Sheep grazing as a silvicultural tool to suppress brush

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Abstract

The possibility of using livestock as a biological agent to control unwanted ground vegetation in Pacific Northwest coniferous forests has been discussed for over 50 years. However, little quantitative information has yet been published documenting the efficacy of livestock in suppressing brush and other ground vegetation in commercial Douglas-fir *(Pseudotsuga menziesii)* plantations. Therefore, a study was conducted in 1981 and 1982 to evaluate the potential for using herded sheep to control competing vegetation in Douglas-fir plantations in Pacific Northwest coniferous forests. Three 4- to 6-year-old plantations were grazed once each year during the May to September grazing season. Estimates of current year's growth present in October, both inside and outside a livestock exclosure on each study plantation, were used to evaluate the effects of grazing. In general, utilization of brush by sheep was moderate to heavy, except in the spring of 1982, when brush was lightly utilized. Sheep grazing effectively reduced ($p<0.01$) both total understory plant growth and brush net current year's growth on all plantations. Reduced brush biomass on grazed areas was associated with greater Douglas-fir diameter growth in 1981–82 and 1982–83. By 1985, trees in grazed areas were 5% taller ($p<0.05$) and 7% greater in diameter ($p<0.01$) compared to ungrazed controls. Our data and observations suggest that sheep may be effectively used as a biological control agent for brush control in coastal Douglas-fir forests.

Key Words: biological control, Douglas fir, forest grazing, agroforestry

A major problem in establishing and maintaining conifer plantations in the Pacific Northwest is the control of competing vegetation (Newton 1964, Cleary 1978, Stewart et al. 1984). The main target species for brush suppression in Pacific Northwest coniferous forests include red alder *(Alnus rubra)*, thimbleberry *(Rubus parviflorus)*, salmonberry *(Rubus spectabilis)*, and vine maple *(Acer circinatum)*. Interest in controlling unwanted vegetation using biological agents has risen in recent years because of the economic and environmental benefits of such programs (Hedrick 1975). In the past, insects have generally received the most attention as possible biological control agents. However, prescribed grazing with domestic livestock has recently gained considerable attention (Sharrow and Mosher 1982, Kosco and Bartolome 1983, Wood 1987, Brock 1988) as a method of suppressing unwanted vegetation. Sheep grazing has been proposed as a silvicultural tool to suppress brush in Douglas-fir plantations in Oregon's Coast Range (Sharrow and Leininger 1983).

An advantage of properly controlled livestock grazing over other mechanical or chemical control methods is that unwanted vegetation may be removed while simultaneously producing marketable animal products (Sharrow and Leininger 1983). However, in order for livestock to be successful as biological agents, 2 conditions must be met: (1) Livestock must utilize unwanted target vegetation, but not significantly damage the commercially valuable crop, and (2) target species must not regrow substantially following defoliation.

The purpose of this study was to evaluate the potential for using herded sheep as a biological control agent to suppress brush in Douglas-fir plantations.

Methods

The study was conducted approximately 15 km west of Alsea, Oregon. The maritime climate is typified by cool, moist winters and warm, dry summers. Most of the approximately 250 cm of precipitation falls as low intensity rain from October through May (Corliss 1973). Elevation of the study areas ranges from 75 to 450 m. Soils are described by Corliss (1973) as slickrock gravelly loams (Pachic Haplumbrept).

Three 4- to 6-year-old Douglas-fir plantations in the Alsea Ranger District, Siuslaw National Forest, were selected for study. Study sites were restricted to plantations having the vine maple *(Acer circinatum)*—sword fern *(Polystichum munitum)* plant community because it is the most extensive plant community in the Alsea District (Corliss and Dyrness 1965).

A band of 700 ewes with lambs and a band of 900 dry ewes grazed the forest in 1981 and 1982, respectively. The grazing season was from May to September both years. Stocking rate averaged 5.8 ha/band day and 6.2 ha/band day in 1981 and 1982, respectively. Each year, a series of plantations, ranging in size from 10 to 40 ha, was grazed according to a predetermined schedule. Within this schedule, one study plantation was grazed in May, one in July, and one in August.

A 30 m by 30-m livestock exclosure was established on each study plantation prior to grazing. These exclosures served as reference areas and allowed observations and comparisons to be made on adjacent areas which had been grazed and ungrazed by livestock. Exclosures were constructed of 0.8 m high woven wire which allowed wildlife continued access to the exclosed areas. The effect of sheep-grazing on tree growth was evaluated by comparing measurements of tree height and diameter for 100 permanently "tagged" trees within the exclosure to those of 100 adjacent trees in the grazed region of each study plantation. Height and diameter measurements were taken using a graduated pole and caliper, respectively, each year immediately prior to sheep grazing in 1981 and 1982, in summer 1982, and in fall 1985.

