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LONG-TERM GRASS DYNAMICS WITHIN A MIXED-GRASS PRAIRIE

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Abstract. Western portions of the Edwards Plateau are dominated by a grass mosaic which consists of a rhizomatous midgrass, tobosagrass [*Hilaria mutica* (Buckl.) Benth.], and two stoloniferous short grasses, common curlymesquite [*Hilaria belangeri* (Steud.) Nash] and buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.]. Permanent 0.3 m x 6 m belt transects were established on three major soil series (Tobosa, Ozona, Valera) across several grazing treatments on the Texas Range Station near Barnhart, Texas, and the distribution of perennial grasses was mapped in 1951 (pre-drought), 1953 (drought), 1957 (post-drought), and 1987. Cover showed no consistent trends in relation to grazing. Total grass cover and composition within each soil series was found to be similar in 1951 and 1987, but cover was reduced by 20 to 56% during the drought period due primarily to a decrease in short-grass cover. This grassland mosaic exhibits a high degree of resistance and resilience to climatic variability.

Key Words. resistance, resilience, drought, tobosagrass, *Hilaria mutica*, community stability, mosaic grassland, Edwards Plateau, Texas

INTRODUCTION

Studies conducted on North American grasslands have documented significant long-term changes in community composition, productivity, and structure following periods of drought and grazing by wildlife and domesticated herbivores (Gardner 1950, Thomas and Young 1954, Weaver and Albertson 1956, Coupland 1958, Scifres *et al.* 1970, Herbel *et al.* 1972, Smeins et al . 1976, Wright and Van Dyne 1976). For example, Weaver (1961) found that during the drought of the 1930's many midwestern grasslands were converted from communities of tallgrass prairie climax dominants to communities consisting of drought-resisting and drought-evading mid-grass and short-grass species. Gradually, over a 20-year period, these subseral and invading species were replaced by climax dominants which reestablished from dormant rootstocks and seed.

A grassland community of the Edwards Plateau region of western Texas, which has experienced both periodic drought and grazing, has been studied extensively since the 1950's. Permanent sampling points established in 1950 presented an excellent opportunity to address long-term vegetation dynamics within this mixed-grass prairie community. Dominant species, tobosagrass [*Hilaria mutica* (Buckl.) Benth.], common curlymesquite [*Hilaria belangeri* (Steud.) Nash], and buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.] are common members of southwestern grasslands and are an important source of forage for domestic livestock.

Earlier studies by Thomas (1951, 1954) and Gonzalez (1957) focused on the influences of soils, precipitation, and grazing management on short-term vegetation dynamics of this grassland. Other studies have addressed methods of brush control and improving forage value (Herbel 1963, Wright 1973, Britton and Steuter 1983, Neuenschwander and Wright 1984).

The primary objective of this study was to identify long-term perennial grass dynamics of this southern mixed-grass prairie community with emphasis on the effect of periodic drought, soil type, and grazing by domestic herbivores.

STUDY AREA

The study was conducted at the Texas Range Station located 13 km south of Barnhart, Texas in the northwestern corner of Crockett County which is within the Edwards Plateau Land Resource Area. The climate is subtropical steppe, and the annual growing season averages 233 days (ESSA State Climatologist, Texas). Average annual precipitation is 52.0 cm, which occurs mostly as rainfall during spring and fall peaks. Precipitation is highly variable with annual totals as low as 19.3 cm and as high as 117.4 cm (Figure 1). Summer temperatures can be hot with temperature maxima of 37-43 C being common (ESSA State Climatologist, Texas).

The vegetation is characterized by a graminoid mosaic of the clonal rhizomatous midgrass tobosagrass and the stoloniferous short grasses common curlymesquite and buffalograss, with a scattered woody overstory of honey mesquite (*Prosopis glandulosa* var. *glandulosa* Torr.) (Thomas and Young 1954). Perennial grasses of lesser importance include sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.], vine mesquite (*Panicum obtusum H.B.K.),* threeawns (*Aristida* spp. L.), hairy grama (*Bouteloua hirsuta* Lag.), and tumblegrass [*Schedonnardus paniculatus* (Nutt.) Trel.]. Forb species include western bitterweed (*Hymenoxys odorata* DC.), common broomweed [*Xanthocephalum dracunculoides* (DC.) Shinners], grassland croton [*Croton neomexicanus* (Muell.) Arg.], Englemann daisy (*Engelmannia pinnatifida* Nutt.), manystem evax (*Evax multicaulis* DC.), and silverleaf nightshade (*Solanum elaeagnifolium* Cav.). Various cacti (*Opuntia* spp. Mill.) are also locally abundant within the study area. Plant nomenclature follows Gould (1969).

