only survivor. It became established in patches near the road and as scattered plants in the study area.

Mule deer *(Odocoileus hemionus)* in the study area are both resident and migratory. Tahoe National Forest wildlife biologists estimated resident deer to number fewer than one per 100 acres, and migratory deer between 700 and 1,000. Migratory deer passed through the study area mostly between May 1 and June 1 on their way to higher elevations and between October 1 and November 15 when they returned to winter range.

Grazing, which began in summer 1981 (but after the growing season) and has continued annually to the present, was by a band of dry (nonlactating) ewes (600-1,150 animals), and occurred intermittently from June to September each year. The sheep were experienced with wildland grazing and the plant species in the area. Water was available and well distributed throughout the allotment. A herder with several dogs guided and guarded the sheep. The sheep were trucked to the allotment, allowed to become acclimated to the area and the forage for a few days, and then herded back and forth through the study area. Sometimes, they grazed for several weeks elsewhere in the allotment and then again moved through the area for a few days in the fall before shipment to a wintering area. Forest range conservationists estimated that utilization of deerbrush (*Ceanothus integerrimus* H. & A.) in the burn ranged from 40 to 65 percent, and 60 percent overall from 1982 through 1986.

Treatment and Study Methods

Three replications of four treatments, completely randomized, comprised the experimental design. Analysis of variance and Tukey tests were used for analysis. Significance in all tests was at $\alpha = 0.05$. Because information was gathered from permanent plots measured each year, the data are not truly independent from year to year. The α levels or type I errors given for various tests apply to each measurement and year separately. The overall error rate could increase by as much as the given amount for each measured variable each year. Treatments and agents (ponderosa pine always present) were:

Treatment	Agents
Manually grub all other vegetation	Hand tools
once (spring 1983); exclude deer and sheep	High fence
Control	High fence
Exclude sheep and deer *(fig. 2)*	
Grazing	Low fence
Exclude sheep	
Grazing	No fence

Figure 2—Sheep and deer are excluded by the 7-foot fence. Note deerbrush and bull thistles in foreground.

A replicate consisted of about 0.1 acre on which 15 to 20 ponderosa pine seedlings were surrounded by two rows of buffer (seedlings receiving similar treatment). The nonbuffer seedlings were measured annually in the fall for height and diameter at 12 inches above mean ground line and checked for browsing and trampling damage by deer and sheep. Sampling intensity for quantifying woody and herbaceous vegetation was six randomly selected milacre (one-thousandth of an acre) subsamples in each replication. Each subsample was centered on a pine seedling. Woody shrubs and herbaceous vegetation were measured annually for density, foliar cover (the sum of shadows that would be cast by leaves and stems of individual species expressed as a percentage of the land surface [Daubenmire 1968]), and average dominant height (average of the three tallest stems measured from mean ground line to bud).

Overall survival of ponderosa pine seedlings was 85 percent in 1982. Visual observations showed that stem and crown development of the pines was good and that they were growing well. Damage to pine seedlings (recorded only if the terminal shoot was browsed) amounted to 2 percent in 1982, while shrub cover was reduced an estimated 25 percent (Thomas 1984). We report results of this study from spring 1983 through fall 1991.

