Effects of Clipping on Some Range Shrubs

GEORGE A. GARRISON

Range Conservationist (Research), Pacific Northwest Forest and Range Experiment Station, U. S. Forest Service, Portland, Oregon

ONE of the primary objectives in big game management is to keep game numbers in balance with the forage supply. If an area is supporting less game than the available feed will permit, game managers have a chance to meet demands for game abundance. If the animals are too numerous for the forage supply, a planned reduction of herd size is needed to prevent wasteful reduction in numbers by starvation and disease and, in the long run, serious damage or destruction of the game habitat.

Balancing game animals with their food supply has been difficult, however, because little is known about the amount of grazing that important forage plants can withstand, yet maintain themselves in a healthy, productive condition. Signs of a depleted shrub or browse supply for big game are obvious, but indications of use levels that permit sustained production are not known for many important shrubs.

This article presents the results of clipping studies in eastern Oregon and Washington seeking information on the resistance of five commonly browsed shrubs to various intensities of twig removal. Use of this knowledge in connection with utilization checks should help range administrators and grazing managers keep informed on the status of the game-forage supply.

Of the numerous woody species browsed by big game and range livestock, results of clipping experiments have only been reported for a relatively few species. Utilization studies and clipping projects on the Kaibab National Forest (Julander, 1937) have provided information on some effects of twig removal and on the desirable level of use for quaking aspen (*Populus tremuloides*) and Stansbury cliffrose (*Cowania stansburiana*). A study in northern Idaho (Young and Payne, 1948) provided similar information for redstem ceanothus (*Ceanothus sanguineus*), Saskatoon serviceberry (*Amelanchier alnifolia*), Utah honeysuckle (*Lonicera utahensis*), and rose (*Rosa* spp.). In these two studies, growth or production was determined by measuring twig length prior to each annual clipping. Effects of clipping on white cedar (*Thuja occidentalis*) and nine hardwoods of the Lake States have also been reported (Aldous, 1952). Trends in production (green weight) and sum of harvested twig lengths were the primary observations reported for mountain maple (*Acer spicatum*), white birch (*Betula alba* var. *papyrifera*), beaked hazelnut (*Corylus cornuta*), mountain ash (*Sorbus americanus*), redosier dogwood (*Cornus stolonifera*), willow (*Salix* spp.), black ash (*Fraxinus nigra*), red-berried elder (*Sambucus racemosa*), and pin cherry (*Prunus pennsylvanica*).

The present study was started in 1945 by the U. S. Forest Service. The objective was to determine the optimum intensity of clipping for five important shrubs: antelope bitterbrush (*Purshia tridentata*), snowbrush ceanothus (*Ceanothus velutinus*), rubber rabbitbrush (*Chrysotham-*

nus nauseosus), creambush rockspirea (*Holodiscus discolor*), and curlleaf mountainmahogany (*Cercocarpus ledifolius*).

Methods of Study

One-quarter acre game-proof exclosures, each containing one of the five species to be studied, were established on the Fremont, Malheur, and Whitman National Forests in Oregon, and the Snoqualmie National Forest in Washington. Each shrub species was studied in from two to five different locations. For all species except curlleaf mountainmahogany, 15 shrubs were selected per exclosure and three plants assigned to each of five treatments, including four intensities of clipping current twig growth, and an unclipped group. Clipping treatments consisted of 25 percent harvest (lightly clipped), 50 percent harvest (moderately clipped), 75 percent harvest (heavily clipped), and 100 percent harvest (completely clipped). The assigned intensity of annual harvest for any plant was applied to every twig except for the 25 percent harvest. This treatment was performed by clipping 50 percent from only every other twig. Selected shrubs in each exclosure were clipped for at least four successive years; however, those in some exclosures were harvested five times and certain individual plants were clipped seven times.

