

THE EFFECT OF HURRICANE ALLEN ON THE NEAR-SHORE VEGETATION OF SOUTH PADRE ISLAND

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ABSTRACT.—The effect of Hurricane Allen (Aug. 10, 1980) on the near-shore vegetation of South Padre Island was assessed by comparing data obtained in line transects before and after the hurricane. Eight species of plants were present in the Backshore Zone prior to the hurricane; after the hurricane, only three species were present and percent cover was only 11% of that before the hurricane. The foredunes of this zone were completely leveled and a belt of *Sesuvium portulacastrum* was obliterated. Conversely, plants of the taller Primary Dune Zone were not greatly disturbed by the hurricane. Numbers of species and percent cover were similar in pre- and post-hurricane transects. However, before the hurricane, *Ipomoea stolonifera* was dominant on both the windward and leeward slopes. After the hurricane, *Uniola paniculata* was dominant on the windward slopes and *Schizachyrium scoparium* was dominant on the leeward slopes. Apparently, low-growing, shallow-rooted species such as *Sesuvium portulacastrum* and *Ipomoea stolonifera* are more greatly affected than grasses because they are more easily dislodged or covered by sand transported by water surges.

The predominant land form along the Gulf Coast of Texas consists of a series of barrier islands. Padre Island is the longest of these islands, it extends from Corpus Christi on the north to the Brazos-Santiago Pass at Port Isabel on the south; a distance of about 182 km. The Mansfield Channel separates the northern two-thirds of the island from South Padre Island.

The mechanism(s) of origin of the barrier islands is a subject of considerable controversy (Hoyt, 1967; Fisher, 1968), but workers agree that Padre Island began forming about 4,500 years ago (Dahl, et al., 1974), and that hurricanes are important factors in the development of the barrier islands. Major hurricanes have occurred at South Padre Island six times since 1844. The most recent was Hurricane Allen on August 10, 1980.

During hurricanes, the storm surge or overwash moves large volumes of sand from the beach, foredunes, primary dunes, and offshore areas to the interior and bay-tidal flats and into the bay. In the process large expanses of vegetation are denuded or covered. Study of the effects of hurricanes on vegetation of barrier islands has been devoted primarily to the revegetation of overwash areas (Godfrey and Godfrey, 1972, 1976); and little is known of the immediate consequences for vegetation. However, Harris and Chabreck (1958) reported on the immediate effects of Hurricane Audrey on marsh vegetation of Marsh Island, Louisiana and Chabreck and Palmisano (1973) reported on the immediate effects of Hurricane Camille on the marsh vegetation of the Mississippi River delta. Both studies showed that the hurricanes resulted in a drastic reduction of vegetation due to the sweeping action of wind and water, that either uprooted or ripped apart plants which were subsequently carried away by the current. Herein we present data on the immediate effect of Hurricane Allen to the near-shore vegetation of South Padre Island.

METHODS.—The pre-hurricane data come from the study of Judd, et al. (1977) on the vegetation of South Padre Island. In this study, we drove north from the Brazos-Santiago jetties and enumerated the

number of washovers encountered and determined their widths using odometer distance to the nearest 0.16 km. We used the line intercept technique to analyze vegetation. At 3.2 km intervals along the length of the island, transects established perpendicular to the longitudinal axis of the island were extended across the foreshore, backshore, and primary dune zones (Judd, et al., 1977). These transects were subdivided into 10 m intervals and readings were taken along the total length of each interval. Frequency and foliage cover were recorded for each species and from these data relative frequency, relative cover, and an importance index based on the sum of relative cover and relative frequency were calculated. In October and November of 1980, after Hurricane Allen had struck in August, we repeated these transects.

RESULTS.—Washovers.—Mean width of washovers in 1980 was 434 m compared to 238 m before the hurricane; however, the number of washovers was similar—26 in 1977, 23 in 1980. Apparently, overwashes in 1980 followed the old washover channels formed during Hurricane Beulah (September 20, 1967). The greater widths of washovers in 1980 suggest that the margins of the primary dunes were eroded and that dunes that had formed in the interior of old washovers were eroded completely. Consequently, there were slightly fewer, but much wider, washovers.

Vegetation.—The terminology of topographic zones followed was that of Judd, et al. (1977). Data in Judd, et al. (1977) were based on 18 transects. In 1980 we obtained 12 transects. Since we did not run transects in washovers (washovers are bare), the greater widths of washovers in 1980 resulted in fewer transects, i.e., some of our 3.2 km intervals coincided with the location of washovers.

