Interrelationships of Huisache Canopy Cover with Range Forage on the Coastal Prairie

C.J. SCIFRES, J.L. MUTZ, R.E. WHITSON, AND D.L. DRAWE

Abstract

Grass production was monitored based on seasonal harvests under various canopy covers of huisache on a Coastal Prairie blackland range site during 1978 and 1979. Grass production (Y) was not decreased in 1978, compared to that on essentially brush-free areas, until huisache canopy cover (X) exceeded 30% based on the relationship, $\hat{Y} = 2{,}346 + 20X - 0.62X^2$. Texas wintergrass standing crop apparently increased as huisache canopy cover increased to 25%, and its growth during winter partly compensated for standing crop losses of warm season species during the winter. In 1979, the contribution of the cool-season species was masked by greater production of warm-season species. Consequently, grass production decreased with increasing huisache canopy cover according to the relationship, $\hat{Y} = 4{,}047 - 14.9X - 0.29X^2$. Based on the functional relationship $\hat{Y} = a - b_1X - b_2X^2$, coefficients of determinations (r^2) ranged from 0.50 to 0.96 when estimates of annual production of grasses or production for the growing season only were regressed against huisache canopy cover.

Excessive brush cover is frequently cited as the primary limitation to effective management of Texas rangelands for livestock production (Smith and Rechenthin 1964). The generally negative attitude toward the role of woody plants on rangeland has provided the impetus for intensive research on control methods and implementation of control measures on hundreds of thousands of hectares of rangeland during the past 25 years (Scifres 1980). However, the increasing value of rangeland resources for wildlife habitat and recreation has stimulated an awareness of the need for maintaining adequate brush cover for wildlife. This awareness has provided the basis for reconsidering "brush management" in lieu of "brush control" for optimizing overall secondary production from rangelands (Box and Powell 1965, Scifres 1980).

Understanding the interactions of woody plants, required in certain amounts as food and cover for important game animals such as white-tailed deer *(Odocoileus virginianus)*, and the production of herbaceous range forages vital for livestock production is critical to development of effective brush management systems. Most research on this subject has related tree stand density and/or canopy cover to end-of-year herbaceous standing crop. In general, these studies have shown that as the density of canopy cover of woody plants increases, herbaceous standing crop decreases (Jameson 1967, Halls and Schuster 1965, Dahl et al. 1978). Grelen and Lohrey (1978) reported that the relationship between basal area (X) of longleaf pine *(Pinus palustris)* and herbaceous standing crop (Y) was $\hat{Y} = 1{,}670 - 6.8X$. Although the coefficient of determination was low ($r^2 = .20$), the variation in the relationship could be reduced when that proportion of the variation attributable to May through September rainfall was isolated as an independent variable. Koshi (1953) reported the relationship $\hat{Y} = 1{,}250 - 18.39X$ between predicted end-of-season herbaceous forage standing crop (Y) and canopy cover of woody plants (X) in the Texas Post Oak *(Quercus stellata)* Savannah. The relationship was developed within a canopy cover range of 0 to 20%, and with about 80% of the long-term average annual rainfall.

No research results are available concerning range herbage production interrelationships with woody plant canopy cover on the Coastal Prairie. The Coastal Prairie supports extensive stands of huisache *(Acacia farnesiana)* and mixed brush *(Prosopis-Acacia)*. However, native vegetation in this resource area gives the Coastal Prairie high potential for livestock production, and it supports large herds of white-tailed deer. The objective of this research was to quantify the influence of increasing huisache canopy cover on herbaceous production on the Coastal Prairie.

Description of the Study Site

The research was conducted on the Rob and Bessie Welder Wildlife Refuge about 8 km south of Sinton, Texas, on the Coastal Prairie. The Coastal Prairie is the southernmost extension of the tallgrass prairie. Long-term records indicate that the area has an annual average rainfall greater than 76 cm (Drawe et al. 1978). Average annual rainfall for the Welder Wildlife Refuge during the past 20 years is about 93 cm with a low of 43 cm in 1963 and a high of 127 cm in 1973 and 1976 (Mutz et al. 1978). The growing season lasts about 300 days, and the Coastal Prairie is characterized by warm temperatures, coastal air movements, and high relative humidities.