Curlleaf mountainmahogany, because of its tendency to become treelike, received somewhat different treatments from the other four shrub species. Ordinarily, only twig growth up to about 54 inches from the ground is considered available for deer use, so twig clipping was confined here. All three types of harvest consisted of complete twig removal in this "pruning zone", but differed as to frequency of clipping. Three plants were clipped in the first and fourth years of the study; three in the first, second, and fourth years; and three in all four years. A fourth group was left unclipped.

Every species studied was clipped either in the fall, mid-, or late-winter, and the season of harvest assigned each exclosure was used throughout the study. Thus, interference with carbohydrate storage was minimized. Dates of clipping coincided with the time that adjoining ranges were ordinarily used by deer or elk.

Individual plant measurements included air-dry weights of twigs harvested and average twig length computed from a sample of 40 to 100 twigs per shrub which were measured prior to clipping. Notes were made of flowering vigor, general condition, and growth habit. Photographs were made of typical plants in each clipping intensity group. Total yields for shrubs subjected to less than 100 percent clipping were calculated by use of coefficients developed for each species and clipping intensity. The coefficients also took into account differences in weight among various portions of the twigs, due to such things as twig taper. To compute total yield of, for example, a moderately (50 percent) clipped plant of rabbitbrush, the weight of the harvested material was multiplied by the coefficient 2.36. Yield data for three intensities of clipping were of this nature, except for the fifth observation on snowbrush ceanothus plots. Yields in this instance were obtained by 100 percent harvests for all treatment classes; consequently, no adjustments of twig weights were necessary.

Despite an attempt to select shrubs in each exclosure for uniformity of size and condition, there was considerable variation in initial harvest weight in some exclosures. Consequently, in the statistical analysis of the weight data, covariance methods (Pechanec, 1941, and

Snedecor, 1946) were used. This procedure was valuable in adjusting final mean yields for variability of initial mean yields. The method is valid except where initial variability of plants is so great that their growth and response to clipping is dissimilar. Situations of this nature can be exposed by tests of homogeneity of regression coefficients and of variances (Snedecor, 1946).

Results

The general procedure of using clipping treatments and harvested twig weights to study the resistance of shrubs as reported in a previous article (Garrison, 1952). Results presented here are from exclosures that escaped damage, or were least affected by these attacks.

Antelope Bitterbrush

In two exclosures, bitterbrush twig yields at the fourth and fifth annual harvests were greater under the moderate intensity of clipping than any other intensity; in the third exclosure, heavily clipped plants gave the greatest yield (Table 1).

Moderate clipping in all bitterbrush exclosures induced development of twig

TABLE 1

Adjusted mean twig yields (air-dry weight) under different intensities of clipping at fourth or fifth harvest

CLIPPING INTENSITY, PERCENT	ANTELOPE BITTERBRUSH EXCLOSURE			SNOWBRUSH CEANOTHUS EXCLOSURE		RUBBER RABBITBRUSH EXCLOSURE		CREAMBUSH ROCKSPIREA EXCLOSURE	
	1	2	3	1	2	1	2	1	2
	Grams			*Grams*		*Grams*		*Grams*	
25	15	45	24	646	422	57	128	30	98
50	48	75	33	486	434	64	176	156	167
75	13	58	52	284	194	91	239	173	129
100	21	52	47	292	322	43	200	166	234
Number of harvests	5	4	4	5	5	5	4	4	4
Probability level, percent*	1	50	30	1	5	20	30	40	30

* Probability level of one percent signifies the odds are 99:1 that differences in yields were due to clipping intensities rather than chance. Odds are 19:1 for five percent level, 4:1 for 20 percent, 1:1 for 50 percent.

under various degrees of twig removal was found to be workable and soundly conceived. Nature of twig growth and presence of dead material were useful indicators of a plant's ability to sustain production at each intensity of clipping. Photographs were a useful aid in recording some qualitative results, for it was sometimes difficult to adequately describe growth characteristics.

Not all exclosures were carried through to a satisfactory completion because insects or rodents damaged some shrubs, and crown characteristics intermediate to those of lightly and completely clipped plants. Plants moderately clipped made some height growth, and they were stimulated to produce twigs from lateral buds remaining on the clipped twigs. The abundance of twigs formed full, productive-looking crowns. Twig growth tended to be arranged in broom-like masses, but not conspicuously so because of their close spacing.