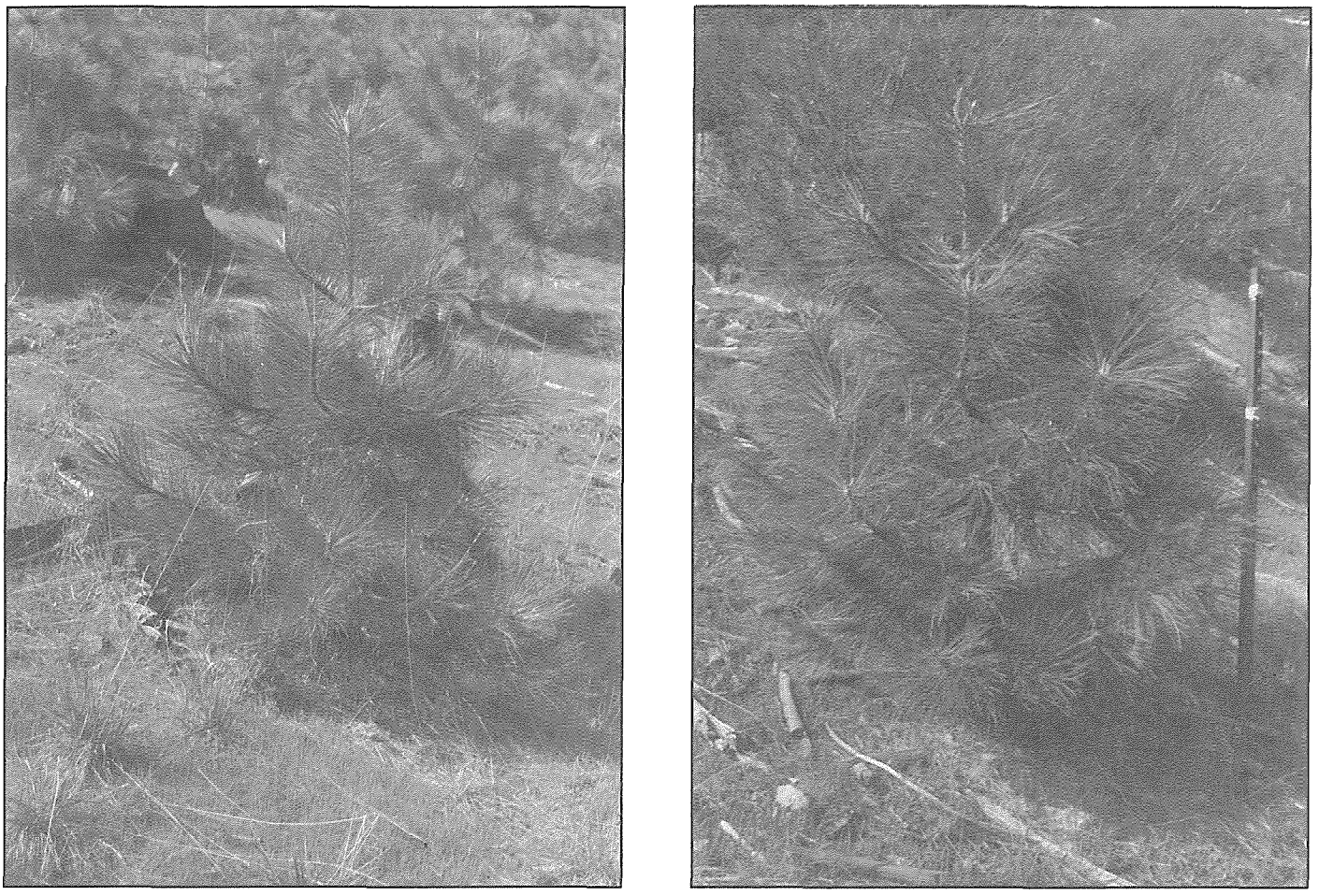
Results and Discussion

Controlling vegetation in young conifer plantations involves more than just manipulating the tallest plants. The shortest plants are often capable of capturing available resources and limiting conifer seedling survival and growth. Too often, effective control of the tallest plants results in a shift to shorter plants of equal or greater competitive ability. For this reason, and because we wanted to denote vegetative trends for each treatment, we quantified several growth parameters of not only pines and deerbrush, but also of grasses, bull thistles, and other forbs.

Ponderosa Pine

Survival of ponderosa pine seedlings was 100 percent in all treatments for the 1983-1991 period. Damage was minimal *(fig. 3)*. Sheep nipped the terminal shoot on one 5-year-old seedling, on seven 6-year-old seedlings, and on four 7-year-old seedlings. All seedlings developed new leaders, and damage in 1991 is not discernible. No damage from deer was recorded on study plots,

Figure 3—Although deerbrush was heavily browsed, almost all ponderosa pine seedlings were not damaged.



