Shrub Invasion of a Southern New Mexico Desert Grassland Range[1]

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The grazing value of a large portion of the desert grassland in southwestern United States has been greatly reduced during the last 100 to 150 years by the invasion of undesirable shrubs. Although much of the present area is now lightly infested, infestation does not have to be heavy before range productivity is seriously damaged. As the economic welfare of the Southwest depends in large measure upon its grazing and soil resources, investigations to determine the extent of shrub invasion, rate of range deterioration, and possible reasons for this retrogression in plant cover are important. In this study, records of vegetational changes, environmental conditions, and forage utilization were compiled and analyzed in an attempt to determine the extent of shrub invasion on a southern New Mexico semidesert grassland range over a thirty-year period.

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Study Area

The Jornada Experimental Range, where data analyzed in this study were collected, lies within a basin adjacent to the Rio Grande Valley, Dona Ana County, south-central New Mexico. The area is typical of much of the semidesert grassland of the Southwest. The experimental range contains approximately 145,000 acres of essentially flat mesa land ranging in elevation from 3900 to 4700 feet. The climate is arid; wind movement and evaporation rates are high, measuring approximately 35,000 miles and 100 inches per annum, respectively (Ares, 1952). Rainfall averages 9 inches per annum over the 90-year period of record, and has the winter-summer pattern typical of the Southwest. More than 50 percent of the annual total falls during the summer months of July, August, and September.

Much of the vegetation consists of species occurring largely or exclusively in the desert grassland formation. Black grama (*Bouteloua eriopoda*) communities occur on the upland sites and tobosa grass (*Hilaria mutica*) in the lowlands. Other grasses in association with these two dominant species, but less abundant, are *Aristida* spp., *Bouteloua* spp., *Hilaria* spp., *Muhlenbergia* spp., and *Sporobolus* spp. Shrubby species include: honey mesquite (*Prosopis julifora* var. *glandulosa*), western honey mesquite (*P. juliflora* var. *torreyana*), tarbush (*Flourensia cernua*), creosotebush (*Larrea tridentata*), snakeweed (*Gutierrezia sarothrae*), soapweed (*Yucca elata*), salt bush (*Atriplex canescens*), *Acacia* spp., and *Opuntia spp.* Of these, mesquite, tarbush-creosotebush and snakeweed associations are the most prominent, covering extensive areas and forming distinctive vegetation types.

The mesquite of the area is a shrub growing in many-stemmed clumps 3 to 5 feet in diameter. It has an extensive root system, the taproot often extending to a depth of 20 to 50 feet and the laterals reaching as fas as 40 to 50 feet from the root crown. Mesquite is exceptionally drought-enduring and aggressive. It is resistant to grazing and invades grasslands readily when a seed source and transportation medium are present.

Tarbush, also known as blackbrush, is a resinous, thick-leaved shrub that will invade desert grassland sites when the sod is broken. The shrub is unpalatable to livestock, and may poison sheep when the animals graze the ripe fruits of this plant.

Creosotebush, the most common and widely distributed shrub in the desert, is a much-branched, evergreen species. It forms pure stands over much of its range, particularly on sandy or gravelly mesas. The plant is worthless as forage, and the growth of better forage plants is restricted where it is abundant.

Snakeweed is an aggressive suffrutescent perennial that rapidly invades areas where the grass cover has been depleted. This plant develops a deep taproot during its first season, and establishes abundant lateral roots as it matures. Snakeweed is poisonous to cattle when eaten in quantity, and its presence in dense stands during periods of normal rainfall is believed to indicate overuse of the more palatable forage.

Study Methods

Vegetation maps and field write-up sheets of the experimental range compiled during

range reconnaissance surveys in 1915 and 1928 were compared. Mosaics made from 1946 aerial photographs of the area were also analyzed. Vegetation types were delineated on the mosaics and these types were evaluated to determine vegetation dominants. The vegetation types, as they appear on the maps and mosaic, were planimetered to determine the acreage of each. From these data the percentage of shrub cover on the experimental range at different periods was calculated and analyzed.

