Secondary Succession Following Extended Inundation of Texas Coastal Rangeland

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Highlight: *Periodic tropical storms may cause large areas of Texas coastal rangeland to be inundated for several years. The range sites usually support* Acacia-Prosopis *communities prior to flooding with herbaceous vegetation dominated by several species of* Setaria. *Following extended inundation with fresh water, secondary succession proceeds from a sedge-sodgrass stage through a sodgrass-bunchgrass stage to a bunchgrass stage. Longtom (*Paspalum lividum *Torr.) initially stabilizes the areas as free-standing water withdraws, followed by common bermudagrass (*Cynodon dactylon *(L.) Pers.) as the surfaces dry. Sprangletops (*Leptochloa *spp.) are among the earliest desirable species to appear during succession, followed by species of* Trichloris *and* Eragrostis. *In many cases, spike dropseed (*Sporobolus contractus *Hitchc.) forms a stable vegetation stage on the areas. Although highly productive, periodic prescribed burning is required for effective utilization of the spike dropseed.*

The Texas Coastal Prairie, which occupies nearly 4 million ha, is a nearly level, slowly drained plain less than 46 m in elevation on the eastern edge of the South Texas Plains (Gould, 1969). The Coastal Prairie is characterized by average annual rainfall of about 90 cm and a growing season of more than 325 days. Natural vegetation has developed in response to warm temperatures and the relatively high humidity characteristic of semitropical environments. Potential vegetation is mostly grassland dominated by species such as big bluestem (*Andropogon gerardi* Vitman), seacoast bluestem (*Schizachyrium scoparium* var. *littoralis* (Nash) Gould) and several *Panicums*. Use of introduced grasses such as buffelgrass (*Cenchrus ciliaris* L.) as tame pasture in conjunction with native range is a common practice following brush control. The Coastal Prairie supports a general cover of woody plants characterized by honey mesquite (*Prosopis glandulosa* Torr. var. *glandulosa*), various acacias (*Acacia* spp.), oaks (*Quercus* spp.), and pricklypears (*Opuntia* spp.). Drainage is usually a problem but soils are highly productive. Much of the Coastal Prairie is utilized for production of row crops adapted to semitropical conditions following development of drainage systems.

The Coastal Prairie grades into the Rio Grande Plain on the west and the southern portion of the coast supports vegetation similar to this western area. However, near the coastline, the Coastal Prairie exhibits unique ecological characteristics. Many of these characteristics are in response to periodic, high-intensity coastal storms which release massive amounts of precipitation inland. Since the area drains slowly, lowlands and depressed areas may be inundated, usually with fresh water, for periods of 5 to 10 years. Inundation for such extended periods has an apparent drastic affect on vegetation and may remove a considerable percentage of the rangeland from grazing use. The rangeland vegetation then must be replaced by the slow process of secondary succession. During successional change, land area required to support an animal unit (A. U.) may increase from 4.5 ha/year to greater than 9.3 ha/year.[1] Observations in the area indicate that as much as 3 to 5% of the rangeland within 25 km of the coast may be affected at one time or another by the tropical storms. These inundated areas, commonly referred to as "lagunas" present unique management problems to ranchmen. Since little was known about specific successional aspects, this study was conducted to determine the vegetational pattern of lagunas in the Coastal Prairie following extended inundation.

Study Location

The study area is located on the El Sauz Ranch near Raymondville in Willacy County, Tex. Vegetation has characteristics of both the Texas Coastal Prairie and the Rio Grande Plain. Species composition of the specific study area was most similar to that of the Rio Grande Plain.[2] Inland areas support a dense cover of mixed, woody vegetation which can generally be classified as an *Acacia-Prosopis* association. These were classified as "Chaparral-bristlegrass" communities by Box and Chamrad (1966). Large single-stemmed honey mesquite dominates the overstory with species such as huisache (*Acacia farnesiana* L.), spiny hackberry (*Celtis pallida* Torr.), lime pricklyash (*Zanthoxylum fagara* (L.), Sarg.) and bluewood (*Condalia obovata* Hook.) in a thicketized, secondary layer. Pricklypear and barbwire acanthocerus (*Acanthocereus pentagonus* (L.) Britt and Rose) are common succulents. Under long-term grazing, grasses are usually dominated by several species of *Setaria*.

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[1] Personal communication with management staff, El Sauz Ranch, Raymondville, Texas.

[2] Durham, G. P., and C. J. Scifres. 1973. Unpublished data.