A B

Figure 4—After six growing seasons, differences in pine stem and crown were visually apparent among some treatments, but not yet statistically so:

and none from trampling by either deer or sheep was noted. Although some differences among treatments were visually apparent *(fig. 4)*, none were statistically significant until 1989 *(table 1)*, when average pine diameter in grubbed treatments was significantly larger ($p < 0.05$) than that in the control. Pine cover in grubbed plots also was significantly larger in 1989-1991 relative to the control and areas grazed only by deer. Pine height, diameter, and foliar cover in the treatments grazed by sheep or deer did not differ from each other, grubbed treatment, or control after 10 years of grazing.

Deerbrush

In fall 1983 or after one growing season, deerbrush plants in the grubbed treatment were few and short with little cover *(table 2)*. In other treatments, however, several thousand plants per acre were present, which by 1985 had significantly more density and height. No significant differences were present in density, cover, or height among grazed treatments or control *(fig. 5)*. Not until 1985 did average cover and height differ significantly between the control treatment and the areas grazed by sheep and deer. However, because cover and height did not differ significantly between the deer-grazed and control treatments, we presumed that most of the reduction in deerbrush cover and height was due to grazing by sheep. In 1991, or after 10 years of grazing, deerbrush plants were still significantly fewer in grubbed plots, but no longer differed significantly among treatments in height. Foliar cover was the parameter most affected by sheep grazing, differing significantly (59 percent lower than control) for grazed plants. Never during the study did deerbrush density, cover, or height differ significantly between the deer-grazed and control treatments, and utilization of this resource by deer apparently was minor.

Grasses

Although not present initially, cheatgrass (*Bromus tectorum* L.) first began to invade the study area in 1983. By 1984, it was well established *(table 3)*. Consequently, almost all recorded data pertain to cheatgrass, although a few plants of orchard

C

(A) Grazing, (B) Grubbing, (C) Control.

grass, invading from the roadside, are included. Since 1984, density, cover, and height have been characterized by extreme variability. Differences among treatments were not generally significant for grass parameters during the study period, although treatment means show that plants in grazed areas in 1991 were significantly shorter than plants in the control.

Bull Thistle

This thistle was not recorded in the study area until 1984 *(table 4)*, after it had invaded by wind in fall 1983, germinated after the fall rains, wintered over as an inconspicuous plant, and grew rapidly the next spring. The species was most numerous in 1984, declined in 1985, and was virtually absent thereafter except for a few short, slender plants in the grubbed areas. Density and cover of plants in grubbed areas were significantly greater than counterparts in other treatments in 1985. Like cheatgrass, bull thistle readily became established on the bare ground of the grubbed areas.

Other Forbs

Because individual species of forbs, other than bull thistle, were relatively small and scattered, data on them were combined. And because height of individual species varied widely and an average would be meaningless, only cover was quantified. Nearly all the forb species noted earlier are pioneers and well adapted to disturbance. Early in the study, they could be found throughout; later, some species were becoming scarce in grazed areas. Prickly lettuce and goat's beard, for example, were utilized extensively by both deer and sheep *(fig. 6)*, and in 1989 could be found only behind fences in the grubbed areas. Bindweed and gumweed are additional examples of preferential grazing. In two of the three grubbed replicates, bindweed nearly fills the exclosure, but no plants exist outside the fences. Inside the fences, gumweed madia averaged 3.6 feet tall; outside, it averaged about 4 inches in height.

Foliar cover of forbs other than bull thistle differed significantly ($p < 0.05$) among treatments only in 1984 and 1985 *(table 5)*. In general, significantly more cover was present in grubbed areas, with no differences occurring between grazed areas and control.