The study area was composed primarily of blackland range sites typified by Victoria clay (Udic Pellustert) and Monteola clay and Monteola complex (Typic Pellustert). Upland vegetation is typified by mixed-brush communities interspersed with almost solid stands of huisache. Drawe et al. (1978) classified the mixed-brush stands as "chaparral-bristlegrass communities" with blackbrush acacia *(Acacia rigidula)*, lime pricklyash *(Zanthoxylum fagara)*, lotebush *(Zizyphus obtusifolia)*, brazil *(Condalia obovata)*, Texas persimmon *(Diospyros texana)*, agarito *(Berberis trifoliolata)*, and spiny hackberry *(Celtis pallida)* as the primary woody components. Huisache, the primary woody species in the "huisache-mixed grass communities," invaded the immediate study site after application of mechanical brush control treatment of the original "chaparral-bristlegrass" communities in 1963 (Mutz et al. 1978). The huisache stands are composed of plants usually having from 1 to 5 main stems 4 to 20 cm in diameter.

The 480-ha study pasture was part of a three-herd, four-pasture grazing system stocked with cows and calves at roughly 1 AU/5 ha except for December 5, 1979, through March 14, 1979 when it was deferred.

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Materials and Methods

On May 11, 1978, 12 huisache stands of varying canopy cover were selected based on visual assessment. Brush canopy cover was estimated based on intercepts along five permanent lines, 47 m long and spaced 1.6 m apart, established in each stand.

Five grazing exclosures were equidistantly spaced along each center line in May 1978. After random selection of one of the cardinal directions, herbaceous vegetation in a 0.25 m^2 area was harvested to ground line at 1 m from each grazing exclosure immediately following their establishment. These samples were separated into grasses and forbs, oven-dried, and weighed to provide an estimate of initial standing crop (SC_i). Standing crop (SC_1) in a 0.25 m^2 plot inside each exclosure was harvested to ground line, separated into grasses and forbs, oven-dried and weighed the following July 1978. A 0.25 m^2 plot located 1 m from each exclosure was also harvested in July for an estimate of standing crop under grazing (SCG_1). The difference in standing crop inside the exclosure and initial standing crop (SC_1–SC_i) was considered an estimate of herbaceous production since the previous sampling. The exclosures were relocated, and this procedure was repeated during the fall (October), winter (February), spring (April–May), and summer (July–August) until late fall (November) 1979. For grazing periods subsequent to the first evaluation (spring 1978), herbage produced for the period was estimated from the difference between standing crop inside the exclosures (SC_t) and that on adjacent grazed areas harvested at the beginning of that grazing period (SCG_{t-1}). In November 1979, the grasses were further separated into cool-season and warm-season categories.

Herbage production for each year was estimated as the summation of standing crop differences ($SC_t - SCG_{t-1}$) categories (grasses, forbs) for each of the sampling periods. The functional relationship, $Y = a + bX$, $Y = a + b_1X + b_2X^2$, $\log Y = a + bX$, and $\log Y = a + b(\log X)$ were used to evaluate the response of the dependent variables [grass production for the year, grass produced for the growing season (May–October), and total herbage (grasses + forbs) produced for the growing season each year] to variation in the independent variable, huisache canopy cover. Based on significance of regression coefficients (b) using t-test ($P \leq .05$) and magnitude of coefficients of determination (r^2), the quadratic equation was chosen as the best expression of the relationships. Data from 1978 and 1979 were compared by testing differences between Y intercepts by *F*-tests and regression coefficients by t-tests ($P \leq .05$).

Results and Discussion

Rainfall Conditions

Annual rainfall was 83 cm in 1978 and 87 cm in 1979, 89 and 94%, respectively, of the average for the preceeding 20 years. During 1978, 14% of the annual rainfall occurred during the first quarter (January–March), compared to 25% of the annual total occurring during the same period in 1978 (Fig. 1). About 24% of the annual rainfall during both years was received during the second quarter (April–June). However, about half of the second quarter rainfall in 1978 was received in June, whereas rainfall was more evenly distributed during the second quarter in 1979. Rainfall during the third quarter (July–September) of 1979 represented 44% of the annual total compared to 39% of the total rainfall occurring at the same time in 1978. The fourth quarter (October-December) was relatively dry in 1979 (7% of the annual rainfall) compared to the fourth quarter of 1978 when 23% of the annual rainfall was received. Thus, the primary difference between the years of study was the slightly greater amount and improved uniformity of distribution of rainfall from March through September 1979, compared to the same period in 1978 (Fig. 1).

