Shrub Invasion of Southern Arizona Desert Grassland

ALBERT L. BROWN

Assistant Range Ecologist, University of Arizona, Tucson, Arizona

ENCROACHMENT of mesquite, burroweed, and other noxious shrubs has seriously reduced the carrying capacity of thousands of acres of desert grassland ranges. Two principal theories have been advanced for this invasion—grazing and control of fires.

In the early part of the century Griffiths (1910), and Thornber (1910) observed the large mesquites along the water courses, and the presence of young mesquites on the ridges separating them. Griffiths predicted that both mesquite and other shrubs would increase in size and number on these ridges. Both expressed the opinion that fire, formerly unchecked and with abundant fuel, had maintained the grassland in its original shrub-free state. They believed that livestock grazing had controlled fires indirectly through removal of fuel by trampling and grazing. Later, Wooton (1916) observed that Griffiths' prediction was coming true. He noted that occasional fires were the only check on the increasing shrubs.

Leopold (1925) advanced this same theory for the short-grass areas of northern Arizona and called attention to the encroachment of oak and juniper from the higher elevations. This invasion followed the cessation of fires which was shown by burn scars to have been some 40 years earlier. He doubted, however, that the lower levels of the desert grassland ever supported sufficient vegetation for widespread or frequent fires.

Humphrey (1949) called attention to the earlier work of Thornber, Griffiths and Wooton. In a study of two burned areas near Tucson, Arizona, he observed that burroweed and snakeweed were effectively controlled by fire. He also recorded a moderate degree of control of such shrubs as jumping cholla, mesquite and palo verde.

The grazing theory also has many adherents (Allred 1948, Upson et al 1937, Young et al 1948). In general, they believe that breakdown of the sod and compaction of the soil surface through grazing pressure and drought has led to the invasion of shrubs, causing a grazing disclimax. In refutation of the fire theory of shrub control, Allred (1948) has pointed out that some of the most frequently recurring fires are in the Texas brush country where mesquite is densest. It should be kept in mind that Allred's observations pertain primarily to Texas while the workers referred to in the previous paragraphs obtained their results in Arizona.

Further support is lent to the grazing theory by the fire-resistant nature of mature mesquites. Although the top is readily killed by hot grass fires, the plant is a stump sprouter, and usually sprouts following severe injury to the top. Many other desert plants are similar to mesquite in this respect.

Neither of these theories has been adequately proved. Doubtless both fire and grazing have played an important part in the ecology of the desert grassland. Further information concerning the rate of shrub invasion, its relation to management practices and forage production, and the successional relationships of the invaders is necessary for control of the

shrubs and for management of ranges following control.

A study designed to obtain some of this information was established in 1931 on the Santa Rita Experimental Range in southern Arizona. The results herein reported show shrub changes over an 18-year period.

Description of the Experiment

Study Area

The study area is typical of vast areas in the desert grassland type. It is located on an alluvial fan at an altitude of 3800 feet, approximately midway in the elevational range of the desert grassland.

Average annual precipitation is 15.6 inches, falling in two distinct rainy seasons. More than half of the precipitation comes during July, August and September; the remainder, mostly in December, January, February and March. Winters are mild with light snows and short freezes. Summers are hot, with means during July, August and September ranging from 75 to 85 degrees F. Maximum temperatures above 100 degrees F. are common during these months.

Most of the native perennial grasses make their growth during the summer rainy season, the growing season being limited by precipitation rather than by temperature. Because of low humidity, frequent high winds, and high temperatures, evaporation is rapid during the growing season. A 14-year record obtained in the study area shows an average annual evaporation rate of 109 inches.

The vegetational aspect is one of grassland dominated by a light stand of mesquite, with a moderate understory of shrubs. The important forage grasses are black grama (*Bouteloua eriopoda*), Rothrock grama (*Bouteloua rothrockii*), Arizona cottongrass (*Trichachne californica*), and poverty three-awn (*Aristida divaricata*).