Table 1—*Average diameter, height, and cover of ponderosa pine, Cap Allotment, Tahoe National Forest, California, 1983-1991*

Year	Treatment	Diameter	Height	Cover
		inches	*ft*	*pct*
1991	Grubbed	5.5 a[1]	13.2 a	83 a
	Deer	4.0 ab	10.8 a	46 b
	Sheep and deer	4.2 ab	10.8 a	61 ab
	Control	3.9 b	10.2 a	35 b
	Standard error	0.3	1.3	6
1989	Grubbed	4.0 a	9.8 a	64 a
	Deer	3.0 ab	8.2 a	27 b
	Sheep and deer	3.1 ab	7.2 a	41 ab
	Control	2.7 b	7.9 a	23 b
	Standard error	0.2	0.7	7
1986	Grubbed	2.0 a	4.5 a	18 a
	Deer	1.7 a	4.7 a	10 a
	Sheep and deer	1.5 a	3.5 a	12 a
	Control	1.4 a	4.1 a	7 a
	Standard error	0.2	0.3	4
1985	Grubbed	1.5 a	3.3 a	13 a
	Deer	1.3 a	3.6 a	9 a
	Sheep and deer	1.0 a	2.7 a	8 a
	Control	1.0 a	3.0 a	5 a
	Standard error	0.1	0.3	2
1984	Grubbed	1.0 a	2.3 a	7 a
	Deer	0.8 a	2.4 a	5 a
	Sheep and deer	0.7 a	1.9 a	5 a
	Control	0.8 a	2.2 a	4 a
	Standard error	0.1	0.3	1
1983	Grubbed	0.5 a	1.3 a	4 a
	Deer	0.4 a	1.4 a	3 a
	Sheep and deer	0.4 a	1.4 a	3 a
	Control	0.4 a	1.3 a	2 a
	Standard error	0.1	0.3	1

[1]For each year, treatment means in each column followed by the same letter do not differ significantly according to a Tukey Test ($\alpha = 0.05$).

***Table 2**—Average density, cover, and height of deerbrush, Cap Allotment, Tahoe National Forest, California, 1983-1991*

Year	Treatment	Density	Cover	Height
		Plants/acre	*pct*	*ft*
1991	Grubbed	944 a[1]	7 b	3.8 a
	Deer	3,111 b	43 ac	5.8 a
	Sheep and deer	3,111 b	23 bc	4.6 a
	Control	3,278 b	56 a	6.6 a
	Standard error	423	6	0.4
1989	Grubbed	611 a	7 b	5.7 a
	Deer	3,222 b	55 ac	6.4 a
	Sheep and deer	3,000 b	28 bc	5.1 a
	Control	3,278 b	61 a	6.9 a
	Standard error	459	5	0.4
1986	Grubbed	389 a	4 b	3.7 ac
	Deer	3,222 b	35 ac	4.9 ab
	Sheep and deer	3,000 b	17 bc	3.1 c
	Control	3,389 b	47 a	5.2 b
	Standard error	476	5	0.3
1985	Grubbed	389 a	3 b	3.0 b
	Deer	3,222 b	28 ac	3.9 bc
	Sheep and deer	3,167 b	17 bc	2.6 b
	Control	3,555 b	42 a	4.4 ac
	Standard error	522	5	0.3
1984	Grubbed	278 a	1 a	1.2 a
	Deer	3,278 b	24 b	3.4 a
	Sheep and deer	3,000 b	11 ab	2.0 a
	Control	4,055 b	23 b	3.5 a
	Standard error	765	5	0.3
1983	Grubbed	223 a	1 a	0.3 a
	Deer	3,278 b	13 ab	2.3 b
	Sheep and deer	3,556 b	8 ab	2.0 b
	Control	4,944 b	17 b	2.6 b
	Standard error	810	3	0.3

[1]For each year, treatment means in each column followed by the same letter do not differ significantly according to a Tukey Test ($\alpha = 0.05$).