Functional Relationships

Based on comparisons of Y intercepts and regression coefficients, data for years of study could not be pooled. In 1978, 50% of the variation in annual production (kg/ha) of grasses (Y) was attributed to variation in huisache canopy cover [X(%)] with the

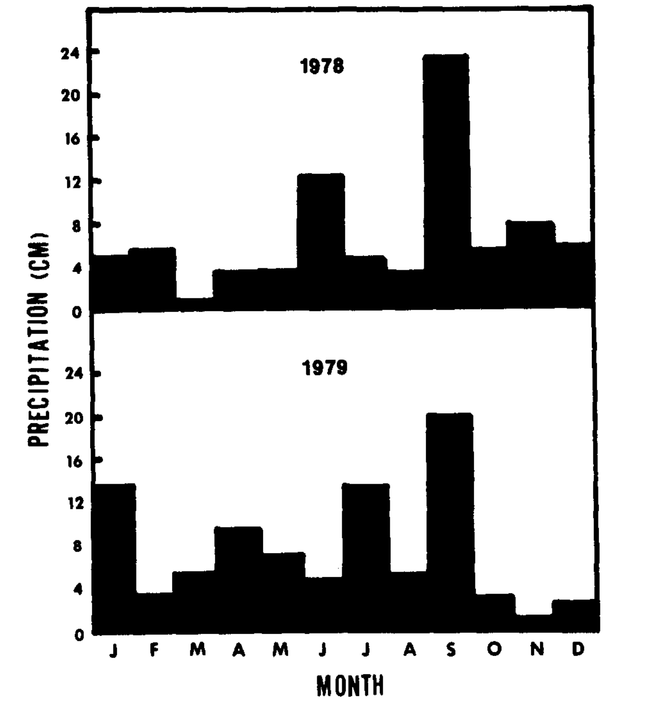

Fig. 1. *Monthly precipitation (cm) on the Welder Wildlife Refuge where the influence of huisache on herbage production was evaluated in 1978 and 1979.*

relationship $\hat{Y} = 2{,}345 + 20X - 0.62X^2$ (Fig. 2). Annual production of grasses did not decrease until huisache canopy cover exceeded 32%. This response curve was assumed to reflect the increasing importance of Texas wintergrass *(Stipa leucotricha),* the most abundant cool-season species on the study area, as huisache canopy cover increased from 0 to 32%. Although grasses were not separated into season-of-growth fractions to allow direct evaluation of the contribution of Texas wintergrass to annual production, consideration of grass produced during the warm season only was accepted as an indirect test. Based on the warm season only, 74% of the variation in NCSC of grasses could be attributed to variation in huisache canopy with the relationship, $\hat{Y} = 3{,}569 - 3.1X - 0.43X^2$ (Fig. 3). The negative sign of the linear regression coefficient, compared to the positive value in the equation for annual production of grasses, supports the hypothesized effect of cool-season species, primarily Texas wintergrass, on grass production in 1978.

Brock et al. (1978) reported that canopy zones of honey mesquite *(Prosopis glandulosa* var. *glandulosa)* on the Rolling Plains of Texas were characteristically dominated by Texas wintergrass while relatively small amounts of cool-season species occurred in the interstitial zones. Honey mesquite canopy reduction by various brush control methods caused a shift in the botanical composition of the stand towards increased relative abundance of warm-season species.

The difference (1,223 kg/ha) between the Y intercept of the functional relationship describing influence of huisache canopy cover on annual production of grasses (Fig. 2), compared to that of the equation for grass produced during the growing season only (Fig. 3) for 1978, provided an estimate of loss of the warm-season fraction during the winter, attributed primarily to weathering, in the absence of huisache canopy cover. The magnitude of weathering loss decreased as huisache canopy increased. For example, predicted weathering loss of 40% huisache canopy cover in 1978 was 603 kg/ha and 521 kg/ha at 60% huisache canopy cover, about half the predicted loss in the absence of huisache.

