Control of Gambel Oak Sprouts by Goats

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Highlight: *A high degree of Gambel oak control can be attained with a combination of mechanical treatment followed by a system of goat grazing. This type of control program can result in significant increases in the amount of forage available for livestock production. Mechanical treatment of the oak is necessary to attain maximum benefit from goats. High stocking rates and the proper time of browsing are important management considerations.*

Gambel oak (*Quercus gambelii*) is an important component of several million acres of foothill rangelands in Arizona, Colorado, New Mexico, and Utah. It is found growing from the pinyon-juniper zone to the aspen-spruce zone. The value of Gambel oak on rangelands is questionable. Control studies have indicated that significant increases in soil moisture, forage production, and beef production can be expected in areas where Gambel oak is controlled (Marquiss, 1972).

Goats have been used successfully in the southern part of the United States to control a number of oak species, including live oak (*Quercus virginiana*), post oak (*Quercus stellata*), Spanish oak (*Quercus falcata*), and blackjack oak (*Quercus marilandica*) (King, 1956; Magee, 1957; Norris, 1968). Studies in several countries indicate that goat browsing may cause certain detrimental effects to other types of vegetation, but that the goat is of considerable value for brush control and utilization of herbage not normally taken by other stock (Campbell et al., 1962).

The success of goat browsing in an oak control program is largely dependent on animal grazing preference and the physiology of the plants themselves. The preference of goats for the leaves and buds of brushy species has been noted in a number of areas (Campbell et al., 1962; Norris, 1968). Oak-sprout kill by goat browsing is a result of continued defoliation and subsequent reduction of carbohydrate reserves. Results from studies on defoliation on total available carbohydrate (TAC) storage levels substantiate this (Donart and Cook, 1970; Trlica and Cook, 1971). The effect of defoliation becomes more pronounced if repeated at frequent intervals and at the critical times of the year when carbohydrate reserves are normally low (Cook, 1966). A twelve-year study on oakbrush by Shepherd (1971) revealed that annual clipping and defoliation to the extent of more than 60% of the current year's production was necessary before the plants showed a marked decline in vigor.

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Manuscript received July 30, 1974.

Study Area and Methods

The study was conducted on the San Juan Basin Research Center near Hesperus, Colorado. The elevation of the area is approximately 7,600 ft. Average annual precipitation is 18.8 inches, most of which is received in the winter and late summer months. Vegetation expression indicates that the study area lies in a transition zone between the ponderosa pine and the pinyon-juniper zones. The vegetation is dominated by Gambel oak with a sparse stand of ponderosa pine trees appearing intermittently throughout. The understory is composed primarily of Kentucky bluegrass (*Poa pratensis*) and western wheatgrass (*Agropyron smithii*). Rangelands in better condition may also have such desirable grass species as needleandthread (*Stipa comata*), Junegrass (*Koeleria cristata*), Arizona fescue (*Festuca arizonica*), and mountain muhly (*Muhlenbergia montana*). Rabbitbrush (*Chrysothamnus* spp.), hairy golden-aster (*Chrysopsis villosa*), lupine (*Lupinus* spp.) and other browse and forb species are also found in the study area in varying quantities.

Goats have been used to open up oak areas since 1968 at the San Juan Basin Research Center. Both the smaller Angora and the larger milk-type goat have been grazed. Figure 1 shows an example of oak control by Angora goats. The actual study sites include pastures ranging in size from 4 to 6 acres. Three different treatments were grazed by goats for control evaluations: 1) undercut oak, 2) undisturbed oak, and 3) combined-treatment of oak. The undercut oak area was comprised of two 4.5-acre pastures, both of which were undercut in 1964. Vigorous root sprouting resulted from this treatment the following year. The undisturbed oak type consisted of two 4.0-acre pastures. The oak in these areas ranged in size from small, immature plants to large, mature specimens that reached a height of 12 to 15 ft. The combined-treatment of oak was made up of three 6.0-acre pastures. Each pasture was one-third roller-chopped, one-third bulldozed and brush-raked, and one-third was undisturbed native oak. The roller-chopping was done in October of 1969, and the bulldozing and brush-raking was done in the spring of 1970. Root sprouting resulted from both treatments the following year.

The undercut pastures have been grazed by goats since the spring of 1968, the undisturbed oak pastures since 1969, and the combined-treatment pastures since 1971. The goats were used on a rotational basis among pastures. They were moved from the pastures when 90 to 95% of the oak leaves were utilized. They were then returned to the earlier grazed pastures when new leaves were produced.