The terrain is mostly level (0-1% slope) with scattered shallow depressions and playa lake beds. Soils on the station, mapped in 1938 by Carter, Templin, and Mowery (unpublished), were formed from underlying hard limestone of the Washita division of the Lower Cretaceous. Soil series include Ozona (Kavett), Valera, Tobosa, Randall, and Irion. Data presented here are from the Ozona, Valera, and Tobosa soil series which account for approximately 90% of the land area. Ozona series soils are shallow clay loams (<35% clay) over limestone with thick indurated caliche at 30-51 cm (Petrocalcic Calciustoll). Soils of the Valera series are moderately deep, clayey (40-50% clay) soils formed over calcic or petrocalcic horizons at 51-82 cm (Petrocalcic Calciustoll). Tobosa series soils are deep, clayey (45-55% clay) soils with solum depths of 100-215 cm to underlying hard limestone (Typic Chromustert) (Figure 2).

METHODS

Permanent belt transects (0.3 x 6 m) were established in 1950 within several grazing treatments on Ozona, Valera, and Tobosa soil series. The location of perennial vegetation within each belt transect was mapped, by species, during the summers of 1951 (pre-drought period), 1953 (drought period), 1957 (post-drought)

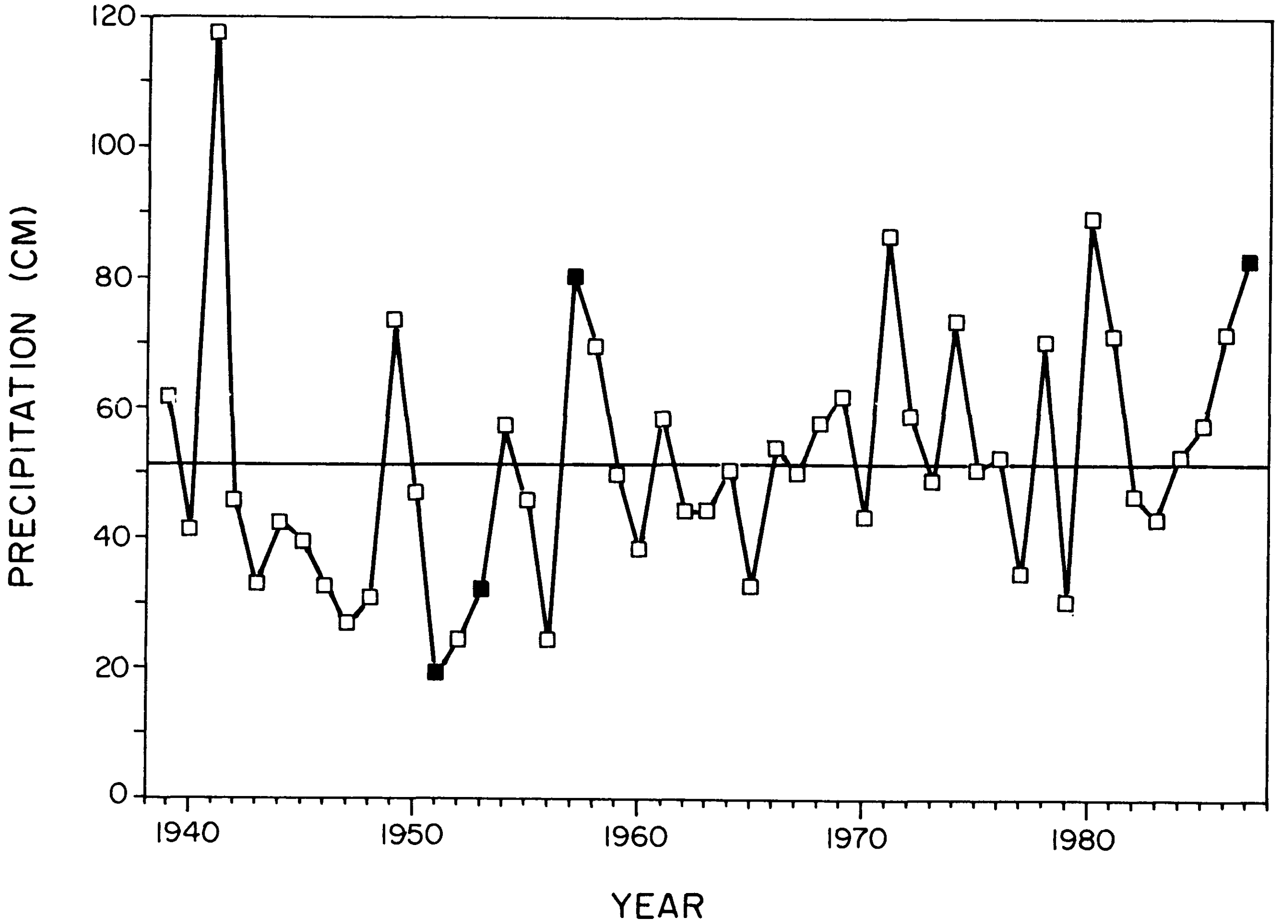

FIG. 1. Annual precipitation at the Texas Range Station, Barnhart, Texas from 1939 to 1987. The horizontal line represents the mean annual precipitation. Solid squares represent vegetation sampling years.

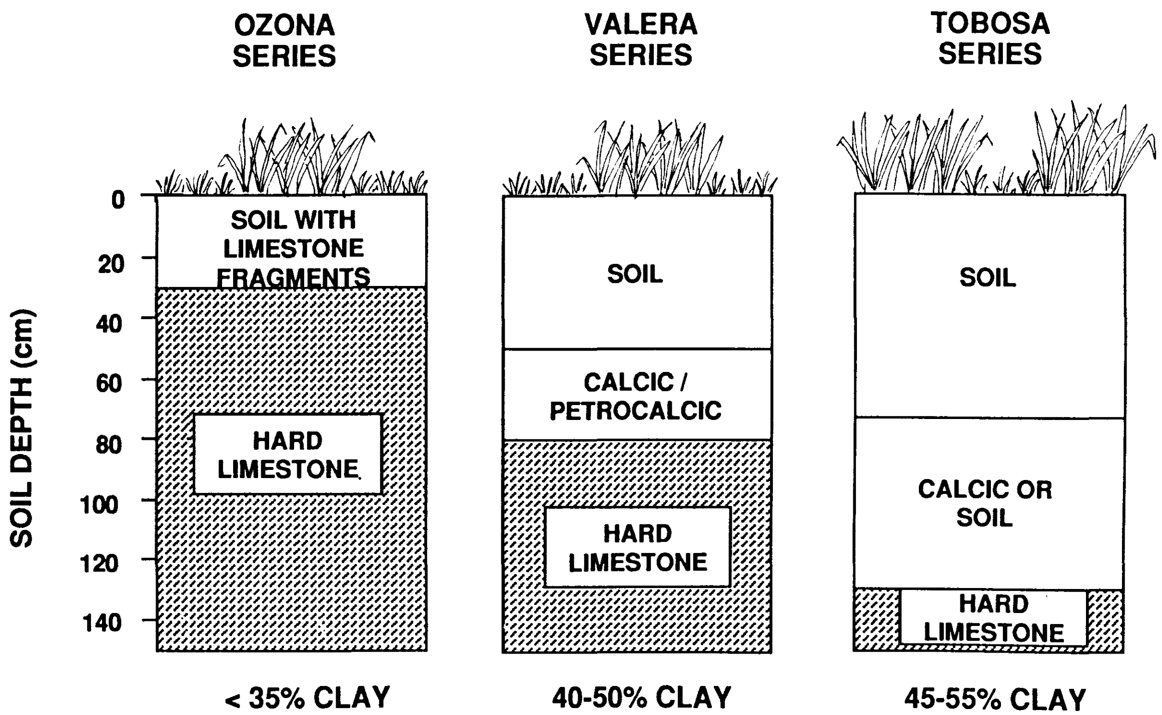

FIG. 2. Simplified schematic of typical soil profiles on Ozona, Valera, and Tobosa soil series on the Texas Range Station. The short-grass and mid-grass configuration is also illustrated for each series.

and 1987 using contiguous quadrats (30.5 x 30.5 cm) centered on 6 m belt transects (Thomas 1951, 1954). While 1951 is identified as pre-drought, it will be noted that 1951 had low rainfall (Figure 1). The two years prior to 1951 had above-normal to normal precipitation (Figure 1) and the vegetation in the early summer of 1951 still reflected the previous year's rainfall. Plant canopy cover was determined by measuring the distance of intercept, by species, along a line drawn down the center of each transect map. Fifty-two of the original belt transects were relocated and sampled in 1987 for comparison with the earlier mapping dates (n = 14, 17, and 21 for Valera, Tobosa, and Ozona soil series, respectively).