Response of annual production of grasses in 1978 to increasing huisache canopy cover differed somewhat from the relationship in 1978. Coefficients of variation were reduced, compared to those in 1978, regardless of dependent variable (Table 1). In 1979, 72% of

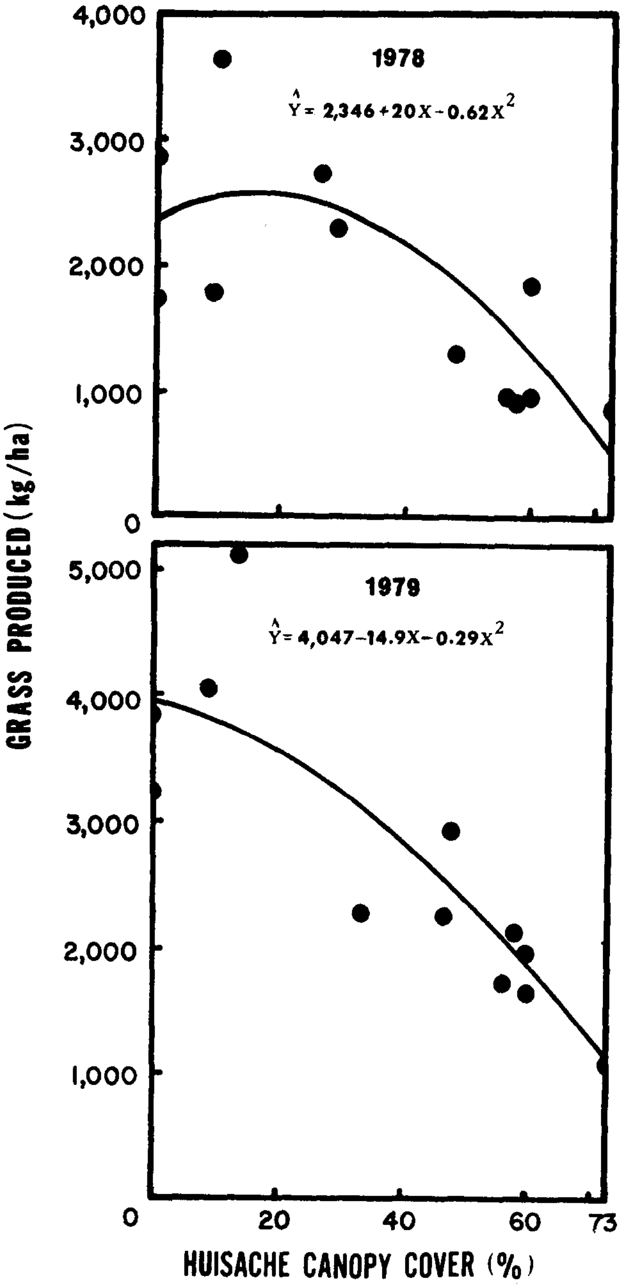

Fig. 2. *Influence of varying huisache canopy cover (%) on annual production of grass (kg/ha) on Welder Wildlife Refuge during 1978 and 1979.*

the variation in annual production of grasses was attributable to variation in huisache canopy cover according to the equation, $\hat{Y} = 4,047 - 14.9X - 0.29X^2$ (Fig. 2). Grass production was greater in 1979 than in 1978, presumably the result of more rainfall and more favorable rainfall distribution in 1979 than in 1978. Rainfall from July through September, about 38 cm, promoted a flush of growth of warm-season species late in the growing season. Thus, the influence of Texas wintergrass was not as pronounced in 1979 as in 1978, presumably the result of the "masking effect" of the increased abundance of warm-season grasses.

The lower rainfall in the fourth quarter of 1979 (6.1 cm), compared to that in 1978 (19.1 cm), also apparently reduced the amount of standing crop loss attributable to weathering. Grass produced during the 1979 growing season was the only case in which the quadratic expression did not significantly improve the data fit, when regressed against huisache canopy cover, compared to the simple linear expression. However, for the sake of uniformity, the quadratic expression $\hat{Y} = 4,578 - 47X - 0.013X^2$ is

Table 1. Coefficients of variation (%) of herbaceous production associated with varying huisache canopy cover in 1978 and 1979 on the Welder Wildlife Refuge near Sinton, Texas.