Shrubs include mesquite (*Prosopis velutina*), burroweed (*Haplopappus tenuisectus*), velvet-pod mimosa (*Mimosa dysocarpa*), fern acacia (*Acacia angustissima hirta*), prickly pear (*Opuntia engelmannii*), bisnaga (*Echinocactus wislizenii*), cane cholla (*Opuntia spinosior*), catclaw (*Acacia greggii*), baccharis (*Baccharis brachyphylla*), ocotillo (*Fouquieria splendens*), range ratany (*Krameria parvifolia*), and jumping cholla (*Opuntia fulgida*).

Of these, only the first six occurred in sufficient numbers on all plots to be analyzed individually.

Mesquite has long been recognized as a noxious plant because of its ability to compete with range grasses for a limited moisture supply. Further, its dense growth habit makes cattle-working operations difficult on heavily infested ranges.

Burroweed is a poisonous half-shrub which causes severe livestock losses on southern Arizona range lands. It also competes seriously with the native grasses because of its ability to utilize winter rainfall.

Velvet-pod mimosa is only locally important as a noxious plant. It is a low-growing, moderately palatable shrub, armed with recurved prickles, and has a tendency to form impenetrable thickets.

Fern acacia is a suffrutescent shrub which is not considered noxious. It is rather palatable to livestock.

Prickly pear is recognized as a noxious plant in the Great Plains and in southern Texas, but has received little attention in the Southwest, having been more or less confined to lower elevations on poorer range. However, it has increased on the better rangelands in recent years.

Bisnaga, another member of the cactus family, has never been considered as a noxious plant.

Methods

The study area was divided into three 100-meter-square blocks, each containing 2.47 acres. Two of these were fenced in 1931. One block was fenced with barbed wire and chicken wire to exclude larger rodents and cattle. The second was fenced with barbed wire only, to exclude cattle, but allow grazing by rodents. The third block was left open to grazing by both cattle and rodents. This grazing has been heavy, and was aggravated by severe droughts in 1947 and 1948.

The three blocks were subdivided into 10-meter-square plots. All shrubs on the three blocks were mapped by location in 1931, 1940, and 1949.

Results

Total shrubs increased on all three blocks throughout the 18-year period (Fig. 1). Under open grazing, shrub numbers increased from 1305 in 1931 to 2443 in 1949, an increase of 87 percent. Under cattle exclusion, shrubs increased from 651 to 1343 during the same period, or 106 percent. Under total protection, they increased from 616 to 930, or 51 percent. A large proportion of these numbers is made up of burroweed. This plant is comparatively susceptible to drought and was probably reduced in numbers during the drought years of 1947 and 1948. If burroweed is excluded from the comparisons, the remaining shrubs increased 34 percent under open grazing, 83 percent under cattle exclusion, and 79 percent under total protcction.

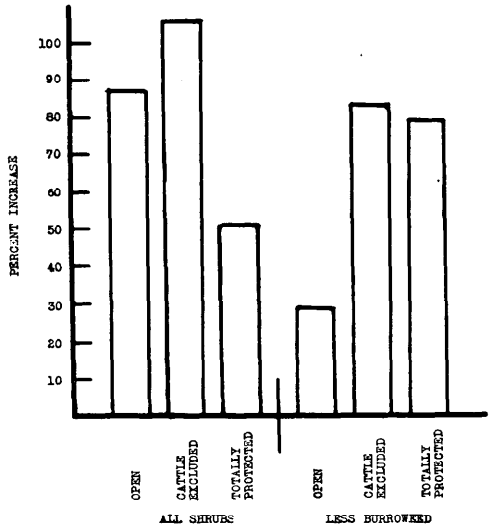

FIGURE 1. Eighteen-year changes in the number of shrubs under three degrees of protection from cattle and rodents.