Evaluations of oak control have been made each year, beginning in 1969 on the undercut area and on other treated

Table 1. Annual goat stocking rates (days/acre) and frequency of defoliation on three oak treatment areas (1968-1973 data).

Treatment	Year	Stocking rate	Frequency of defoliation[1]
Undercut	1968	206	2
	1969	146	3
	1970	44	2
	1971	19	1
	1972	6	1
	1973	0	0
Undisturbed	1969	222	2
	1970	133	2
	1971	60	1
	1972	55	1
	1973	102	2
Combined treatments	1971	135	2
	1972	98	2
	1973	36	1

[1] 90-95% removal of all oak leaves available to the goats.

areas since 1972. All mechanically treated areas were evaluated in terms of total percentage sprout kill at the beginning of each grazing season. The undisturbed oak areas were evaluated in terms of percentage dead stems to goat browse line (approximately 7 ft from the ground). Evaluations taken in any given year primarily reflected the result of the previous years' browsing.

Hand-plucked simulation diet samples were collected in 1973 for nutrient analysis. Samples were collected of both the oak leaf and the forb-grass portion of the diet. Chemical analyses were made for protein, phosphorus, and gross energy content.

Results

Undercut pastures

The oak sprouts were very vigorous and approximately 3 ft tall when browsing was initiated in 1968. A high stocking rate of about 200 goat days per acre was used (8 goats per acre for 25 days). As Table 1 indicates, the stocking rate dropped rapidly with each successive year of the study as a result of the decrease in the number of live sprouts available. Results of the control evaluation are given in Table 2. In the first study the number of dead sprouts increased markedly from 1969 to 1970, due primarily to the three defoliations the oak was subjected to in 1969 (Table 2). Control of oak sprouts increased gradually through 1972, reaching a high of nearly 95% dead sprouts. Goats were not used in the pastures in 1973 because of the lack of oak regrowth. The 1973 evaluation (taken at the end of the growing season) revealed, however, that a few sprouts appeared during the late summer of 1973.

Table 2. Percent oak sprouts controlled by goat browsing (1969-1973 evaluations).

Treatment	Percent oak control[1]				
	1969	1970	1971	1972	1973
Undercut	31	85	90	93	85
Undisturbed	–	43	79	80	72
Combined treatment					
Roller-chopped	–	–	–	10	23
Brush-raked	–	–	–	5	11
Undisturbed	–	–	–	23	51

[1] Percent sprout kill in the mechanically treated areas; percent dead stems to goat browse line in the undisturbed areas.

Fig. 1. *Growth of oak in enclosure ten years after root plowing. Goat grazing has completely eliminated oak on the outside of the enclosure.*

Undisturbed oak pastures

Goats were first grazed in these areas in 1969. As in the undercut pastures, a high first-year stocking rate was used (Table 1). A similar, but less pronounced, trend of decreasing goat carrying capacity was noted through 1972. A higher number of goat days per acre was necessary in 1973 to achieve complete defoliation. This was a result of: 1) an abnormally high amount of precipitation preceding the browsing season, and 2) the browsing season following two consecutive years of only one defoliation per year (Table 1). Goat browsing in these areas created a highlined appearance that extended up to about 7 ft on the mature oak. This opened up the understory somewhat but killed only a small portion of the larger oak plants.

As Table 2 shows, the percentage of dead stems in the undisturbed areas has leveled off at 75 to 80%. This is to be expected in an undisturbed area since most of the photosynthetic tissue is beyond the goats' reach. As a consequence, very little, if any, reduction in stored carbohydrate levels occurs and the plants are able to function normally while taking on a pruned appearance.

Combined-treatment pastures

The three pastures comprising the combined-treatment area have been used by the goats since the spring of 1971. The initial stocking rate was considerably lower than for the 1964 undercut area (Table 1). This was due primarily to the shorter time interval between mechanical treatment and goat browsing—that is, the sprouts were not as numerous or as vigorous, thus requiring fewer goat days for defoliation. A greater number of dead stems were counted in the undisturbed one-third of the area after 3 years of browsing than in the other control area previously discussed in the first study. The goats preferred to spend most of their time in the undisturbed area, probably because of a shading and shelter effect offered by the larger oak plants. The degree of kill on the bulldozed and brush-raked, and roller-chopped areas was somewhat lower than expected. Although the pastures were defoliated twice per year, the time lapse between defoliations was probably enough to allow a partial restoration of carbohydrate reserves. The result was a much more gradual decline in sprout kill than

Table 3. Protein, phosphorus, and gross energy content of goat diet samples (1973 data).