	Coefficient of variation (%)	
Herbage production variable	1978	1979
Annual, grasses only	38	28
Growing season, grasses only	22	9
Growing season, grasses + broadleaves	16	11

presented and accounted for 87% of the variation in grass production for the 1979 growing season as attributable to variation in the huisache canopy cover. The intercept for the equation representing influence of huisache canopy cover on grass production during the growing season only was 531 kg/ha less than the intercept of the equation relating response of grass production for the year. Therefore, in the absence of the influence of the huisache, an estimated

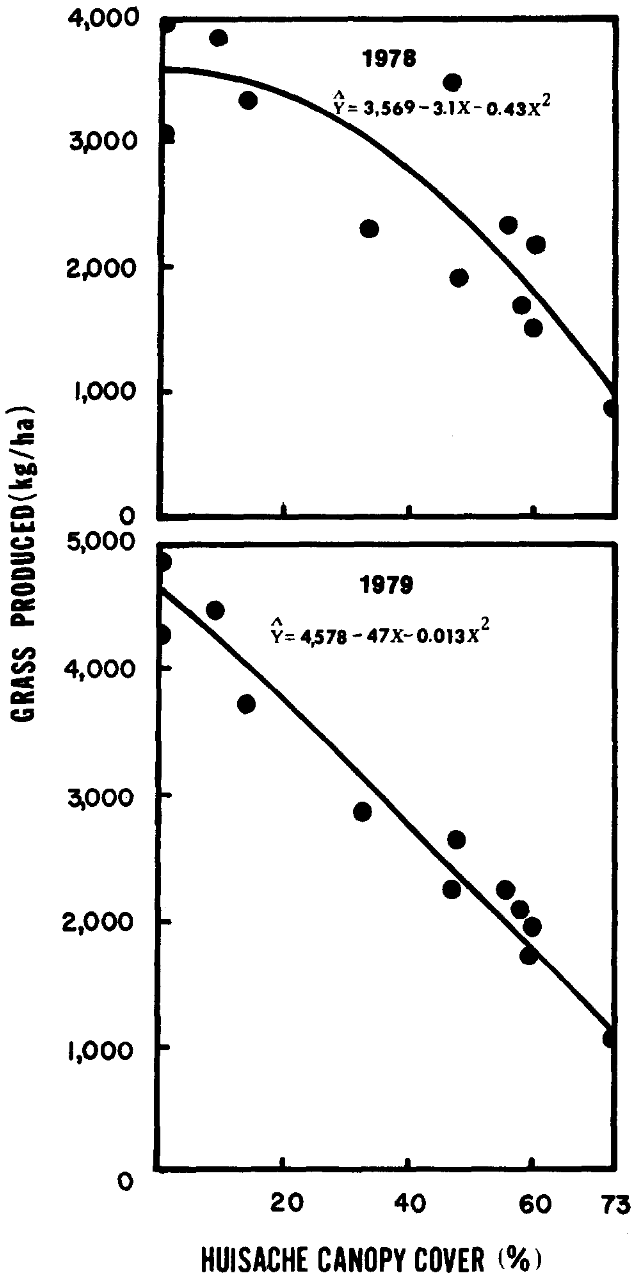

Fig. 3. *Influence of varying huisache canopy cover (%) on grass produced (kg/ha) during the 1978 and 1979 growing seasons on the Welder Wildlife Refuge.*

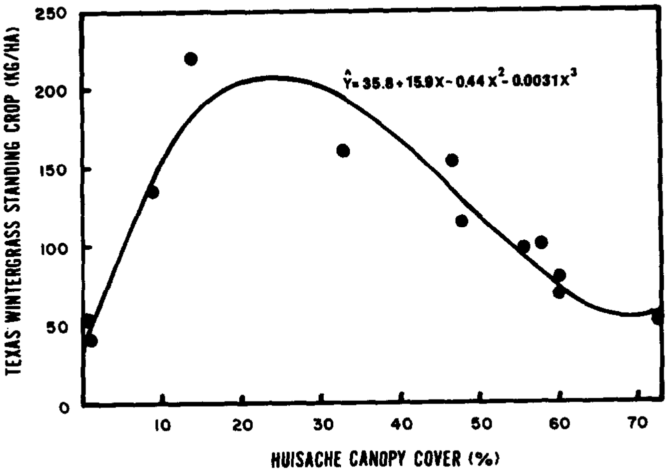

Fig. 4. *Influence of varying huisache canopy cover (%) on standing crop of Texas wintergrass in November 1979 on the Welder Wildlife Refuge.*

weathering loss of about 12% occurred in 1979 whereas an estimated 34% loss occurred in 1978.