Main stems of unclipped and lightly clipped plants had grown taller by the

end of the study, but supported relatively few and short twigs (Table 2). Most of their leaves were borne on tiny spurs which studded the long, ascending stems and branches. Thus, unclipped and lightly clipped plants produced open, graceful crowns (Fig. 1), but generally the least amount of forage.

clipping intensities consisted of definite broom-like clusters of twigs (Fig. 2—*Left*). These brooms were quite prominent because of their wide spacing and knot or fist of dead stubs, visible in the heart of each twig cluster. Amount of dead material gradually increased in the crowns of these heavily and completely clipped

TABLE 2

Average twig lengths of treatment classes at fourth or fifth observation

CLIPPING INTENSITY, PERCENT	ANTELOPE BITTERBRUSH EXCLOSURE			SNOWBRUSH CEANOTHUS EXCLOSURE		RUBBER RABBITBRUSH EXCLOSURE		CREAMBUSH ROCKSPIREA EXCLOSURE	
	1	2	3	1	2	1	2	1	2
	Inches			*Inches*		*Inches*		*Inches*	
0	1.6	2.6	1.7	3.5	2.5	7.2	10.8	6.3	4.7
25	1.7	3.4	2.1	4.2	2.4	5.4	10.0	5.6	5.2
50	1.7	3.6	2.1	3.5	3.4	8.2	11.7	7.0	5.6
75	1.6	4.5	3.3	4.1	2.7	6.8	13.5	6.9	7.4
100	2.2	4.2	3.2	4.2	3.4	7.3	12.8	7.2	8.0
Number of harvests.....	5	4	4	5	5	5	4	4	4

FIGURE 1. No browsing or clipping of this antelope bitterbrush plant for four years resulted in a shrub with an open crown and little current twig growth. Most of the leaves are borne in tiny clusters or "spurs" on old wood. Witness stake in this and following photographs is graduated in 6-inch units.

In the first two bitterbrush exclosures, heavy and complete clipping practically prevented height growth. By the fourth harvest, crowns of plants under these

plants, and after the fourth harvest it commonly amounted to 10 to 20 percent of heavily clipped plant crowns and 20 to 50 percent of the crowns of completely clipped plants. Mortality in upper portions of completely clipped plants was accompanied by production of several long twigs on the basal portions of stems. Vigor of these plants continued to decline; yet, by the seventh harvest only one plant had died.

Site of the third exclosure was more favorable to bitterbrush than the other two locations. Here, heavy and complete clipping did not produce such acute indications of degeneration as occurred in the other two exclosures. On the contrary, plants in these groups produced such an abundance of long twigs that they had a pin cushion appearance (Fig. 2—*Right*). Although there were no gains in height, there was no dead material in crowns of heavily clipped plants and under complete clipping the dead material amounted

to no more than 10 percent of each shrub crown after the fourth harvest.

Snowbrush Ceanothus

Lightly and moderately clipped snowbrush at the fifth annual harvest had higher twig yields than any other group (Table 1). Twig yields of the lightly and moderately clipped groups did not differ significantly from each other. Both groups of plants had an abundance of foliage, and neither contained any dead branches. In height and general appearance, however, plants under these two types of clipping did differ from each other. Lightly clipped plants were taller at the end of four years, and their crowns more open near the ground than the moderately clipped plants.

Unclipped plants became the tallest and bore a rather sparse amount of foliage at the ends of their long, erect stems. Outer portions of these stems were usually unbranched, and the annual growth of their tips was short (Table 2). The sparseness of branching and foliage gave the unclipped plants an open, stemmy appearance.