***Table 3**—Average density, cover, and height of grass, Cap Allotment, Tahoe National Forest, California, 1983-1991*

Year	Treatment	Density	Cover	Height
		Plants/acre	*pct*	*ft*
1991	Grubbed	13,611 a[1]	0.3 a	2.0 ab
	Deer	3,722 a	0.1 a	1.6 ab
	Sheep and deer	16,944 a	0.3 a	0.9 a
	Control	3,333 a	0.1 a	2.2 b
	Standard error	5,056	0.1	0.3
1989	Grubbed	23,833 a	0.1 a	2.5 a
	Deer	6,817 a	0.1 a	2.2 a
	Sheep and deer	10,378 a	0.1 a	1.5 a
	Control	4,592 a	0.1 a	2.1 a
	Standard error	8,090	0.1	0.5
1986	Grubbed	80,982 a	6.0 a	1.6 a
	Deer	13,222 a	2.0 a	1.9 a
	Sheep and deer	47,629 a	2.0 a	1.2 a
	Control	34,167 a	2.0 a	1.4 a
	Standard error	21,072	1	0.3
1985	Grubbed	35,889 a	6.0 a	1.3 a
	Deer	10,222 a	2.0 a	1.4 a
	Sheep and deer	6,592 a	2.0 a	1.0 a
	Control	44,481 a	3.0 a	0.9 a
	Standard error	39,700	1	0.3
1984	Grubbed	30,666 a	6.0 a	1.6 a
	Deer	109,607 a	19.0 a	1.5 a
	Sheep and deer	34,276 a	5.0 a	1.2 a
	Control	17,666 a	5.0 a	1.2 a
	Standard error	44,733	4	0.1
1983	Grubbed	56 a	–	0.2 a
	Deer	388 a	–	0.7 a
	Sheep and deer	56 a	–	0.4 a
	Control	222 a	–	0.4 a
	Standard error	147	–	0.1

[1]For each year, treatment means in each column followed by the same letter do not differ significantly according to a Tukey Test ($\alpha = 0.05$).

Figure 5—Deerbrush in grazed areas is shorter and has fewer flowers compared to plants in the fenced control.

***Table 4**–Average density, cover, and height of bull thistle, Cap Allotment, Tahoe National Forest, California, 1983-1991*

Year	Treatment	Density	Cover	Height
		Plants/acre	*pct*	*ft*
1991	Grubbed	667	–	0.2
	Deer	0	–	–
	Sheep and deer	778	–	0.3
	Control	0	–	–
	Standard error	–	–	–
1989	Grubbed	111	–	1.5
	Deer	0	–	–
	Sheep and deer	111	–	0.3
	Control	0	–	–
	Standard error	–	–	–
1986	Grubbed	166	–	1.0
	Deer	0	–	–
	Sheep and deer	0	–	–
	Control	0	–	–
	Standard error	–	–	–
1985	Grubbed	1,388 a[1]	3.0 a	1.6 a
	Deer	167 b	0 b	1.2 a
	Sheep and deer	111 b	0.1 b	1.1 a
	Control	0 b	0 b	– a
	Standard error	235	0.3	0.3
1984	Grubbed	5,055 a	5.0 a	2.2 a
	Deer	445 a	0.2 a	1.7 a
	Sheep and deer	4,944 a	2.0 a	1.5 a
	Control	667 a	0.5 a	1.4 a
	Standard error	1,608	1.3	0.3
1983	Grubbed	0	–	–
	Deer	0	–	–
	Sheep and deer	0	–	–
	Control	0	–	–
	Standard error	0	–	–

[1]For each year, treatment means in each column followed by the same letter do not differ significantly according to a Tukey Test ($\alpha = 0.05$).

***Table 5**—Average forb cover, Cap Allotment, Tahoe National Forest, California, 1983-1991*

Year	Treatment	Cover
		pct
1991	Grubbed	4 a[1]
	Deer	1 a
	Sheep and deer	0 a
	Control	2 a
	Standard error	2
1989	Grubbed	7 a[1]
	Deer	1 a
	Sheep and deer	1 a
	Control	2 a
	Standard error	2
1986	Grubbed	7 a
	Deer	3 a
	Sheep and deer	1 a
	Control	6 a
	Standard error	2
1985	Grubbed	8 a
	Deer	2 ab
	Sheep and deer	0 b
	Control	4 ab
	Standard error	2
1984	Grubbed	12 a
	Deer	2 b
	Sheep and deer	3 b
	Control	7 ab
	Standard error	2
1983	Grubbed	6 a
	Deer	5 a
	Sheep and deer	2 a
	Control	2 a
	Standard error	2

[1]For each year, treatment means followed by the same letter do not differ significantly according to a Tukey Test ($\alpha = 0.05$).