Materials and Methods

A lowland area inundated following hurricane "Beulah" in 1967 was selected for study. The study area was circular and approximately 2.5 km in diameter. Slope from center to the upper edge was approximately 3 to 5%.

Eight sample lines were established radiating from the center of the study area to the upper edge, where vegetation was undisturbed by the standing water. Starting at the present water's edge and at 60-m intervals along each line, sampling stations were established. At each sampling station, 10 sample areas were randomly located for estimation of basal cover of the vegetation using a 10-point, inclined, frame. Duplicate soil samples were recovered at approximately 120-m intervals from 0 to 15, 15 to 30, and 30 to 60 cm deep. Soil characteristics evaluated were soil texture by the hydrometer method, soil reaction on a soil-water (1:2) slurry, and organic matter as determined by the acid digestion-titration method. Soil nutrients considered were calcium, magnesium, phosphorus as P_2O_5, and potassium as K_2O. Estimates of nutrient level were accomplished by the Texas A&M University Soil Testing Laboratory.

Basal cover data were sorted at each sampling station by dominant species. The two or three dominant species (those which provided more than 50% of the cover) at each sampling station were used to delineate vegetation zones. After determination of zonation by dominant species, associated species composing 1% or more of the composition based on cover estimates were considered in final characterization of the vegetation.

Several additional, similar areas were observed after formulation of vegetational patterns on the primary study area. These observations were included in final interpretation of data from the study area. Observations from May to December, 1974, included degree of use of the inundated areas by wildlife and domestic livestock.

Results and Discussion

Potential vegetation for the study areas is probably open grassland or savannah supporting scattered honey mesquite and huisache (Box and Chamrad, 1966). Grasses such as four-flower trichloris (*Trichloris pluriflora* Fourn.), white tridens (*Tridens albescens* (Vasey) Woot. and Standl.), switchgrass (*Panicum virgatum* L.) and plains bristlegrass (*Setaria macrostachya* H.B.K.) in conjunction with buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.), and Hartweg paspalum (*Paspalum hartwegianum* Fourn.) would probably dominate the site. Spike dropseed (*Sporobolus contractus* Hitchc.) tends to increase under overgrazing on such sites. The soils are typically poorly drained, slowly permeable and the study areas typically receive considerable runoff.

Rangeland previously inundated for extended periods on the Texas Coastal Prairie serve as excellent wildlife habitat. Numerous species of waterfowl were observed near the areas which had free-standing water. Tracks noted around shoreline in the central portions of the lagunas indicated that species such as javelina (*Pecari tajaco* L.), feral hog (*Sus scrofa* L.), nelgai antelope (*Boselaphus tragocamelus* Pallas) and whitetail deer (*Odocoileus virginiana* Boddaert) frequently utilize the areas as watering and feeding sources. Livestock usually grazed the central portions of the lagunas more heavily than on the periphery. This heavy use undoubtedly affects successional patterns. Shorelines usually ranged from 7 to 30 m in width from free-standing water to areas with vegetal cover in lagunas 3 to 5 years old. Box and Chamrad (1966) working in a similar area noted "bands of vegetation" around lakes and ponds.

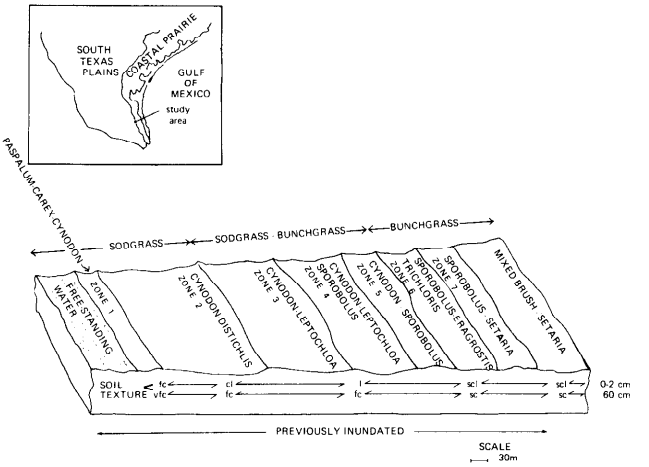

Fig. 1. *Generalized vegetation zones based on dominant genera moving upslope from free-standing water through previously flooded areas to the original mixed brush-*Setaria *communities.*

However, they made only general observations relative to species composition and relationships of the zones.