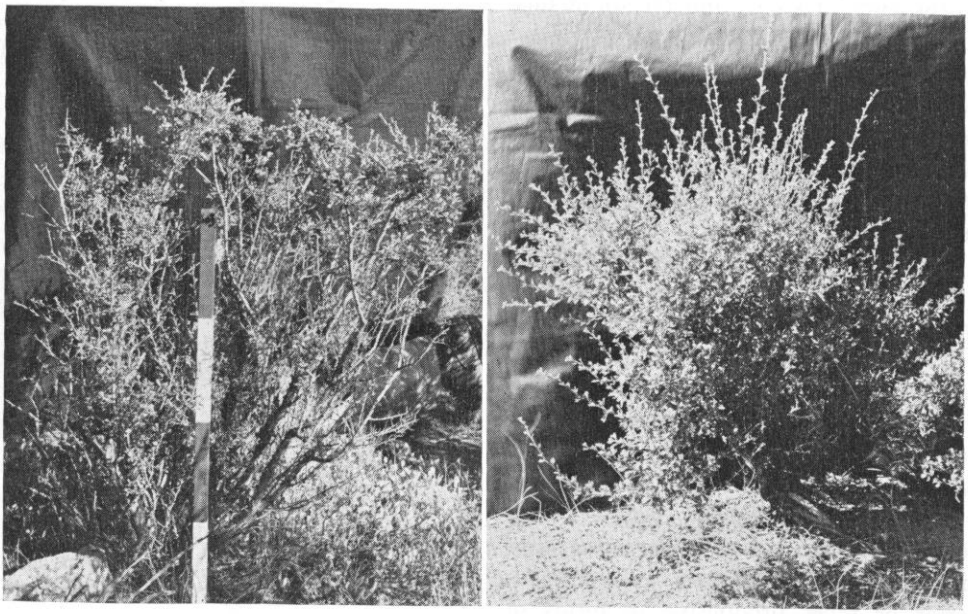

FIGURE 2. EFFECTS OF COMPLETE REMOVAL OF CURRENT TWIG GROWTH
Left—This plant of antelope bitterbrush growing on a rather dry bitterbrush site has had complete removal of current twig growth for four years. About 30 per cent of the wood in its crown is dead. *Right*—Growing on a rather favorable site, this antelope bitterbrush plant produced an abundance of twigs, even though it also had all current twigs clipped off for four years. Although not apparent in the photograph, about 10 per cent of old crown portions are dead.

Heavily and completely clipped plants made no gains in height; instead, they developed branched, scraggly crowns. After the fourth harvest, as much as 20 percent of each crown of the heavily clipped plants died. Even more dead material was observed in the crowns of completely clipped plants; fifty percent of one crown had died. The seventh annual harvest of completely clipped plants killed practically all the original crown; yet, the following season these plants managed to produce a few small shoots near stem bases.

Rubber Rabbitbrush

Greatest twig yields of rubber rabbitbrush at the fourth or fifth annual harvest were obtained from heavily clipped plants (Table 1). By the fourth harvest, crowns of these plants were composed of a combination of broom-like twig growth on the ends of stems and an abundance of long, new shoots (Table 2), produced along the sides of old stems whose upper ends had died back. This dieback commonly amounted to 40 percent of the old crown after the fourth harvest, and only twigs of average length were then produced.

Moderately clipped plants produced well. Their crowns consisted of healthy-appearing twig brooms and only a small amount of dead material. Seven annual harvests were carried out for one plant in the moderately clipped group. Its productivity was maintained during the years of the study.

Unclipped and lightly clipped plants grew taller than plants under other clipping intensities, but they were not superior or most productive in terms of average twig lengths and twig yields.

Completely clipped plants were among the less productive ones at the fourth and fifth harvests. Most of the terminal parts of the old crown died after the fourth clipping, and 70 to 80 percent of current growth of completely clipped plants was from lower portions of old wood. Following the seventh annual harvest of this group, most of the old crown parts died, and all twig growth originated from root crowns or from lower portions of old stems.