Standing crop of Texas wintergrass in November 1979 serves as an example of the general relationship of cool-season grasses and huisache canopy cover (Fig. 4). "Best fit" of the data resulted from the equation, $\hat{Y} = 35.8 + 15.9X - 0.44X^2 + 0.0031X^3$, from which 88% of the variation in Texas wintergrass standing crop (kg/ha) was attributable to variation in percent huisache canopy cover with coefficient of variation of 20%.

The bulk of the herbaceous broadleaves produced in both years were warm-season forbs. Thus, functional relationships for total herbage produced during the growing season only were considered to be more reliable than annual herbage production as indicators of the influence of huisache canopy cover on herbaceous stands. Functional relationships describing the response of total herbage production during the growing season to varying huisache canopy cover (%) were $\hat{Y} = 4{,}068 - 15X - 0.24X^2$ ($r^2 = 0.80$) for 1978, and $\hat{Y} = 5{,}681 - 38X - 0.24X^2$ ($r = 0.94$) for 1979. Based on differences in intercepts of prediction equations for the growing season (total herbage produced–grass production), about 500 kg/ha of broadleaves were present in 1978 in contrast to about 1,100 in 1979 in the absence of huisache canopy cover. The difference between years was attributed to increased abundance of annual sumpweed *(Iva annua)* in 1979.

Ecological and Management Implications

These data indicate that the influence of huisache canopy on grass production is most pronounced in years when rainfall amount and/or distribution are most favorable for growth of warm-season species. The composition of herbaceous vegetation changes markedly as huisache canopy cover increases. In the absence of huisache, herbaceous stands are dominated by warm-season grasses such as little bluestem *(Schizachyrium scoparium)*, big cenchrus *(Cenchrus myosuroides)*, meadow dropseed *(Sporobolus asper* var. *drummondii)*, big bluestem *(Andropogon gerardii)*, and other highly productive grasses desirable for livestock grazing (Mutz et al. 1978). As huisache canopy cover increased in this study, the absolute amount of Texas wintergrass increased and the proportion of warm season grasses decreased. Drawe et al. (1978) have also noted that "As the huisache overstory increases the understory herbaceous vegetation has shifted to more shade-tolerant and/or cool-season species such as Texas wintergrass, canarygrass (*Phalaris* sp.), ozarkgrass (*Limnodia arkansana* (Nutt.) L.H. Dewey), and common six-weeksgrass (*Vulpia octoflora* (Walt.) Rydb.)."

Although Texas wintergrass is of less grazing value than many mid and tall grasses during the warm season (Powell 1966), it furnishes green feed when the warm-season grasses are dormant and of extremely low nutritional value. Much of the warm-season standing crop is lost to weathering during the winter, and that left standing is low in energy and protein content (Durham and Kothmann 1977). The huisache cover apparently ameliorates the environment, much as honey mesquite functions in the Rolling Plains (Brock et al. 1978), providing conditions favorable for Texas wintergrass growth and development.

Increasing huisache canopy cover also influences botanical composition of the forb stands. For example, forbs on areas without huisache cover were primarily annual sumpweed, frostweed *(Verbesina virginica)*, sawtooth frogfruit *(Phyla incisa)*, lanceleaf frogfruit *(P. lanceolata)*, and "sun-loving" prairie forbs such as clasping coneflower *(Rudbeckia amplexicaulis)*, silverleaf nightshade *(Solanum elaeagnifolim)*, western ragweed *(Ambrosia psilostachya)*, Hooker eryngo *(Eryngium hookeri)*, Texas croton *(Croton texensis)*, and straggler daisy *(Calyptocarpus vialis)*. Common forbs occurring in the shade of the huisache were Karnes sensitive-briar *(Schrankia latidens)*, American snoutbean *(Rhynchosia americana)*, least snoutbean *(R. minima)*, Carolina geranium *(Geranium carolinanum)*, yellow woodsorrel *(Oxalis dillenii)*, violet ruellia *(Ruellia nudiflora)*, Florida snakecotton *Froelichia floridana)*, and clammy groundcherry *(Physalis heterophylla* var. *villosa)* with spiny aster *(Aster spinosus)* and water hyssop (*Bocopa* spp.) occurring on wetter areas.