Paspalum-Carex-Cynodon **zone (1)**

A band of sedges and stoliniferous and/or rhizomatous grasses occupying the shoreline and into the standing water was characterized as a *Paspalum-Carex-Cynodon* zone (Fig. 1). It was the first of three sodgrass zones grading upslope. The primary grasses were longtom (*Paspalum lividium* Trin.) and common Bermudagrass (*Cynodon dactylon* (L.) Pers.) (Fig. 2). Several species of sedge, mostly *Carex* spp., were present at the periphery of the shoreline and, in most instances, formed pure communities into the free-standing water. Longtom occupied the almost saturated soil apparently too dry for maximum development of sedges and too wet for common bermudagrass. Longtom is adapted to wetlands and is evidently an initial

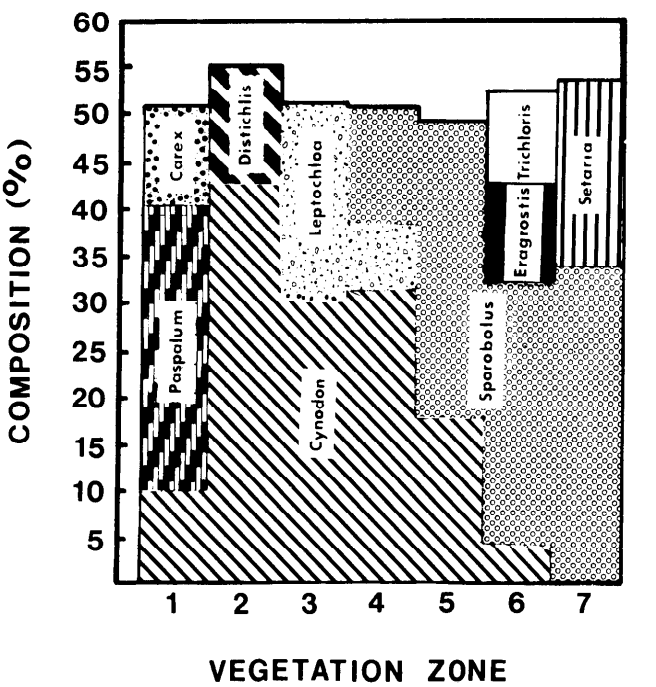

Fig. 2. *Composition of dominant vegetation as determined from estimates of basal cover by zones of previously inundated Texas Coastal Prairie.*

stabilizer of lowlands in the coastal zone. Rhizomes of longtom frequently extend into free-standing water 1.5 m or more and apparently maintain photosynthetic activity during flotation. The species roots at the nodes in saturated soil along the shoreline. Consequently, longtom forms dense mats of vegetation over logs and other surface debris. Box and Chamrad (1966) observed longtom stolons to actually grow much like a vine up the stems of large herbaceous plants. The species is evidently palatable and is heavily utilized along the laguna shorelines. This utilization augments lateral spreading and, in some cases, may be responsible for formation of heavy longtom mats. Box and Chamrad (1966), describing vegetation surrounding lakes and ponds near Sinton, Tex., some 320 km north of the study area, indicated that longtom was replaced by buffalograss as the water receded. Common Bermudagrass replaced longtom as the soil dried upslope in the present study. The similarities in growth habit of common Bermudagrass and buffalograss and the association with longtom would give credence to generalizing and referring to the first few vegetation bands as sodgrass zones.

Soils of the shoreline and first vegetation zone range from fine clay in texture at the surface to very fine clay at 60 cm deep. They were basic in reaction with pH varying from 7.6 in the surface 15 cm of soil to 8.2 at the 30-cm depth (Table 1). Soils of these zones were high in calcium (>3000 ppm) and magnesium (>250 ppm). Potassium levels exceeded 600 ppm and phosphorus decreased from about 200 ppm in the surface 15 cm of soil to about 100 ppm at the 60-cm depth. Organic matter ranged from 1 to 2% but generally decreased with depth. The first vegetative zone varied in width from 15 to 60 m. It usually extended to 30 m upslope from the point where the shoreline intersected free-standing water.

Cynodon-Distichlis **zone (2)**

This zone was usually less than 300 m in width (averaging 180 m) and was dominated by common Bermudagrass and seashore saltgrass (*Distichlis spicata* L.). Seashore saltgrass was almost completely restricted to the band of vegetation in the second zone (Fig. 2). Visual observations indicated less grazing preference for seashore saltgrass than for longtom or common Bermudagrass and less use of the zone by grazing animals in general than was noted in the first zone.