Creambush Rockspirea

Production of rockspirea (or oceanspray) was greatest for heavily clipped plants in the first exclosure (Table 1). In the second exclosure, the completely clipped plants were the most productive. Neither group of plants formed broom-like clusters that were as dense and productive-appearing as those of other shrub species, and after the fourth harvest some of this terminal twig growth was dead. Much of the new growth was in the form of long, unbranched water sprouts or suckers, originating at various places along the sides of old stems and branches. Some of the suckers attained a length of 36 inches in one season.

Current twig production of moderately clipped plants was also a combination of terminal twig growth and some suckering. Thus, average twig length was generally greatest for moderately or more heavily clipped plants (Table 2). Moderately clipped plants differed from the more heavily clipped plants with respect to vigor; there were no dead portions in the crowns.

Lightly clipped plants had the lowest yields of the clipped rockspirea plants at the fourth harvest. Tips of their stems resembled unclipped plants for they had only a little branching. There were only a few suckers.

Curlleaf Mountainmahogany

Stature and twig harvest of this half-tree, half-shrub were greatly different from the other shrubs studied, and these conditions resulted in a radically different response to clipping. After the first year's harvest of twigs in just the 0 to 4½ foot zone, very little twig growth reoccurred here. Production in the clipped zone diminished with each additional clipping. A rest of one or two years between harvests was of almost no benefit in restoring production in the clipped zone (Table 3). Response of this species was about the same as that of a tree to thorough pruning of lower branches, in that the first complete twig harvest was the greatest yield for the pruned zone and only a few small shoots were produced

thereafter from tiny unclipped spurs on the trunk or main stems.

Some small plants of this species whose entire crowns were within reach of big game were later found on open range and examined. It appeared these plants were responding to grazing much like antelope bitterbrush, and that perhaps a moderate annual harvest would foster the highest productivity.

TABLE 3

Average twig yields (air-dry weight) of curlleaf mountainmahogany from that portion of the shrub between the ground and 4½ feet in height, 1945–1948

FREQUENCY OF COMPLETE HARVEST	1945	1946	1947	1948
	Grams			
First and last years	215	—	—	11
First, second, and fourth years	285	43	—	5
All four years	177	35	9	1
Probability level, percent.				5

Flower Production

Although only rather subjective ratings were made of flower production, some evidence of a general relationship between clipping intensity and flower production was found. Moderate or heavier clipping suppressed flowering of antelope bitterbrush, snowbrush ceanothus, and creambush rockspirea. Flowering of rubber rabbitbrush was only suppressed by heavy and complete clipping intensities. Curlleaf mountainmahogany produced flowers only on the upper, unclipped branches.

Discussion

All species were stimulated to greater productivity when many or all twig ends were clipped off once a year during the inactive growth period. In general, removal of a terminal bud resulted in the production of two or more new twigs the next growing season from lateral dormant buds beneath the cut end. This phenomenon has been commonly observed by those interested in horticulture or plant physiology. Practical use is made of this response when ornamental shrubs are "headed-in" (Bailey, 1943, pp. 2,819–2,820). In many plants the terminal bud of a main stem or stems apparently has an inhibiting effect upon lateral bud development. Release of lateral dormant buds from this apical dominance can be done by destroying or injuring the terminal bud. If the bark has not become too hard or thick, dormant buds can, upon release, produce shoots even from the basal portions of stems. These growth correlations are usually explained by physiologists in terms of a hormonal mechanism (Meyer and Anderson, 1939, Chapter 34). The inability of highlined mountainmahogany to produce regrowth on the lower part of the plant probably illustrates the inhibiting effect of terminal leaders when they are out of reach and ungrazed.

Spectacular as terminal twig removal may be in stimulating shrubs to greater twig production, the study results surely have shown that twig harvesting can become a devitalizing process if carried on at too great an intensity for too long a time. Many shrubs in good condition when subjected to high intensity of winter grazing or clipping may not show evidence of serious degeneration for a few years. This capacity of certain shrubs to withstand some abuse is important, for unavoidable overgrazing may occur during a year of low twig production or before proper harvest can be obtained of browse-eating big game.