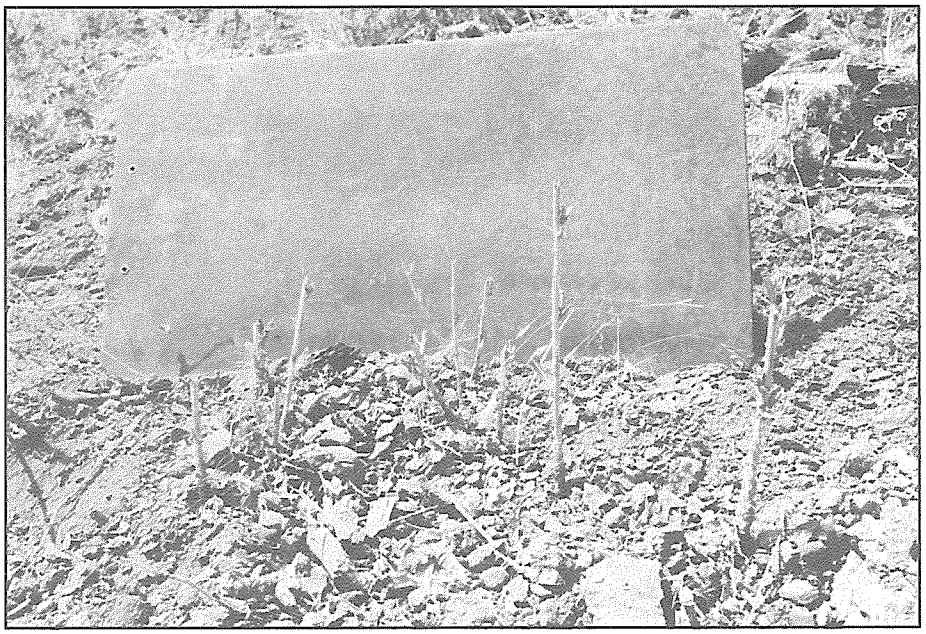


Figure 6—Only stubs of prickly lettuce *(Lactuca serriola)* remain after grazing by sheep and deer.

All Species

Species composition of the study area was influenced mostly by the dominance of ponderosa pine and deerbrush, and to a lesser degree by grazing and grubbing. Grubbing removed one dominant species—deerbrush—and provided site resources for forbs and grasses. Grazing did the same thing, but to a lesser degree. New deerbrush plants emerged from dormant seeds in the soil, and many herbaceous plants became established from wind-blown seeds. Grazing greatly reduced the number and size of several forbs, and was not a vector of alien species into the area. At the end of the study, mean number of shrubs, forbs, and grasses, including ponderosa pine, by treatment, was:

Treatment	Principal Agents	Species
Grubbing	Pines, deerbrush	22
Deer	Pines, deerbrush, deer	18
Grazing	Pines, deerbrush, deer, sheep	20
Control	Pines, deerbrush	11

The effect of treatment was to create an environment characterized by many large pines in grubbed and grazed areas, and by a dense mass of tall, sometimes fallen-over deerbrush plants in deer and control areas. In the latter areas, number of species was a function of the presence or absence of unoccupied or unshaded ground.

Conclusions

The individual treatments comprising this study, applied in an area burned by wildfire, provide a means for portraying plant succession in a natural but protected state (control), after a second disturbance (grubbing), and with and without grazing by sheep and deer. Ecologists, wildlife biologists, vegetation management specialists, ranchers, and others should find the interrelationship of deerbrush, thistles, forbs, and grasses *(tables 2-5)* useful, especially with regard to magnitude and timing of development as modified by grubbing and grazing. The aboveground portion of deerbrush in the control from 1983 through 1991, for example, had decreased by 34 percent in density, but increased by 229 percent in cover and by 154 percent in height.