The foreshore was devoid of vegetation before the hurricane as well as after. The backshore extends from the berm crest to the seaward base of the primary dunes. This zone is usually not subject to inundation except during high spring tides or storm tides and therefore it is vegetated. Prior to Hurricane Allen, sea oats, *Uniola paniculata*, and sea purslane, *Sesuvium portulacastrum*, were of almost equal importance in the backshore zone, but these occurred in two distinct belts. Nearest to the berm crest the vegetation consisted of isolated patches of *Sesuvium portulacastrum* which usually occupied the tops of small dunes. Westward these embryonic dunes graded into taller foredunes which supported growths of *Uniola paniculata* and beach morning glory, *Ipomoea stolonifera*. At infrequent locales railroad vine, *I. pes-caprae*, was present instead of *I. stolonifera*. *Fimbristylis castanea* occurred in the interdune swales where the water table was near the surface. A total of eight species were present in the backshore zone and total cover was 4.7%. After Hurricane Allen, only three species were present and total cover was only about 0.5% (Table 1). Six species that were present before Hurricane Allen in the backshore zone were absent in the post-hurricane transects (Table 2). The most striking feature was the absence of the *Sesuvium* belt. Also, *Ipomoea stolonifera*, which ranked third in importance prior to the hurricane, was absent. Both *S. portulacastrum* and *I. stolonifera* are low-growing and shallow-rooted. Apparently, these species were either swept away by the water surge and/or covered by transported sand. In fact, the storm surge obliterated the foredunes. In the process, much *Uniola paniculata* and *Fimbristylis castanea* were covered, but because these species are relatively tall, many stems remained emergent. *Sporobolus virginicus* was known to occur in this zone prior to the hurricane, but it was infrequent in occurrence and low in abundance and did not occur in the transects before Hurricane Allen.

TABLE 1.—Comparison of the relative importance of species occurring in the backshore zone.

Species	Freq.	Rel. Freq.	% Cover	Rel. Cover	Importance Value	Rank	Pre-hurricane Rank
<i>Uniola paniculata</i>	4.2	57.1	0.456	88.4	145.5	1	1
<i>Fimbristylis castanea</i>	2.1	28.6	0.058	11.2	39.8	2	6
<i>Sporobolus virginicus</i>	1.0	14.3	0.002	0.4	14.7	3	

TABLE 2.—Species absent in post-hurricane transects across backshore zone. Data shows pre-hurricane importance.

Species	Rel. Freq.	Rel. Cover	Importance Value	Pre-hurricane Rank
<i>Sesuvium portulacastrum</i>	42.3	27.7	70.0	2
<i>Ipomoea stolonifera</i>	14.1	8.5	22.6	3
<i>Panicum amarulum</i>	3.3	8.5	11.8	4
<i>Ipomoea pes-caprae</i>	4.3	6.4	10.7	5
<i>Schizachyrium scoparium</i>	2.2	0.7	2.9	7
<i>Croton punctatus</i>	2.2	0.4	2.6	8

TABLE 3.—Comparison of the relative importance of species occurring on the windward slopes of primary dunes.

Species	Freq.	Rel. Freq.	% Cover	Rel. Cover	Importance Value	Rank	Pre-hurricane Rank
<i>Uniola paniculata</i>	41.5	34.0	4.28	49.8	83.8	1	2
<i>Ipomoea stolonifera</i>	24.4	20.0	1.02	11.9	31.9	2	1
<i>Oenothera drummondii</i>	12.2	10.0	1.23	14.3	24.3	3	
<i>Croton punctatus</i>	12.2	10.0	.69	8.0	18.0	4	3
<i>Ipomoea pes-caprae</i>	9.8	8.0	.57	6.6	14.6	5	
<i>Schizachyrium scoparium</i>	9.8	8.0	.51	5.9	13.9	6	4
<i>Heterotheca subaxillaris</i>	2.4	2.0	.22	2.6	4.6	7	5
<i>Sporobolus virginicus</i>	2.4	2.0	.06	0.7	2.7	8	
<i>Rhynchosia minima</i>	2.4	2.0	.01	0.1	2.1	9	
<i>Panicum amarulum</i>	2.4	2.0	<.01	<0.1	2.0	10.5	6
<i>Eragrostis oxylepis</i>	2.4	2.0	<.01	<0.1	2.0	10.5	
Total Cover			8.60				

TABLE 4.—Comparison of the relative importance of species occurring on the leeward slopes of primary dunes.