Records of management practices, operating procedures, stocking rates, and 90 years of climatic data were analyzed. An extensive search was made of historical and scientific literature pertaining to the Southwest to determine conditions that have existed throughout the desert grassland region since early Spanish explorations. Factors contributing to possible shrub encroachment were considered in the light of these records.

Table 1. Changes in dominant vegetation, Jornada Experimental Range, 1915 to 1946. Figures are based on a total area of 145,330 acres.

Year	Area occupied by vegetation dominants									
	Grass spp.		All shrubs		Mesquite		Tarbush-Creosote		Snakeweed	
	acres	% of total	acres	% of total	acres	% of total	acres	% of total	acres	% of total
1915	62189	43	83141	57	27545	19	40108	27	15488	11
1928	51818	36	93512	64	47754	33	36730	25	9028	6
1946	44666	31	100664	69	57133	39	36774	25	6757	5
Net change	decrease 17523	12	increase 17523	12	increase 29588	20	decrease 3334	2	decrease 8731	6

Results

The grassland vegetation on the experimental range consists of two major associations; black grama on the uplands and tobosa grass in the swales. In 1915, 43 percent or 62,189 acres of the Jornada mesa were classified as grassland dominant (Table 1). By 1946, only 44,666 acres, or 31 percent of the mesa remained as grassland. This is a 30-year shift from grass to brush of 17,523 acres. Although this loss of grassland acreage is equal to only 12 percent of the total mesa area, it represents a 28 percent loss of the acreage originally dominated by grasses.

A total of 27,545 acres, 19 percent of the mesa, was classed as mesquite dominant in 1915. By 1946, mesquite had become dominant over 57,133 acres or 39 percent of the total area. Although the encroachment took place mainly at the expense of other lower-growing shrubs, large areas that were formerly grassland had also been invaded. The area dominated by mesquite in 1946 represented an increase of 107 percent in the acreage dominated by this shrub in 1915.

Approximately 40,100 acres, or 27 percent of the mesa, was classed as tarbush-creosote dominant in 1915. During the 30-year period between 1915 and 1946 this acreage was reduced by 8 percent. The 3,334-acre loss in tarbush-cresote vegetation was accounted for mainly by the encroachment of mesquite-covered sand dunes.

Snakeweed was dominant on 15,488 acres, or 11 percent of the area, in 1915. Inasmuch as the snakeweed-infested areas occur primarily between the grassland and mesquite types, this suffrutescent shrub seems to be a pioneer invader in the grassland. The 8,731-acre reduction in snakeweed between 1915 and 1946 was due mostly to encroaching mesquite; at the same time, however, snakeweed invaded a large area previously classed as grassland. Therefore, it appears that when range condition is deteriorating, snakeweed makes the initial invasion and later gives way to other woody species. On the other hand, when range condition is improving, snakeweed may be replaced by grasses (Campbell, 1934).

Discussion

Rainfall records for southern New Mexico have been kept since 1853. There are, however, only 90 years of actual record as the data are incomplete for 13 years. This 90-year record indicates a cyclic pattern of precipitation. Five cycles are evident in the graphs compiled by the U. S. Forest Service at the Jornada Experimental Range (Ares, 1952). These cycles oscillate between 18 to 20 years of below-average to 18 to 20 years of above-average precipitation. The 40-year record on the Jornada shows no marked deviations from the other, longer-term records. The period of 1915 to 1926, an 11-year span of below average rainfall on the experimental range, falls within the latter part of the third dry cycle of the longer record. For the next 19 years, rainfall on the Jornada averaged 15 percent above the mean. The present dry cycle, which began in 1945, has averaged 26 percent below the long-term mean (Ares, 1952).