The treatments also provide insight into the response of ponderosa pine seedlings growing with different amounts of competing vegetation. Comparing results of the grubbed treatment to those of the control shows that removing deerbrush provided site resources for pines and other vegetation. Grasses, bull thistles, and other forbs took advantage of this and increased in numbers and size for various periods of time. The net effect, however, was that pines grew best in this treatment and differed significantly in diameter and cover from counterparts in the control after 9 and 10 years. Pines in the control and in treatments grazed by deer alone or by deer and sheep together grew relatively tall and thin with no significant differences in stem height or diameter among the three treatments. But deerbrush, when grazed by sheep and deer, was reduced significantly (59 percent) in foliar cover relative to the control after 10 years. Because deerbrush grazed by deer alone did not differ significantly from ungrazed deerbrush (control), we concluded that the large reduction in deerbrush cover was caused by the sheep. In spite of the chronic (1985-1991) and significant reduction of deerbrush, diameter and height of pines were not significantly larger. Ten years of grazing had little effect. The most likely reason is that deerbrush remained competitive. Deerbrush root systems were intact and competed directly with pine roots for soil moisture—the limiting resource in this summer-dry climate.

A principal tenet of vegetation management is that, to have value, release must be effective soon after treatment. Because grazing has not demonstrated a significant gain in pine growth after 10 years, and grubbing did not do so until the ninth year, these treatments appear to rank low in the silviculturists' repertory of effective treatments.

Contributions to forestry have occurred, however. The pine seedlings are numerous and growing well, albeit at less than the potential of the site. The sheep have reduced the size of the shrubs, and accessibility has been increased. The sheep have prospered, and on several occasions the owner has expressed satisfaction with the weight gains of his sheep and the high proportion of ewes that produced two lambs. There is a larger picture also. In a world seemingly ever in need of more food and fiber, a simultaneous yield of conifer growth and meat and wool is attractive. It is especially attractive on marginal timberland where dual yields of wood and animal products could make ownership profitable, whereas the yield of each alone would not.

The effect of the sheep on deer was examined in terms of available forage and, specifically, whether differences in vegetation occurred between treatments grazed by deer alone and by sheep and deer. In general, differences in density, cover, and height of deerbrush, grasses, and bull thistles, and cover of forbs did not differ significantly between these treatments—indicating that sheep did not have a deleterious effect on availability of forage for deer.

After 10 years of grazing, the overall condition of the plant community and the range specifically is best described as "good." The combined density of the plant community in grazed areas (including that of pines but not forbs) in 1991 is more than 21,400 plants per acre. Combined foliar cover of pines and grass is more than 84 percent. The distribution of pines and grasses across the landscape is even and that of deerbrush has not changed. Plainly, plenty of plants remain and, if anything, utilization of forage has not been as much as it could have been.

References

Biging, Greg S.; Wensel, Lee C. 1984. **Site index equations for young-growth mixed conifers of northern California**. Res. Note. 8. Berkeley, CA: Department of Forestry and Range Management, University of California; 13 p.

Daubenmire, R.F. 1968. **Plant communities: a textbook on plant synecology**. New York: Harper and Row; 300 p.

Fullmer, Donald G. 1987. **Sheep grazing for plantation release**. A Foresthill Ranger District case study. In: Proceedings, Eighth annual forest vegetation management conference; 1986 November 5-6; Sacramento, CA. Redding, CA: Forest Vegetation Management Conference; 149-163.

Hall, F.C.; Hedrick, D.W.; Keniston, R.F. 1959. **Grazing and Douglas-fir establishment in the Oregon white oak type**. Journal of Forestry 57(2): 98-103.