RESULTS AND DISCUSSION

The limited number of belt transects resampled within each grazing treatment/soil series combination made comparisons between grazing systems difficult. However, initial evaluation of the small data set revealed no consistent trend or difference in plant cover between the various grazing systems across years. Thomas (1954) observed that variation in vegetation composition on the station could be largely attributed to soils differences and annual precipitation rather than grazing treatment. Therefore, data collected among the grazing treatments were pooled by soil series for further analysis.

Total grass canopy cover, almost exclusively tobosagrass, common curlymesquite, and buffalograss, was found to be similar within and between soil series in 1951 and 1987 (Table 1). Both 1951 and 1987 were preceded by 2-3 years of normal to above-normal precipitation and therefore represent plant cover under favorable growth conditions. Tobosagrass cover was highest on the Tobosa soil series, while common curlymesquite and buffalograss cover were higher on the Ozona and Valera soils series prior to the drought period (1951) and in 1987. However, following a drought period which began in late summer 1951, the perennial grass canopy cover declined 56%, 43%, and 20% on the Ozona, Valera and Tobosa soil series, respectively, from 1951 to 1953 (Table 1). This decline was completely accounted for by a reduction in short-grass cover on all soil series. Large reductions in buffalograss cover, and other short-grasses, during drought periods has been previously documented in the Great Plains (Albertson and Tomanek 1965). The canopy cover of tobosagrass was unchanged or increased slightly on all soil series during the same period, however, a 24-37% decrease was observed across all soils from 1953 to 1957. No explanation has been developed to explain this decline during a period of nearly normal precipitation.

Table 1. Percent canopy cover (Mean ± S.E.) of tobosagrass and short-grass communities (common curlymesquite plus buffalograss) on the Ozona, Valera, and Tobosa soil series in 1951 (pre-drought), 1953 (drought), 1957 (post-drought), and 1987 at the Texas Range Station, Barnhart, Texas.

	Canopy Cover			
	1951	*1953*	*1957*	*1987*
		%		
Total Grass				
Ozona	92 ± .57	36 ± 1.3	56 ± 1.4	93 ± .41
Valera	95 ± .43	52 ± 1.6	58 ± 1.6	91 ± .72
Tobosa	84 ± .68	64 ± 1.4	52 ± 1.1	86 ± 1.3
Tobosagrass				
Ozona	15 ± .89	16 ± 1.0	10 ± .57	20 ± .87
Valera	32 ± 1.9	33 ± 1.9	25 ± 1.5	35 ± 1.8
Tobosa	53 ± 1.2	60 ± 1.5	38 ± 1.1	44 ± 1.3
Short-grass				
Ozona	76 ± 1.0	20 ± 1.1	45 ± 1.5	70 ± .92
Valera	62 ± 2.0	20 ± 1.2	32 ± 1.6	55 ± 2.0
Tobosa	31 ± 1.3	5 ± .63	11 ± .94	39 ± 1.5

The wide variation in reduced plant cover between the soils series is attributed to the pre-drought vegetation composition of each soil series and the response of the dominant grass species to drought conditions. Tobosagrass appears to be more tolerant of drought conditions than either of the short-grass species, therefore soils dominated by tobosagrass (Tobosa series) would be expected to maintain a higher proportion of their cover during a drought (Thomas 1954). For Ozona and Valera soils, an alterative hypothesis is that tobosagrass occupies favorable microsites which promote drought tolerance. This possibility is currently under investigation. The proportion of common curlymesquite and buffalograss present in a short-grass community will also effect plant cover during a drought, since earlier research has determined that common curlymesquite is less drought resistant than buffalograss (Thomas 1954).

Comparison of transect maps from 1951 and 1987 indicated that many transects retained the same distribution of plant species within the transect and vegetative composition over the 36-year period (Figure 3). However, several transects were found to have undergone significant changes in plant distribution and species composition during this same period (Figure 4). An evaluation of the change in relative cover of tobosagrass and short-grass from 1951 to 1987 within individual transects suggests that 59% of the transects sampled displayed less than a 15% change in the cover of these growth forms, while 23% of the transects had a 26% or greater change in relative cover of tobosagrass and/or short-grass.