During these periods of extended drouth, grasses make little or no growth, and in many instances grasslands are killed, literally "douthed out." There were, however, individual years within these dry periods when rainfall was adequate and grass growth was excellent. Because of their relatively shallow roots, desert grasses depend on surface moisture for their water requirements; the lack of sufficient surface moisture is a major factor in their death. Shrubs, on the other hand, by virtue of their deeper and more extensive root

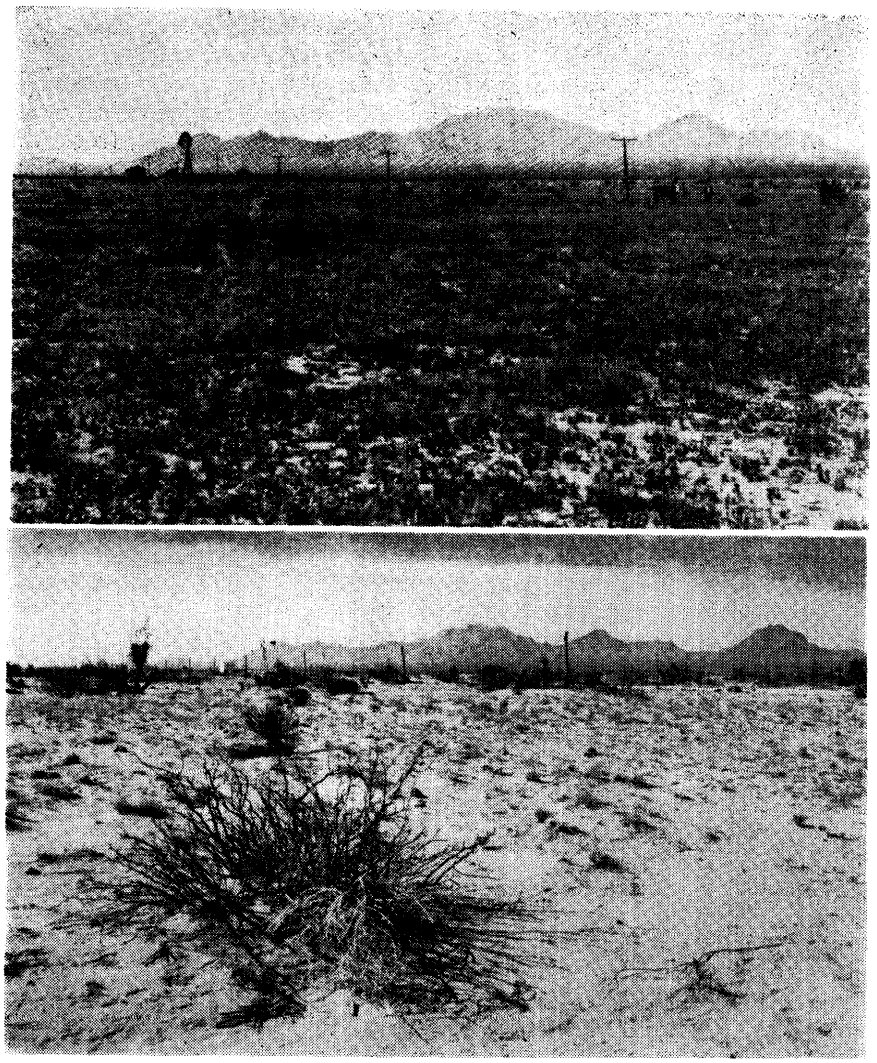

FIGURE 1. *(Above)* South Well, Jornada Experimental Range, as it appeared 35 years ago —typical grassland range with a few scattered invading shrubs. *(Below)* Same area as it is today—wind-blown sand is forming dunes around established mesquite plants.

systems, are able to remain alive by drawing moisture from deeper levels; they may also utilize winter and spring moisture when temperatures are too low for grass growth. These shrubs may continue to grow, therefore, even during drouth years and may invade adjacent grasslands.

When a dry cycle is broken and rainfall is adequate for normal grass growth, the grasses must begin growth from the dormant state or from seed. Those shrubs that have been actively growing are in a position to utilize more of the immediately available moisture than the grasses. Therefore, unless shrub growth is curtailed either during or between drouths, it is reasonable to assume that shrubs will continue to encroach upon and eventually dominate the grasslands under such climatic conditions.