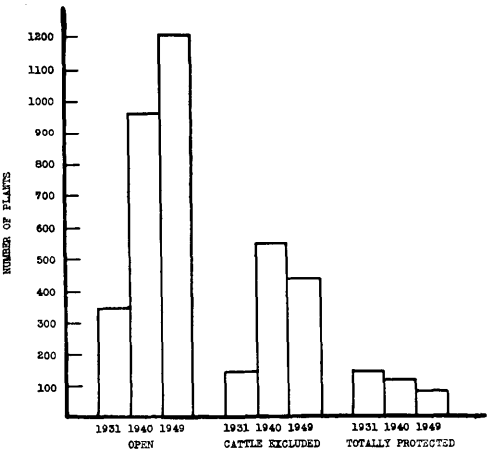

FIGURE 2. Eighteen-year changes in the number of burroweed under three degrees of protection from cattle and rodents.

Burroweed showed a distinct relationship to grazing pressure (Fig. 2). Under open grazing it increased from 347 in 1931 to 1206 plants in 1948, or 248 percent. Under cattle exclusion it increased from 143 in 1931 to 548 in 1940, and then decreased to 413 by 1949, a net increase of 189 percent. Under total protection it decreased from 141 to 82 during the 18-year experiment, a decrease of 42 percent.

Mesquite increased under all treatments (Fig. 3). Under open grazing the number of mesquites increased from 239 to 370, or 55 percent; under cattle exclusion from 344 to 427, or 24 percent; and under total protection from 279 to 364,

or 30 percent. In all cases mesquite increased consistently through the 18-year period. During this time less than 50 mesquites died on the entire area. None of these was more than 10 years old at the time of death.

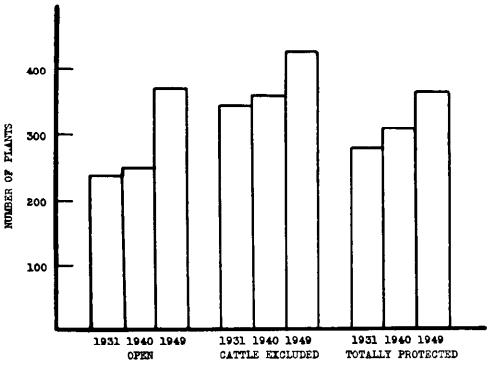

FIGURE 3. Eighteen-year changes in the number of mesquites under three degrees of protection from cattle and rodents.

Velvet-pod mimosa increased from 113 to 161 or 42 percent under cattle exclusion, and from 134 to 192 or 43 percent

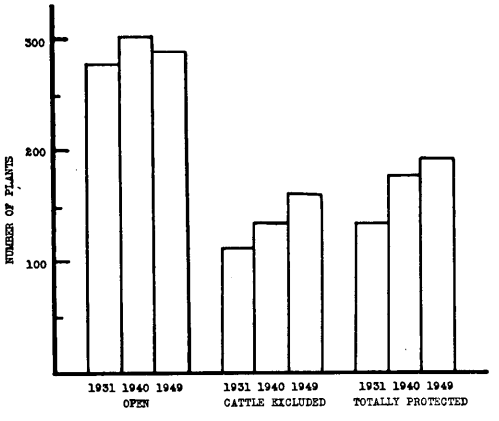

FIGURE 4. Eighteen-year changes in the number of velvet-pod mimosa under three degrees of protection from cattle and rodents.

under total protection (Fig. 4). Under open grazing it increased from 278 in 1931 to 303 in 1940, and then decreased to 289 in 1949, a net increase of 4 percent.

Fern acacia reacted like the mimosa. It increased from 16 to 97 or 506 percent under cattle exclusion, and from none to 57 plants under total protection. Under open grazing it increased from 124 to 138 during the first nine years, and then decreased to 92 plants, a net decrease of 26 percent. Both velvet-pod mimosa and fern acacia, particularly the latter, are somewhat palatable to livestock. It is possible that the decrease in their numbers under open grazing during the last nine years is a result of grazing injury.