Available phytomass and the amount utilized by sheep were determined using the "before and after" technique (Cassady 1941). Current year's growth for all plant species, except vine maple, was estimated by plot-harvest of 10 pairs of randomly located 0.45-m^2 quadrats in each of three 0.05-ha macro-plots per plantation. One quadrat of each pair was randomly selected and clipped prior to grazing, while the other was marked and harvested immediately after sheep left the plantation. Current year's growth was separated by species, oven-dried for 48 hrs at 50° C, then weighed.

Current year's growth and utilization of vine maple were determined using the following methods. Ten vine maple shrubs were randomly selected within each replication prior to grazing. Four branches from each plant were chosen and the available current

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year's growth on 2 randomly selected branches clipped, oven-dried, and weighed. The other 2 branches were marked and treated similarly following grazing. The number of branches on each defoliated vine maple was determined along with the density of vine maple in each replication. Foliage more than 1.5 m above the soil surface was not sampled, as it was considered to be above the reach of sheep (Ingram 1931) and therefore not available for grazing.

Above-ground current year's phytomass present at the end of the growing season on grazed and ungrazed areas was used as an estimate of net phytomass production each year. Sixteen 0.45-m^2 randomly selected quadrats were harvested both inside and outside the exclosure on each study plantation. These samples were oven-dried for 48 hr at 50° C and weighed.

The effect of grazing on net growth of vine maple was evaluated by collecting 20 randomly selected vine maple branches from inside and outside the exclosures in October each year. The current year's growth below 1.5 m was removed from each branch, oven-dried, and weighed. Conversion to kg/ha was made by multiplying biomass per stem times corresponding estimates of the number of vine maple branches per hectare, calculated during the previous sampling.

Data were analyzed as a split plot in time, with grazing as main plots, year as subplots, and plantations as replications in a randomized block design. Differences were tested for significance at the 90% confidence level.

Results and Discussion

Utilization of brush by sheep varied between 1981 and 1982 (Table 1). In 1981, brush received relatively heavy utilization throughout the grazing season. In 1982, sheep browsed brush lightly in the spring, then increased their consumption of brush during July and August. A possible explanation is that sheep began grazing in 1982 when brush species were at an earlier phenological state than in 1981 due to cooler temperatures and more rainfall during the spring of 1982. Evidently, the earlier phenological state of brush in 1982 resulted in brush being less preferred by sheep than in 1981. In addition, the 2 different bands of sheep may have expressed different preferences for brush based on different past histories and experience in grazing species similar to those found in the study sites (Knowles et al. 1973, Gillingham et al. 1976).

Table 1. Current year's growth (kg/ha) of major brush species available to (A) and utilized by (U) sheep on the three study plantations[1].

		Plantation 1		Plantation 2		Plantation 3	
Year	Species	A	U	A	U	A	U
1981	*Acer circinatum*	112	75	55	44	286	120
	Rubus parviflorus	86	33	77	54	47	28
	Rubus spectabilis	14	7	26	9	0	0
	Rubus ursinus	19	17	59	38	14	0
	Subtotal	231	132	217	145	347	148
1982	*Acer circinatum*	106	4	69	31	244	91
	Rubus parviflorus	49	6	89	13	29	13
	Rubus spectabilis	8	0	34	8	9	4
	Rubus ursinus	14	0	77	10	23	10
	Subtotal	117	10	269	62	305	118

[1]Plantations 1, 2 and 3 were grazed in May, July and August, respectively.

The grazing-by-year interaction was not significant ($P>0.10$) for any parameter tested. Therefore, discussion will be limited to the main effects of year and grazing. Neither total net phytomass production nor its components varied ($P<0.10$) between years (Table 2). Approximately 18, 36, and 46% of the October phytomass standing crop was contributed by graminoids (predominantly *Agrostis* spp. and *Holcus lanatus)*, forbs (predominantly *Senecio jacobaea* and *Anaphalis margaritacea)*, and brush, respectively. Sheep grazing reduced total net plant growth by approximately 43% in grazed compared to ungrazed areas. While grazing reduced the annual net growth of forbs by 47% and brush by 56% on grazed compared to ungrazed areas, it had little impact upon graminoids. Presumably, this differential response to grazing reflects a higher ability of grasses to regrow following defoliation than was exhibited by either forbs or browse plants. Grasses on our plantations began to replace tissue lost to defoliation soon after sheep left the plantation. Forbs, which had to activate new buds to initiate growth, were noticeably slower to regrow than were the grasses. Interestingly, shrubs made little or no regrowth following sheep grazing. Many shrubs found in the Coastal Coniferous Forest contain tannins or other compounds which discourage herbivory (Li 1974). The growth strategy of these shrubs appears to be one of investment to avoid herbivory rather than in mechanisms to tolerate herbivory through rapid regrowth following grazing. Our results are in general agreement with other studies which indicate that both cattle (Kosco and Bartolome 1983) and sheep (Hall et al. 1959, McKinnell 1975) may be effectively used to control ground vegetation in coniferous forest plantations.

