Effect of Cages on Yield and Composition in the California Annual Type[1]

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Techniques which employ cages or other types of small exclosures are used extensively in range research to determine total plant production on grazed areas. Differences between weights of forage on paired plots, one enclosed and one not, are used to measure forage removal by livestock. Usually data of these kinds are given without reference to the effect of the cage or exclosure upon the microenvironment within the exclosure and, hence, upon the plants themselves. In other words, any differences in forage weight between the closed and unclosed areas that may be due to the exclosure itself are usually ignored.

Daubenmire (1940) described several cases in which the material of which permanent enclosures were made acted as a barrier to wind movement, insolation, and precipitation. Reduced wind resulted in deposition of snow in winter, dust in summer, and most certainly altered humidity and temperature. The enclosure itself catches wind transported materials and intercepts rainfall which further change the environment within.

In England cage techniques have been used for many years and criticized on the basis that growth was greater within the cage than outside (Cowlishaw, 1951). Williams (1951) established that cages reduced wind velocity and light and increased relative humidity. Temperatures within a cage were lower, the same as, or higher than the temperature outside. Apparently less wind and less loss of latent heat in evaporation caused temperatures to increase, while the shading effect of the cage acted in the opposite direction. The relative importance of these opposite effects may be different at various times of the day and with various combinations of weather. They suggest that less heat is lost at night, and, therefore, less dew and frost occurs under the cage than outside.

Cage techniques to measure herbage yield have been used in the California annual type (Bentley and Talbot, 1951). The vegetation is well adapted to the use of square foot plots and cages because it is a thick mixture of many low growing species. However, one question concerning their use is unanswered: Does the cage have a significant effect on the enclosed vegetation?

During the growing season of 1955-1956 (November to June), 110 cages that were being used in conjunction with grazing trials on the Hopland Field Station were also situated to show the effect of cage. This location is in the coast ranges of California about 100 miles north of San Francisco and 40 miles from the coast. The study was entirely concerned with the herbaceous cover in the California annual-grass type. Many of the plots were in openings in the grass-woodland type; others were actually under a thin and scattered canopy of the woodland trees.

In November, 1955, before the beginning of fall rains, cages were located in a grid system in four pastures. At each cage location two areas within approximately 20 feet of each other were selected for uniformity of vegetation in terms of kinds of plants, density, and height of the previous season's growth. A coin was flipped to determine which of the two similar areas was caged.

The cages varied somewhat in size and shape, but in general they

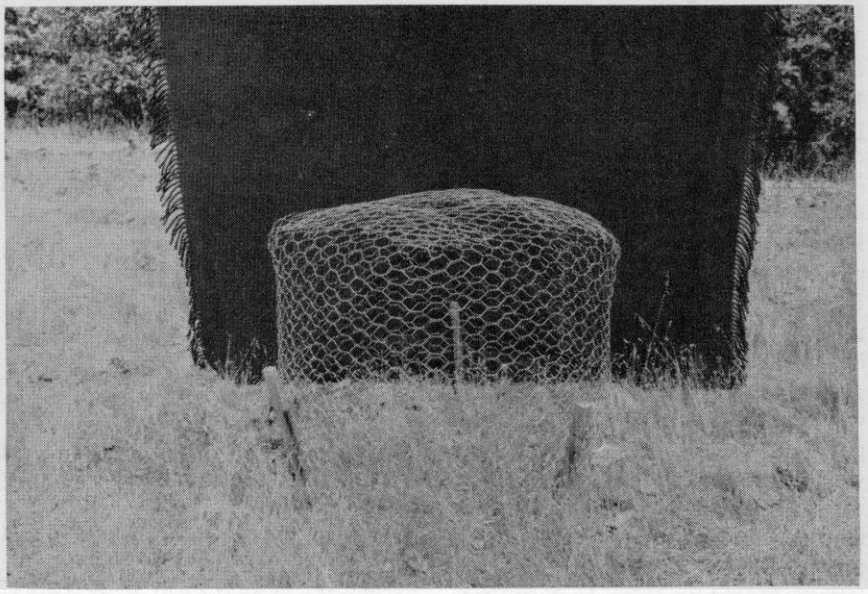


FIGURE 1. A cage of the type used in the study. It is constructed of 1½-inch mesh stucco netting and is approximately 3½ feet in diameter.