Prickly pear increased markedly under all three treatments. Under open grazing there was an increase from 28 to 120 plants, or 329 percent; under cattle exclusion from 14 plants to 149, or 964 percent; and under total protection from 20 plants to 99, or 395 percent. The increase of this plant, its ability to survive grazing pressure, and its ability to invade well-grassed areas strongly suggest its importance as a noxious range plant in the middle and upper desert grassland.

Bisnaga, like prickly pear, increased under all three treatments. Under open grazing the number of plants increased from 7 to 32, or 357 percent; under cattle exclusion from none to 65; and under total protection, from 11 to 84, or 664 percent.

Cane cholla, jumping cholla, catclaw, ocotillo, baccharis, and range ratany were nowhere abundant. They were placed in a miscellaneous grouping which increased under all treatments. As a group, these plants increased as the grazing pressure was reduced. Under open grazing these plants increased from 282 to 354 in 1940, and then decreased to 334 in 1949, a net increase of 18 percent. Under cattle exclusion the numbers decreased from 21 in 1931 to 16 in 1940, and then increased to 31, a net increase of 48 percent. Under total protection, these plants increased rather uniformly throughout the 18 years,

from 31 to 52, an increase of 68 percent. The large numbers under open grazing are due to the relative abundance of catclaw and baccharis in the open plots. A separate analysis excluding catclaw and baccharis from the comparisons showed the plants following the same trends, but with increases of 18 percent under open grazing, 48 percent under cattle exclusion, and 58 percent under total protection.

Discussion

Although burroweed decreased somewhat under protection from grazing, the response was not sufficient to have practical application in elimination of burroweed. Even under the extremely light rate of grazing resulting from rodent use alone, the plant increased. The reduction in numbers through 18 years of total protection was too small to be of importance. As the 1949 mapping followed two years of severe drought, it is possible that subsequent studies might show an increase under total protection, instead of a decrease. Moderation in grazing may reduce the rate of burroweed invasion, however.

Mesquite increased only half as much under protection as under open grazing, but the 30 percent increase noted under protection seems to preclude the possibility of grazing management as a means of control in this area. These trees are very long-lived and well-adapted to the desert grassland environment. They are artificially controlled only with difficulty, and natural mortality of mature plants is extremely small.

The increases of all shrubs except burroweed under all treatments are at variance with the theory that grazing has directly affected the spread and increase of noxious plants in the desert grassland through breakdown of sod and release of shrubs from grass competition. Instead, it would seem that the shrubs, rather than the grass, were natural dominants of the area, and that the grass was present because of some factor that was unfavorable to the shrubs.

Although fire may have been an important factor, few experimental data concerning the effects of controlled burning on Southwestern range plants, other than burroweed, are available. The effects of fire on both shrubs and grasses under varying conditions must be thoroughly studied before accepting or rejecting the theory that burning originally maintained the desert grassland in a shrub-free state.

Summary

A study was made of shrub invasion in the desert grassland under open grazing, cattle exclusion, and total protection from cattle and rodents in southern Arizona.

Changes in numbers of burroweed and mesquite were directly correlated with grazing pressure. Total protection was insufficient to decrease the numbers of burroweed materially. It did not retard the increase of mesquite sufficiently to appear as a usable method of control.

Increases of other shrubs showed little relationship to protection. Velvet-pod mimosa and fern acacia were reduced by drought-aggravated grazing injury.

The desert grassland is indicated by this study to be subclimax to a desert shrub climax in southern Arizona.

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THE SCOTTISH FARMER

There is urgent need for food production in Scotland. Though the standard of agriculture is comparatively high, production could be considerably increased. Many farms are not up to the level of others with comparable soil and climate, and there are large areas of margin land and hill grazings which once produced much more than they do now. The present high prices and subsidies for liming, draining, and water schemes are sufficient inducement for improving the poor farms.

A good start has been made in improving the hill grazings. Programs have been approved for government grants for over 1,000,000 hill farms extending to over two million acres. This will increase the carrying capacity for beef cattle and sheep.

Lord Boyd Orr
"Scotland"
from a condensation in the Farmers Digest
February, 1950