Table 2. Components of current year's phytomass (kg/ha) present on grazed (G) and ungrazed (U) plantations in October 1981 and 1982.

	Year		Grazing		
Item	1981	1982	G		U
Total Biomass	1418	1600	1096	*	1922
Graminoids	242	316	299		260
Forbs	566	510	374	+	702
Brush	610	772	422	+	960

+,*Years or grazed and ungrazed differ, $p<0.10$ and $p<0.05$, respectively.

The amount of annual net brush growth in the study plantations almost doubled during the 1981 to 1982 period, regardless of grazing treatment (Table 3). Vine maple and the early seral, erect-growing *Rubus* species, thimbleberry, and salmonberry each produced approximately 70–80 kg/ha more phytomass in 1982 than in 1981. Nevertheless, total net brush growth on grazed areas was less than half that on ungrazed areas each year. Net growth of vine maple, thimbleberry, and trailing blackberry *(Rubus ursinus)* on grazed areas was only 51, 32, and 51% of that on ungrazed areas.

Table 3. Mean October current year's phytomass (kg/ha) of major brush species present in grazed (G) and ungrazed (U) plantations during 1981 and 1982.

	Year			Grazing		
Item	1981		1982	G		U
Acer circinatum	88	+	165	86	+	168
Rubus parviflorus	147		218	88	+	278
Rubus spectabilis	13	*	88	44		57
Rubus ursinus	78	*	122	68	*	133
Subtotal	328	+	594	285	*	637

+,*Years or grazed and ungrazed differ, $p<0.10$ and $p<0.05$, respectively.

Sheep grazing did not reduce net annual growth of salmonberry. However, due to the relatively small amount of salmonberry on the study sites, the effect of sheep grazing on this important brush species may not have been adequately assessed.

Tree growth is the best single silvicultural indicator of the efficacy of brush control for commercial timber production. Reduced brush biomass on grazed portions of plantations was consistently associated with greater ($P<0.05$) diameter growth of Douglas-fir trees (Table 4). However, grazing had little impact on tree height

Table 4. Height and diameter growth during 1981–82 and 1982–83 and absolute height and diameter (DBH) in 1985 of Douglas-fir trees from grazed and ungrazed plantations.

Height (cm)	Grazed	Ungrazed	% Difference
1981–82	87.7	87.3	0.4
1982-83	96.4	95.3	1.1
1985	591	564	4.8*
Diameter (mm)			
1981–82	15.7	14.2	10.6*
1982–83	16.6	14.3	16.1**
1985	81.2	76.2	6.6**

+,*,**Grazed and ungrazed differ, $P<0.10$, $P<0.05$ and $P<0.01$, respectively.

during the first 2 years of the study. The immediate positive response of diameter growth to grazing compared to the apparent unresponsiveness of height growth may be related to differences in the nature and timing of cambial and leader growth in Douglas-fir. Leader growth is initiated early in the spring and its potential is related to the number of cells set in the bud which was formed the previous growing season. Cambial growth is indeterminant and occurs whenever growing conditions permit. Emmingham (1977) reported that Douglas-fir leader elongation ended by late July in areas similar to our study sites. In contrast, he observed that cambial growth continued on until October. Light, soil moisture, soil nutrients, and other site resources which may become available for tree growth as a result of our spring-summer grazing treatments would likely be concentrated in the post-spring period when cambial growth is predominant.

By 1985, three growing seasons after grazing treatments ceased, trees in grazed plantations were approximately 5% taller ($P<0.05$) and 7% greater ($P<0.01$) in diameter (DBH) than were trees in ungrazed controls.

Our data suggest that livestock can be effective in suppressing brush on Douglas-fir plantations in Oregon's Coast Range. Properly controlled sheep grazing can be a useful silvicultural tool in managing young plantations and merits serious consideration in the future.

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SRM Election Results

The Elections Committee Chairman, Debra Sherman, along with several other Colorado Section members, counted the ballots for new officers on Friday, December 9, 1988, at the Society for Range Management headquarters. Elected officers are:

Second Vice President—**Stan Tixier**

Directors (1989-1991)—**Charles E. Jordan** and **Phillip L. Sims**

Directors Jordan and Sims will replace retiring Directors Donart and Welch in February 1989.

Ballots and tally sheets are retained in the Denver office for one year for review. Approximately 30% of the membership voted.