Grazing pressure appears to be a factor in this shrub invasion. According to the vegetation maps shrubs increased more rapidly during the interval 1915 to 1928 than between 1928 and 1946 (Table 2). Grassland acreage decreased by 17 percent in the earlier period and by only 14 percent during the later, longer interval. The average stocking rate from 1915 to 1925, which was also a period of drouth, was twice as heavy as during the next 18-year interval when rainfall was above average. Although shrub invasion did not stop with lighter utilization and above average rainfall, it was slower than the encroachment under the reverse conditions of heavy grazing and drouth. Perhaps the change from drouth to more favorable precipitation was responsible for the retarded invasion and the lighter degree of utilization was merely coincidental; however, the theory that grazing pressure is at least partially responsible for shrub invasion is supported by Brown's (1950) study of this encroachment on an Arizona desert grassland range. He noted a 30 percent increase in shrubby vegetation under total protection, and 55 percent increase under open grazing.

No reference to fires in the Jornada area were found in the review of historical literature connected with this study. This might lead to the conclusion that fire, or the lack of fire, has not been a factor in shrub invasion on the grasslands in the area. On the other hand, it has been established that range fires occurred periodically in the desert grassland during the early years of, and before white settlement (Nunez, 1905; Humphrey, 1953). The Jornada area seems to have been an extensive grassland

Table 2. Percent change in vegetation dominants on Jornada Experimental Range for the periods 1915 to 1928; 1928 to 1946; and 1915 to 1946. Type acreage in 1915 equals 100 percent.

Vegetation Dominants	Percent Change		
	1915-1928	1928-1946	1915-1946
Grassland	-17	-14	-28
Mesquite	74	20	107
Tarbush-Creosote	-8	0	-8
Snakeweed	-42	-25	-56

plain relatively free of the shrubby invaders that dominate vast areas there today. It is impossible, however, to determine the extent of shrubby vegetation on the Jornada as it appeared 100 to 150 years ago, as the reports of early travelers through the area give only generalized descriptions of the vegetation and are somewhat conflicting.

Wislizenus (1848) and Marcy (1852) in their reports of the Jornada del Muerto,—the geographical area of which the experimental range is now a part, both comment that they found the grass "good" or "tolerable" and, ". . . a small growth of scrubby brush, which answered very well to cook with; . . . ." Wislizenus also refers to ". . . an abundance of mesquite and palmillas. . ." Beale (1858), however, describes the Jornada plain as thousands of acres of rich soil covered thickly with the finest grass in the world; he makes no comment on the occurrence of any shrubby growth. Froebel (1859) makes no reference to shrubs on the Jornada and says, ". . . there is excellent grass the whole way, . . ."

With the exception of Wislizenus, there was no mention of an extensive shrub cover on the Jornada found in the historical records, and it would seem that if the shrubby vegetation so common there today had existed 100 years ago, it would have been referred to in these reports of early explorations. Although no early travelers on the Jornada reported the evidence of fire, the fact that fires were prevalent throughout the desert grassland, and the area in question apparently was being somehow maintained as desert grassland dominant, might well lead one to conclude that periodic fires, although not reported, may have occurred in the area and may have been a factor in restricting or preventing the spread of shrubs.

Summary

A study was made of shrub invasion over a thirty-year period on a southern New Mexico semi-desert grassland range. Twelve percent of the total area, formerly classed as grassland, is now dominated by shrubs. Twenty-eight percent of the original grassland acreage has been lost to this invasion. Mesquite is the principal invader, having increased its original acreage by 107 percent. Tarbush-creosote type vegetation occupies 8 percent less area than before; the snakeweed dominated acreage has been reduced by one-half.

An analysis of climatic data covering the past 90 years in the area indicates a cyclic climatic pattern that favors the invasion of the grassland by shrubs when other biotic factors have been adversely affecting the grass species, and shrub growth has not been retarded by physiological or mechanical damage.

Grazing pressure by domestic livestock has been important on the area. This utilization appears to be a factor in shrub invasion as it disseminates noxious plant seed, weakens the grass plants, removes the fuel from the ground, and breaks the sod.

A review of scientific and historical literature disclosed that prior to white settlement, the periodic recurrence of wild fires which swept the desert grassland may have been a factor in keeping the grasslands free of shrubby invaders.

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