Conclusions

Huisache stands on the Wilder Wildlife Foundation appear to be typical on the Coastal Prairie, and the blackland range site in this study has been subjected to sound grazing management. Herbaceous warm-season forage production on the Coastal Prairie is characterized by a spring growth peak, a lesser fall peak and usually limited summer growth, the latter being a result of reduced rainfall. The winters are relatively mild and wet, which causes considerable loss of the mature standing crop through weathering. The only cool-season species of any importance is Texas wintergrass and, on the blackland site, it appears to be associated primarily with the huisache stands.

In 1978, there was a tendency for production of grasses to increase as the huisache canopy cover increased from 9 to 30%, compared to open areas. This response was attributed to the increased standing crop of Texas wintergrass which compensated for weathering losses of the warm-season grasses during the winter evaluation period. The production of grasses steadily decreased as huisache canopy cover increased beyond 30%.

Food habits of white-tailed deer vary with season on the Coastal Prairie. During the winter-spring periods of 1963, 1964, and 1965, they were primarily grazers rather than browsers (Chamrad and Box 1968). Although the white-tailed deer strongly preferred forbs, preference for Texas wintergrass was third high and was fifth high for the cool-season species, rescuegrass *(Bromus willdenowii)* and ozarkgrass. On clay soils, huisache is one of the preferred browse species (Drawe and Box 1968).

Since huisache contributes to quality wildlife habitat, especially for white-tailed deer, and since cool-season grasses are critical for improving nutritional status of livestock diets during the winter, it would appear that brush management schemes for the Coastal Prairie should be directed towards thinning heavy stands of huisache rather than clearing extensive areas. Livestock production and wildlife habitat quality can concomitantly be optimized through such a brush management approach.

Literature Cited

Box, T.W., and J. Powell. 1965. Brush management techniques for improved forage values in south Texas. Trans. N. Amer. Wild. and Nat. Res. Conf. 30:285-296.

Brock, J.L., and R.H. Haas, and J.C. Shaver. 1978. Zonation of herbaceous vegetation associated with honey mesquite in northcentral Texas. Proc. Internat. Rangeland Congr. 1:187-189.

Chamrad, A.D., and T.W. Box. 1968. Food habits of white-tailed deer in south Texas. J. Range Manage. 21:158-164.

Dahl, B.E., and R.E. Sosbee, J.P. Goen, and C.S. Brumley. 1978. Will mesquite control with 2,4,5-T enhance grass production? J. Range Manage. 31:129-131.
Drawe, D.L., and T.W. Box. 1968. Forage ratings for deer and cattle on the Welder Wildlife Refuge. J. Range Manage. 21:225-228.
Drawe, D.L., A.D. Chamrad, and T.W. Box. 1978. Plant communities of the Welder Wildlife Refuge. Welder Wildlife Found. Contr. No. 5, Series B (Rev.) 38 p.
Durham, A.J., Jr., and M.M. Kothmann. 1977. Forage availability and cattle diets on the Texas Coastal Prairie. J. Range Manage. 30:103-106.
Grelen, H.E., and R.E. Lohrey. 1978. Herbage yield related to basal area and rainfall in a thinned longleaf pine plantation. So. Forest. Ext. Sta. Bull. 50-232. 4 p.
Halls, L.K., and J.L. Schuster. 1965. Tree-herbage relations in pine-hardwood forests of Texas. J. Forest. 63:282-283.
Jameson, D.A. 1967. The relationship of tree overstory and herbaceo understory vegetation. J. Range Manage. 20:247-249.
Koshi, P.T. 1953. An evaluation of forage production under various den ties of oak woodland. M.S. thesis, Dep. Range and Forestry, Tex A&M College, College Station. 62 p.
Mutz, J.L., C.J. Scifres, D.L. Drawe, T.W. Box, and R.E. Whitson. 197 Range vegetation after mechanical brush treatment on the Coast Prairie. Texas Agr. Exp. Sta. Bull. 1191. 16 p.
Powell, J. 1966. Forage production following selected mechanical bru control practices in south Texas. M.S. thesis, Texas Tech Univ., Lu bock. 73 p.
Scifres, C.J. 1980. Brush Management. Principles and Practices for Tex and the Southwest. Texas A&M Univ. Press, College Station, TX. 360
Smith, H.N., and C.A. Rechinthin. 1964. Grassland restoration. The Tex brush problem. U.S. Dep. Agr., Soil Conserv. Serv. Unnumbered pub cation. Temple, Tex. 33 p.