[1]*The data in this paper were collected as a part of Project 1501 in the California Agricultural Experiment Station.*

[2]*Appreciation is expressed to Lynn Rader and Thomas Bedell for aid in reading the field plots and in making some of the calculations.*

were made of 1½-inch mesh stucco netting with 17 gauge wire. They were approximately 3½ feet in diameter and 2½ feet high (Fig. 1). The wire was folded so that the top of the cage was closed or nearly so.

There was no grazing by domestic animals during the period the cages were in place. Deer were present in one pasture (first two rows of Table 1) and absent from the others.

Measurements of the vegetation were with the pointplot system and square-foot plots clipped both inside and outside of each cage. These field measurements were summarized according to percentage botanical composition, height of the first hit, condition of the soil surface, and weight of material, oven-dry. In one set the clippings were separated according to new growth and mulch from previous years. The clippings were made at ground level.

Effects of Cages on Weight of New Growth

In March the amount of new plant materials was obviously greater inside the cage than outside. The "T" tests of the mean differences were highly significant for two groups of cages in one pasture and significant at the 5 percent level in another pasture. These three mean differences amounted to 108 pounds per acre with a Confidence Interval of 64 pounds, 50 pounds per acre with a CI of 31 pounds, and 110 pounds with a CI of 92 pounds. These data clearly indicate that the cages had an effect on the vegetation. Williams (1951) has shown the reasons to be amelioration of the micro-climate; therefore, repetition of the environmental measurements was not deemed necessary in this study. Of special note is that these results were obtained during the winter period when the mean temperature was 42.5 degrees F. and when freezing temperatures were recorded on 62 percent of the days. Plant growth was slow, and the small increases in amount due to cages was a 16-48 percentage increase.

Grazing by deer probably contributed to the mean differences shown in the first two rows of data in Table 1. They were present at the approximate density of one per 6 acres and they are known to feed on herbaceous plants at that time of year (Longhurst, 1956). Both deer and sheep were absent from the other pastures during the dates shown in Table 1.

When the cages were in place from November to May, and from March to June, no significant mean difference was found between the yields of new growth inside and outside the cages. Both of these periods encompassed the major portion of the fast growing season.

These data are interpreted to mean that cages result in a small but significant increase in plant growth in the California annual type during the cool part of the growing season, but that any differences due to the cages soon disappear as spring temperatures become warm enough for fast growth.

The clippings from one set of cages sampled in March were separated into new and old growth. No real difference was found in the amount of old growth or mulch between the caged and uncaged samples. This indicates similar rates of decomposition under the two conditions during the winter, and that differences were in the amount of green material.

No Effects on Composition

Points were taken to determine the percentage botanical composition of the vegetation on a coverage basis. These were at the rate of 60 points per location, of which 30 were on the caged plants and 30 on the uncaged plants.

The most important plants found were soft chess (*Bromus mollis*), broadleaved-filaree (*Erodium botrys*), ripgut (*Bromus rigidus*), slender oat (*Avena barbata*), hairgrass (*Aira caryophyllea*), fescue (*Festuca dertonensis*), annual clovers (*Trifolium spp.*), nitgrass (*Gastridium ventricosum*), and about 35 other species of minor importance.

Table 1. Differences in oven-dry weights of herbage from paired plots, one caged and the other uncaged.