It should also be remembered that despite increases in twig production with some use, cropping off twigs interferes with flower and seed production for two reasons. First, some shrubs produce

flowers only on the previous season's twigs or older growth, as is the case with bitterbrush and mountainmahogany, and clipping at any season tends to reduce numbers of potential flowers in proportion to amount of twig growth removed. Then there is the influence of clipping on flower and fruit production through its effects on food relations of plant parts, a situation probably common to all grazed or pruned shrubs. Physiologists and horticulturists have long recognized that the profusion of vegetative growth, brought about by moderate to excessive pruning, will monopolize most of the available carbohydrates to the detriment of flower and fruit production (Gourley and Howlett, 1941, Chapter 3). Some degrees of carbohydrate deficiency may permit growth of flowers, but many of the flowers may be sterile.

Conclusions

Growth characteristics and indications of degeneration which showed up during the course of the study must be considered along with production data, in any attempt to interpret study results as suggestions of grazing use levels that can be sustained without damaging the shrubs. In all contemplated uses of the study results, another item to remember is that information presented here should only be applied to fall and winter ranges. Understanding these things, some useful conclusions are possible.

Antelope bitterbrush was most productive under the 75 percent clip on a site with favorable soil moisture conditions, yet this treatment prevented height growth. It is logical to assume that a 60 to 65 percent level of use would be a better recommendation for this shrub on best sites. Under less favorable site conditions, 50 percent twig removal provided best production and this level of use probably can be suggested for the drier bitterbrush sites.

For snowbrush ceanothus, the 25 and 50 percent twig harvests were about equally productive; however, this species is evergreen and a carryover of considerable numbers of leaves from summer to summer is probably necessary to the plant's well-being. Perhaps 35 to 40 percent is a safe level of use.

Rubber rabbitbrush achieved highest production under the 75 percent clip, but not without losing much of the original plant crown. A use level of 50 percent should allow the plant to maintain good vigor. Ordinarily, utilization does not reach this level because of the species' unpalatability.

Creambush rockspirea demonstrated a remarkable productive ability under 75 and 100 percent clipping. High production was a result of an abundance of suckers, the growth of which must have been an excessive drain upon food reserves. This response and the death of some branch tips suggests that a better use level would be 50 to 60 percent.

When curlleaf mountainmahogany gets so tall that its terminal leaders are well out of reach of grazing animals, it is almost inevitable that it will become highlined to some extent with even a rather small amount of use. A tall plant should not be considered as being abused unless main stems and branches are being damaged, or size of the crown is becoming so small that it may not have enough leaf area to supply food for the plant. Neither should a tall plant be considered as contributing to the forage resource except as a source of seed. From casual observations, it can only be speculated that a safe level of use for short plants of this species is about 50 to 60 percent. Furthermore, it might be reasoned that use of small plants is necessary to partially

control their height growth and hold them in a productive condition as long as possible.

Summary

This study was concerned with the extent to which current twig growth of some eastern Oregon and Washington shrub species, which are valuable for big game or livestock forage, could be clipped annually, yet maintain a healthy, productive condition. Twigs of antelope bitterbrush, snowbrush ceanothus, rubber rabbitbrush, creambush rockspirea, and curllcaf mountainmahogany were harvested annually, at least four times. Some plants were clipped seven times. Four intensities, one-quarter, one-half, three-quarters, and all of current twig growth were clipped during late fall or winter.

Each species responded somewhat differently to twig removal, yet in general clipping stimulated twig production to the detriment of flower and fruit production. Production of some shrubs under the heaviest intensities of clipping was remarkable, but after a few years indications of decreasing vitality appeared.

Results of the study suggest some levels of use for sustained shrub production on winter ranges in Oregon and Washington: for antelope bitterbrush on the best sites, 60 to 65 percent, and 50 percent on poorer bitterbrush sites; for snowbrush ceanothus, 35 to 40 percent; for rubber rabbitbrush, 50 percent, but it is seldom used this much; for creambush rockspirea, 50 to 60 percent; and for curlleaf mountainmahogany plants completely within reach of grazing animals, 50 to 60 percent.

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