Associated species in the second vegetation zone included hoary fogfruit (*Phyla nodiflora* (L.) Greene var. *reptans* H.B.K.). Hartweg paspalum, green sprangletop (*Leptochloa dubia* (H.B.K.) Nees), Neally sprangletop (*L. nealleyi* Vasey), knotroot bristlegrass (*Setaria geniculata* (Lam.) Beauv.), Hall's panicum (*Panicum hallii* Vasey), several species of small statured sedges and western ragweed (*Ambrosia psilostachya* DC.). Hoary fogfruit and western ragweed, broadleaved perennials, were the only dicotyledenous species of significant occurrence in the vegetation regardless of zone. Spring aspect includes several additional broadleaved herbaceous species which may be related to high use of lagunas by wildlife.

Cynodon-Leptochloa **zone (3)**

This zone occurred 375 to 460 m from free-standing water and was differentiated from the previous vegetation zone by the increase in importance of green sprangletop (Fig. 2). Green sprangletop, a hardy perennial of good grazing value, developed vigorous stands and contributed 25 to 35% of the composition. Associated species were similar to those in the second vegetation zone composed primarily of mourning lovegrass (*Eragrostis lugens* Nees), Hartweg paspalum, traces of seashore saltgrass, Hall's panicum, several species of sedges, and western ragweed. Soils were similar to those of the previous zone.

Cynodon-Leptochloa-Sporobolus **zone (4)**

This zone occurred 460 to 610 m from free-standing water. Primary species in addition to dominants were Hartweg paspalum and knotroot bristlegrass. This zone and the previous vegetation band were intermediary between the sodgrass and bunchgrass zones (Fig. 1). As in zone three, only trace amounts of seashore saltgrass were contacted. This was the first zone in which spike dropseed became an apparent codominant. This species is grazed by livestock early in the growing season, but becomes extremely coarse and palatability decreases later. Spike dropseed rangeland is burned regularly, often annually, to maintain a growth type more desirable for grazing. Winter burns when spike dropseed is dormant would seem logical for effective management of the study area.

Soil, grading from a clay loam in the surface 15 cm to a fine clay at 60 cm deep, continued to increase in percentage of larger separates as samples were recovered further upslope. Soil reaction ranged from neutral in the surface soil to over pH 8 at 60 cm deep (Table 1). Organic matter decreased from 2% in surface soil to 0.3% at 60 cm deep. As with the previous vegetation zone, calcium and magnesium concentrations were high. Potassium usually exceeded 600 ppm regardless of soil depth and phosphorus ranged from 100 ppm in the surface soil to about 50 ppm at 60 cm deep.

Sporobolus **dominated zones (5, 6, 7)**

Spike dropseed became more prevalent and associated primarily with common Bermudagrass at 670 to 765 m from free-standing water moving upslope (Fig. 2). This *Cynodon-Sporobolus* zone was distinct from either of the adjacent vegetation zones. However, soils were similar to those of the next vegetation zone, the *Sporobolus-Eragrostic-Trichloris* zone, moving upslope. Soils ranged from loam in the surface 15 cm to fine clay at 60 cm deep. Calcium concentrations were similar to those detected in

Table 1. Characterization of soils from various vegetation zones in previously inundated Texas Coastal Prairie.

Zone(s)	Soil depth (cm)	Textural class[a]	pH	Organic matter (%)	Nutrient characteristics (ppm)[b] P	K	Ca	Mg
1,2	0-15	fc	7.6	0.8	195	>600	>3,000	>250
	15-30	fc	7.4	1.8	140	>600	>3,000	>250
	30-60	vfc	8.2	0.8	115	>600	>3,000	>250
3,4	0-15	cl	7.0	1.8	81	>600	2,970	>250
	15-30	cl	7.9	0.5	195	>600	2,870	>250
	30-60	fc	8.1	0.3	52	>600	2,870	>250
5	0-15	l	7.1	1.2	44	>600	2,200	>250
	15-30	l	7.4	1.2	74	>600	2,090	>250
	30-60	fc	8.0	0.6	97	>600	3,000	>500
6	0-15	l	7.0	0.6	32	475	1,210	230
	15-30	l	7.6	0.8	49	560	1,060	212
	30-60	fc	8.9	0.7	62	>600	>3,000	>250
7	0-15	scl	5.3	0.4	32	460	700	145
	15-30	l	6.0	0.8	46	535	760	207
	30-60	sc	8.7	1.0	79	>600	>3,000	>250

[a]Soil textural classes are abbreviated as follows: fc = fine clay; vfc = very fine clay; cl = clay loam; l = loam; scl = sandy clay loam; and, sc = sandy clay.