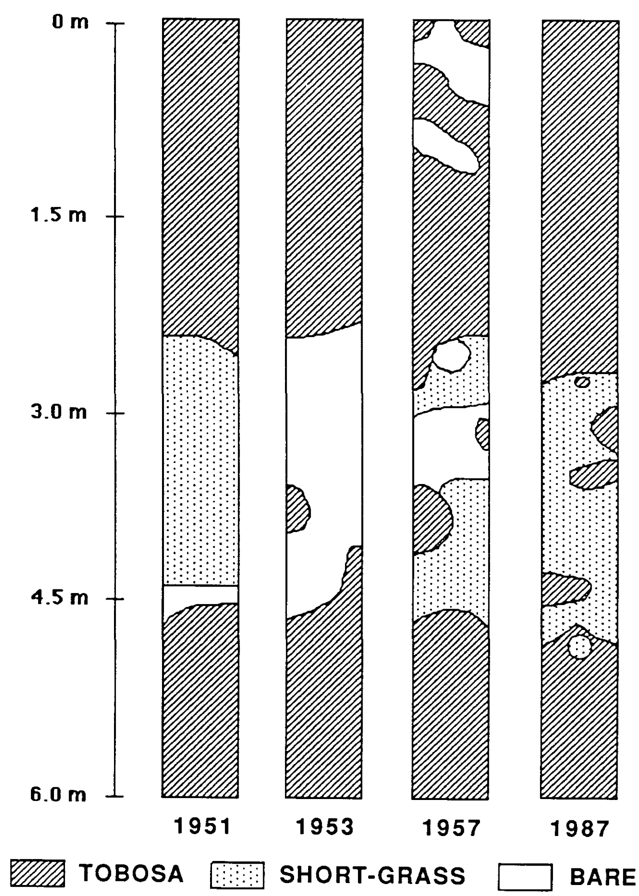

FIG. 3. Long-term vegetation mapping typical of transects which displayed no changes in species composition or distribution from 1951 to 1987.

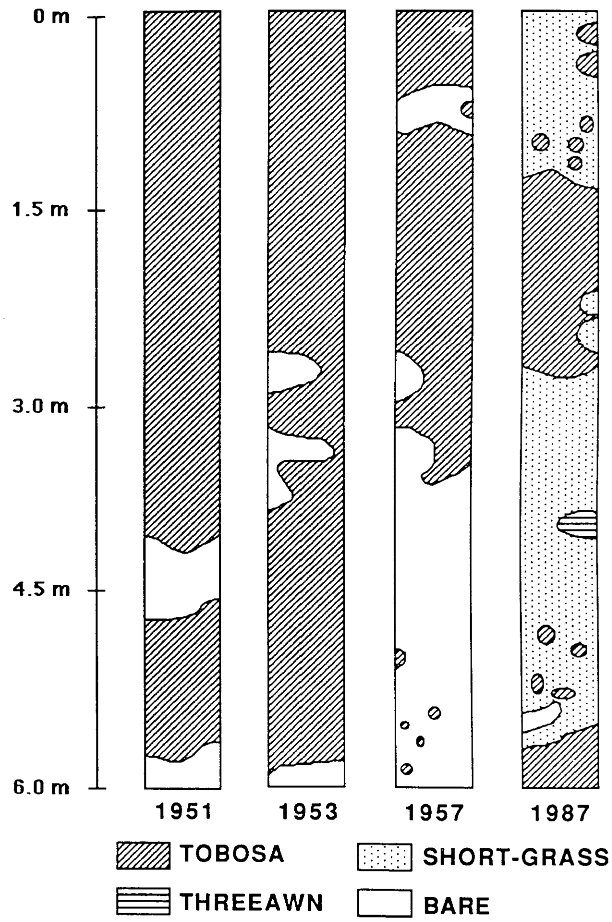

FIG. 4. Long-term vegetation mapping typical of transects which displayed major changes in species composition and/or distribution from 1951 to 1987.

During the drought interval, 1951-1956, significant changes in the vegetation composition of the belt transects occurred. Within all three soil series, areas mapped as short-grass in 1951 were found devoid of vegetative cover during the drought (Figure 3). These same areas were revegetated by short-grass species when favorable precipitation returned (Figure 3). In transects that had tobosagrass, it was found to be rather constant during the drought period, or experienced some decrease in cover, but rarely increased in abundance. This suggests that, although tobosagrass is drought tolerant, encroachment of this species into bare areas created during a drought by the loss of the short-grass component is limited. As noted earlier, by 1987 tobosagrass regained cover lost during the drought. Thomas (1954) observed that tobosagrass did not increase in abundance as quickly as the short grasses when favorable precipitation occurred. This indicates that clonal expansion of tobosagrass is relatively slow even under favorable growth conditions and/or tobosagrass is a poor competitor for resources when short grasses are present.

CONCLUSIONS

It is apparent that productivity and composition of this grassland system is highly influenced by fluctuations in annual precipitation. Nonetheless, the grassland mosaic exhibits a high degree of resistance and resilience to climatic variability. Although it is a dynamic system with a great deal of variation, after nearly 40 years following similar antecedent precipitation events, it exhibits basically the same perennial grass configuration and composition in 1987 as in 1951.

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