Species	Freq.	Rel. Freq.	% Cover	Rel. Cover	Importance Value	Rank	Pre-hurricane Rank
<i>Schizachyrium scoparium</i>	42.9	20.5	6.35	38.7	59.2	1	3
<i>Uniola paniculata</i>	38.1	18.2	3.88	23.6	41.8	2	2
<i>Ipomoea stolonifera</i>	33.3	15.9	2.08	12.6	28.5	3	1
<i>Ipomoea pes-caprae</i>	33.3	15.9	1.19	7.2	23.1	4	
<i>Croton punctatus</i>	19.0	9.1	1.31	8.0	17.1	5	4
<i>Oenothera drummondii</i>	14.3	6.8	0.57	3.5	10.3	6	7
<i>Cassia fasciculata</i>	4.8	2.3	0.60	3.7	6.0	7	5
<i>Rhynchosia minima</i>	9.5	4.5	0.07	0.4	4.9	8	8
<i>Fimbristylis castanea</i>	4.8	2.3	0.26	1.6	3.9	9	11
<i>Panicum amarulum</i>	4.8	2.3	0.09	0.5	2.8	10	10
Unknown	4.8	2.3	0.01	0.1	2.4	11	
Total Cover			16.41				

Prior to Hurricane Allen, six species were present in transects across the windward slope of the primary dunes. *Ipomoea stolonifera* ranked first in importance and *Uniola paniculata* ranked second. Total cover was 7.1%. Eleven species were present in the post-hurricane transects (Table 3) including all six species that were present before the hurricane. Also, total cover was slightly higher (8.6%). However, *Uniola paniculata* now ranked first in importance.

Eleven species were present in the pre-hurricane transects across the leeward slopes of the primary dunes. *Ipomoea stolonifera* was a clear dominant and total cover was 21.3%. In post-hurricane transects in this zone, there were also eleven species present and only two species were different (Table 4). The two species absent in the post-hurricane transects were *Heterotheca subaxillaris* and *Paspalum monostachyum*. These ranked sixth and ninth in importance, respectively. These two species were replaced by *Ipomoea pes-caprae* and an unidentified forb in the post-hurricane transects. Total cover in the post-hurricane transects was slightly lower (16.4%) and the importance rank of the #1 and #3 species of the pre-hurricane transects was reversed.

DISCUSSION.—Peak water surge during Hurricane Allen was estimated as 2.7 m above mean sea level (Espey, Huston and Associates, Inc., 1981). The water surge and the sand transported by the water surge obliterated the foredunes of the backshore zone. Species richness and vegetation abundance was markedly decreased in the backshore zone. However, vegetation on the taller primary dunes was not greatly disturbed, at least on the dunes that were left after the hurricane. There was no decrease in species richness on either the windward or leeward sides of the primary dunes and a decrease in cover was found only on the leeward slopes.

The greater number of species and percent cover on the windward slopes of the primary dunes in the post-hurricane transects may reflect variables introduced by our approach. First, the pre-hurricane census was conducted about four years before the hurricane, so changes in vegetation could have occurred during these years. Second, the pre- and post-hurricane transects were not situated in precisely the same places. Three of the added species, *Sporobolus virginicus*, *Rhynchosia minima*, and *Eragrostis oxylepis*, are infrequent in occurrence and contribute little to total cover. Their presence is probably due to either site variation or changes in vegetation over the years between samples. The presence of *Ipomoea pes-caprae* likely reflects variation in the sites of the transects, because it was present in this zone before the hurricane (Judd, et al., 1977; Lonard, et al., 1978; Lonard and Judd, 1981). *Oenothera drummondii* was present on the leeward slopes of the primary dunes in the pre-hurricane transects (Lonard, et al., 1978). The presence of this species on the windward slopes of the primary dunes after the hurricane may be due to recent establishment. *Oenothera drummondii* was represented by a large number of small individuals that appeared to be seedlings that had germinated after the hurricane.

The lower cover values for *Ipomoea* species, and for *I. stolonifera* in particular, in transects across the leeward slopes of the primary dunes suggest that much *Ipomoea* was covered by sand transported by wind and/or water over the tops of the primary dunes.

Godfrey and Godfrey (1976) reported that on North Carolina barrier islands foredunes may grow to a meter or more in height within four to five years after being levelled by a storm. Data of this type are lacking for Texas barrier islands, but Drawe, et al. (1981) suggest that succession is slow on Padre Island and is inhibited by soil instability, high soil salinity, low soil fertility, and high evapo-transpiration ratio. More importantly, absence of foredunes (and vegetation on them) makes the driving of vehicles easier in the backshore zone. If this zone is allowed to become a traffic corridor, re-establishment of the foredunes and backshore vegetation may be prevented. Limiting vehicles to the foreshore would aid in the re-establishment of the vegetation of the backshore zone, but it would be difficult to enforce.

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