Collection date	Oak leaves			Forbs and grasses		
	Protein (%)	Phosphorus (%)	Gross energy (Kcal/gram)	Protein (%)	Phosphorus (%)	Gross energy (Kcal/gram)
June 22	13.6	.22	4.31	12.4	.21	4.28
June 29	15.1	.23	4.29	7.9	.15	4.21
July 11	11.4	.15	4.29	12.9	.25	4.35
July 21	11.0	.19	4.40	10.4	.17	4.31
Aug. 12	10.5	.17	4.14	8.8	.18	5.55
Sept. 5	8.5	.18	4.44	14.0	.15	4.42
Sept. 11	8.9	.20	4.30	10.2	.10	4.34
Average	11.3	.19	4.31	10.9	.17	4.49

occurred in the undercut pastures of the first study.

Diet samples

The simulated diet samples were collected on seven different dates during the course of the browsing season. The dates of collection generally correspond to a change-of-pasture date. Observations and measurements of species utilization have indicated that the goat diet was usually composed of over 85% oak leaves, about 10% forbs, and 5% grasses. However, the composition of the diet changed quite rapidly when 90 to 95% of available oak leaves were utilized.

The nutrient content of the samples, by collection date, is given in Table 3. The oak leaves showed a gradual decline in protein content as the season advanced. Phosphorus content declined generally, but with considerable fluctuation. The protein content of the forb-grass portion of the diet fluctuated considerably, reflecting the diversity of species present and their differing maturation dates. The seasonal averages for the three classes of nutrients are probably adequate for goat maintenance and a medium level of production (Huston et al., 1971). However, this needs substantiation by several additional years' data, including digestibility trials.

Discussion and Conclusion

Six years of goat browsing data indicate that goats can be effective in an oakbrush control program. There are several important management considerations involved in obtaining the maximum benefit from goats. the oakbrush must first be treated mechanically to allow the animals full access to all the foliage. The time of goat browsing during the season is also important. A study of carbohydrate storage levels in oak roots by Marquiss (1969) revealed that two periods of low storage occur—one in late June, full leaf stage; and another in late August, late summer regrowth (Fig. 2). Repeated annual defoliation during these times will result in the most effective control. At least two defoliations per year are necessary, and these must be accomplished in a short time period, thus requiring high stocking rates. Stocking rates of five to ten goats per acre have been the most successful during the course of this study. From a management standpoint, control beyond 95% appears to be impractical, because this forces the goats to graze grasses or walk the fences seeking more acceptalbe forage.

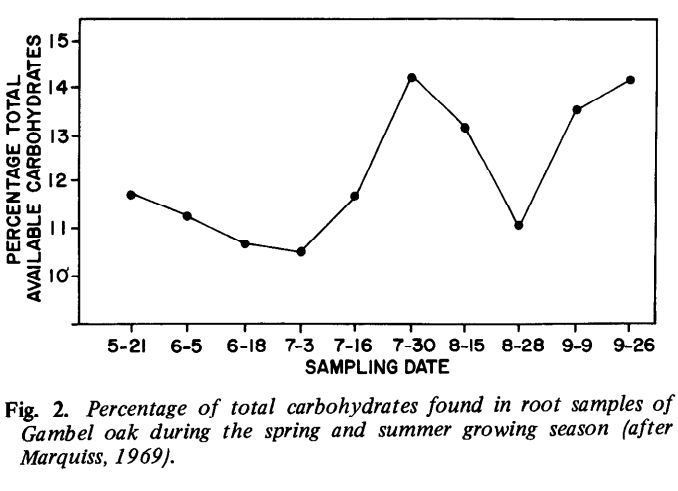

Fig. 2. *Percentage of total carbohydrates found in root samples of Gambel oak during the spring and summer growing season (after Marquiss, 1969).*

All mechanical treatments used have resulted in prolific root sprouting. Bulldozing and undercutting were the most expensive methods. The costs per acre for roller-chopping is considerably cheaper and appears to hold the most promise.

The use of goats on undisturbed oak results in a high-lined appearance up to approximately 7 ft. This does not kill the larger oak plants but does open up the understory somewhat. The opening-up effect also has certain advantages when locating and moving livestock.

Certain problems have been encountered with the goats—the largest being the cost of goat-proof fencing, or possibly, herding. A rotational browsing scheme must be followed, necessitating the use of several pastures. There have been no management problems when cattle and goats are used together in the same area since their diets have in common only 5% of the grass species present.

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