Period cages were on the ground	Number of pairs	Average weight in grams per sq. ft.		Mean difference in grams/sq. ft.	Confidence Interval	
		Caged	Uncaged		Grams	Lbs./acre
Open grass, Nov. 8, 1955 to March 3, 1956	38	3.46	2.33	1.13**	0.6645	64
Grass under thin tree canopy, Nov. 8, 1955 to March 3, 1956	25	2.38	1.88	0.50**	0.3234	31
New growth, Nov. 8, 1955 to March 3, 1956	15	8.16	7.02	1.14*	0.958	92
Mulch, Nov. 8, 1955 to March 3, 1956	15	3.42	3.26	0.16	—	—
Nov. 8, 1955 to May 8, 1956	16	19.72	19.72	0.00	—	—
March 8, 1956 to June 6, 1956	16	11.52	11.23	0.29	—	—

** Significant at the 0.01 level; confidence intervals at the same level.
* Significant at the 0.05 level; confidence intervals at the same level.

Considerable variation in botanical composition and plant height occurred between cage locations. On a pasture basis, or group of cages, as given in Table 1, very little difference existed between the caged and uncaged conditions and, therefore, the data are omitted. This was also true of the percentages of bare soil, moss, mulch, and rocks, measured at the soil surface. The conclusion is reached that the cages had little effect on the kinds of plants and the soil surface conditions. At some specific cages a few species appeared on an ocular estimate basis to be favored or disfavored by the cages, but the data did not bear this out for the whole of a set of cages treated alike.

Summary

This study was undertaken to determine the effect of cages on herbage yield when they are used to protect small plots of vegetation from livestock use. Studies by others indicate that the change in micro-climate under the cages results in an increase in plant growth. Results of this study are in agreement with the reported findings under conditions of slow growth in the winter period. With the onset of warm spring temperatures and rapid growth of the plants, the differences soon disappear, and by plant maturity any effects of the cage on amount of growth, percentage botanical composition, and foliage cover could not be detected in the conditions of this experiment.

The conclusion is reached that the cages, themselves, do not materially influence results of total yield studies and utilization in the area of the experiment. Yields taken in late winter with cage techniques will include a significant cage effect. These results should apply to most of the California annual-grass type, although the point has not been tested at other locations.

LITERATURE CITED

BENTLEY, J. R. AND M. W. TALBOT. 1951. Efficient use of annual plants on cattle ranges in the California foothills. U. S. Dept. Agr. Circ. 870. 52 pp.

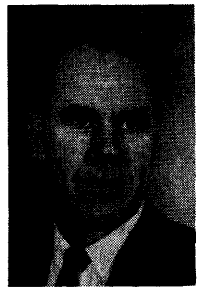
COWLISHAW, S. J. 1951. The effect of sampling cages on the yields of herbage. Jour. Brit. Grassland Soc. 6:179-184.

DAUBENMIRE, R. F. 1940. Exclosure technique in ecology. Ecology 21: 514-515.

LONGHURST, W. M. 1956. Forage interrelationships of domestic sheep and Columbian black-tailed deer. Unpublished manuscript.

WILLIAMS, STELLA S. 1951. Microenvironment in relation to experimental techniques. Jour. Brit. Grassland Soc. 6:207-217.

A Message from the President



By this time of year section field meetings and tours will be in full swing. It is encouraging to see what sizeable summer meetings many sections have worked up. This is surely one of the best ways of advancing the cause of range management, both among our own members and among land users in general.

John Clouston, our Executive Secretary, has new office space in Portland and is rapidly picking up the many facets of a big job. Many of you will see him this summer, for he is planning to attend a number of section meetings, as well as the summer meeting in Jackson.

The May issue of the Journal contains the list of National Committees for 1957. This list is worth your attention, as a group who do much of the work of our Society. Each committee has a definite job to do and each of them will welcome suggestions that any member may have—so don't hesitate to let them know if you have an inspiration!

The latest releases on membership from the Secretary and the Membership Committee show that our old problem of delinquent members is still with us. Bringing these people back into the group is a major job that each section must handle as it sees best. Experience indicates that a personal letter, or better still, direct contact by a section representative is most effective.

The arrangements for the summer meeting at Jackson, Wyoming look good. I hope many of you can be there.