Hill, Robert R. 1917. **Effects of grazing upon western yellow-pine reproduction in the national forests of Arizona and New Mexico**. Bulletin 580. Washington, DC: Forest Service, U.S. Department of Agriculture; 27 p.

Logan, Robert S. 1983. **Agro-forestry: growing trees, forage, and livestock together**. Extension Circular 1114. Corvallis: Oregon State Univ.; 4 p.

McDonald, Philip M. 1982. **Pest vegetation problems in ponderosa pine management**. In: Executive summaries of the proceedings of the 1981 western forestry conference; 1981 December 1-3; Sun Valley, ID. Portland, OR: Western Forestry and Conservation Association; p. 45.

McDonald, Philip M.; Fiddler, Gary O. 1986. **Weed treatment strategies to control losses in ponderosa pine plantations**. In: Helgerson, O.T., ed. Proceedings of a workshop on forest pest management in southwest Oregon; 1985 August 19-20; Grants Pass, OR. Corvallis: Forest Research Laboratory, Oregon State Univ.; 47-53.

Newton, Michael; Preest, David S. 1988. **Growth and water relations of Douglas-fir *(Pseudotsuga menziesii)* seedlings under different weed control regimes**. Weed Science 36: 653-662.

Oregon State University. 1983. ***Foothills for food and forests***. In: Hannaway, D.B., ed. Proceedings of an international symposium; 1983 April 25; Corvallis, OR. College of Agriculture Science. 2, Oregon State Univ. Beaverton, OR: Timber Press; 383 p.

Ritters, Kurt; Brodie, J. Douglas; Hann, David W. 1982. **Dynamic programming for optimization of timber production and grazing in ponderosa pine**. Forest Science 28(3): 517-526.

Severson, Kieth E.; May, M. 1967. **Food preferences of antelope and domestic sheep in Wyoming's Red Desert**. Journal of Range Management 20: 21-25.

Sharrow, Steven H.; Leininger, Wayne C. 1983. **Forage preferences of herded sheep as related to brush control and seasonal browsing damage to Douglas-fir regeneration**. In: Progress Report 1981-1982. Project Number 0066. Corvallis: Oregon Agricultural Experiment Station; 42 p.

Sharrow, Steven H.; Rhodes, Bruce. 1983. **The effect of grazing sheep on clearcuts in Oregon's Coast Range and its impact on big game habitat**. In: Progress Report 1981-1982. Project Number 0066. Corvallis: Oregon Agricultural Experiment Station; 42 p.

Smith, Michael A.; Malachek, John C.; Fulgham, Kenneth O. 1979. **Forage selection by mule deer on winter range grazed by sheep in spring**. Journal of Range Management 32: 40-45.

Thomas, David F. 1984. **The use of sheep to control competing vegetation in conifer plantations**. In: Proceedings Fifth Annual Forest Vegetation Management Conference; 1983 November 2-3; Sacramento, CA. Redding, CA: Forest Vegetation Management Conference; 138-143.

Winward, A.H.; Rudeen, David P. 1980. **Sheep and deer grazing on lodgepole pine plantations**. In: Research in rangeland management. Oregon State Univ. Special Report 586. Corvallis: Oregon State Univ. Agricultural Experiment Station; 22-24.

The Forest Service, U.S. Department of Agriculture, is responsible for Federal leadership in forestry. It carries out this role through four main activities:

- Protection and management of resources on 191 million acres of National Forest System lands
- Cooperation with State and local governments, forest industries, and private landowners to help protect and manage non-Federal forest and associated range and watershed lands
- Participation with other agencies in human resource and community assistance programs to improve living conditions in rural areas
- Research on all aspects of forestry, rangeland management, and forest resources utilization.

The Pacific Southwest Research Station

- Represents the research branch of the Forest Service in California, Hawaii, American Samoa and the western Pacific.

United States
Department of
Agriculture

Forest Service

**Pacific Southwest
Research Station**

Research Paper
PSW-RP-215

Vegetative Trends in a Young Conifer Plantation After 10 Years of Grazing by Sheep