[b]Available N content was low in all samples.

Fig. 3. *Typical "laguna" of Texas Coastal Prairie characterized by remnants of woody plants killed by extended inundation. Photo taken in zone 6 (*Cynodon-Sporobolus*) toward center of laguna.*

zones near free-standing water. Magnesium concentration increased with soil depth to >500 ppm at 30 to 60 cm. The greatest decrease in available nutrients in zone five relative to vegetation zones downslope occurred with phosphorus. Phosphorus concentrations ranged from slightly over 40 ppm in the surface 15 cm of soil to less than 100 ppm at 60 cm deep.

In the *Cynodon-Sporobolus* zone and the *Sporobolus-Eragrostis-Trichloris* zone (Fig. 1 and 3), hoary fogfruit was replaced by western ragweed as the principal broadleaved species. In a similar area, Box and Chamrad (1966) listed spring aster (*Aster spinosus* Benth.) as the prevalent herbaceous species often associated with longtom in the wetlands. The primary grass associated with the dominants in these zones was knotroot bristlegrass. Traces of plains bristlegrass and southwestern bristlegrass (*Setaria schellei* (Steud.) Hitchc.) were also contacted as these zones graded into a *Sporobolus-Setaria* zone at about 765 to 915 m from free-standing water.

Soil texture and pH of the *Sporobolus-Eragrostis-Trichloris* zone was similar to those of the previous zone downslope. However, organic matter content decreased to less than 1% at all depths. Nutrient levels decreased as compared to zones downslope with greatest reductions in potassium and calcium.

The *Sporobolus-Setaria* vegetation zone, as with previous zones, was dominated by spike dropseed (Fig. 2). However, over 20% of the vegetation composition based on basal interceptions was composed of *Setaria* spp. The more prevalent knotroot bristlegrass dominated the lower end of the vegetation zone and huisache, 0.5 to 1 m tall, had reestablished. At the upper end, woody plants, apparently undamaged by standing water, became important components of the vegetation. This zone, the final zone in the vegetation of lagunas, graded into typical mixed-brush communities of Texas Coastal Prairie rangelands. As distance from free-standing water exceeded 915 m, mixed-brush began dominating the vegetation with a concomitant decrease in the presence of spike dropseed. *Setaria* spp. including knotroot, plains, and southwestern bristlegrass, were primary grasses in the mixed-brush communities. Soils on these uplands and in the *Sporobolus-Setaria* zone ranged from sandy clay loam on the surface to sandy clay at 60 cm deep. As opposed to vegetation zones nearer the free-standing water, soil reaction was slightly acid in the surface 15 cm of soil but became basic with increasing soil depths. An average pH 8.7 was recorded at 60 cm deep and organic matter ranged from 0.5 to 1% in this zone. Calcium and magnesium concentrations were greatly reduced as compared to previous zones, especially in the upper foot of soil. In the upper 30 cm of the soil profile, magnesium concentration ranged from 150 to 220 ppm and calcium concentration was from 700 to 750 ppm. Potassium was slightly lower than from vegetation zones near the free-standing water. Concentrations ranged from 450 ppm in the surface 15 cm of soil to 500 ppm in the 15 to 30 cm zone. However, at 12 to 24 inches deep, potassium concentrations exceeded 600 ppm. Phosphorus concentrations were similar to the previous vegetation zones ranging from 30 ppm in the surface soil to about 80 ppm at 60 cm deep.

Lagunas of Texas coastal rangeland present unique management problems due to the variation in botanical composition. Although production was not measured on the study sites, grass cover was usually higher in the previously inundated areas than in those covered with typical South Texas brush. Original vegetation of the area was dominated by mesquite and *Acacia* spp. However, secondary successional patterns established on many of the areas indicate that management requirements for effective use of the rangeland following flooding may differ from the mixed-brush stands. The vegetation zones supporting spike dropseed should be burned periodically. Some ranchmen of the area successfully use the species by burning it annually during the dormant season. Prescribed burning would also be beneficial in removing dead, standing, residual brush and might retard reinvasion of the areas by woody plants.

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