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COMMUNITY RELATIONSHIPS OF SOME SMALL MAMMALS ON PADRE ISLAND NATIONAL SEASHORE, TEXAS

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Padre Island, the longest barrier island in the United States, extends for approximately 182 km along the Texas coast. The island is usually divided into two distinct sections, northern Padre Island and southern Padre Island, which are separated by the Mansfield Ship Channel (Fig. 1). The island was formed on a bed of Pleistocene-age sands and gravel and is subject to annual cycles of sediment deposition from the rivers of Texas and periods of erosion from the actions of waves, wind, and human activities along its length (Baccus and Horton, 1979). The climate of northern Padre Island has been described as subtropical and semiarid, and precipitation, almost always from rainfall, averages from 74 cm at the extreme northern end of Padre Island National Seashore (PINS) to 66 cm at the southern boundary. Average temperature at PINS is 24°C and evaporation rates are high (Weise and White, 1980).

Several investigators have studied mammalian species of Padre Island. Raun (1959), Koepke (1969), and Harris (1988) researched occurrence of mammalian species on the Island. Kennedy et al., (1973) researched the activity pattern of the gulf coast kangaroo rat (*Dipodomys compactus*) from Padre Island, whereas Schmidly and Hendricks (1976), Baumgardner and Schmidly (1981), and Baumgardner (1985) studied systematics and microhabitat usage of *D. compactus*. Segers and Chapman (1984) reported ecological relationships of spotted ground squirrels (*Spermophilus spilosoma*) of Padre Island, and Bailey (1905) and Blair (1952) reported the presence of several mammalian species from Padre Island. Baccus and Horton (1979) conducted an ecological and sedimentary study of the National Seashore. Yzaguirre (1974) discussed distribution and relative abundance (total numbers) of rodents across an east to west transect of Padre Island. However, no researchers attempted to obtain population estimates of small mammals from PINS.

Three localities on northern Padre Island were sampled for small mammals. These localities were designated as Ranger Road (located behind the National Park Service Ranger Station at PINS), Big Ball Hill (located approximately 11.2 km south of the Malaquite Beach Visitors Center), and 1.6 km north of Yarborough Pass (Fig. 1). The goals of our study were to correlate the occurrence of particular species of small mammals with specific vegetation or habitat types at Big Ball Hill of PINS, to compare our distributional data to that of previous investigators, and to obtain population estimates of small rodents from four different habitats at Big Ball Hill.

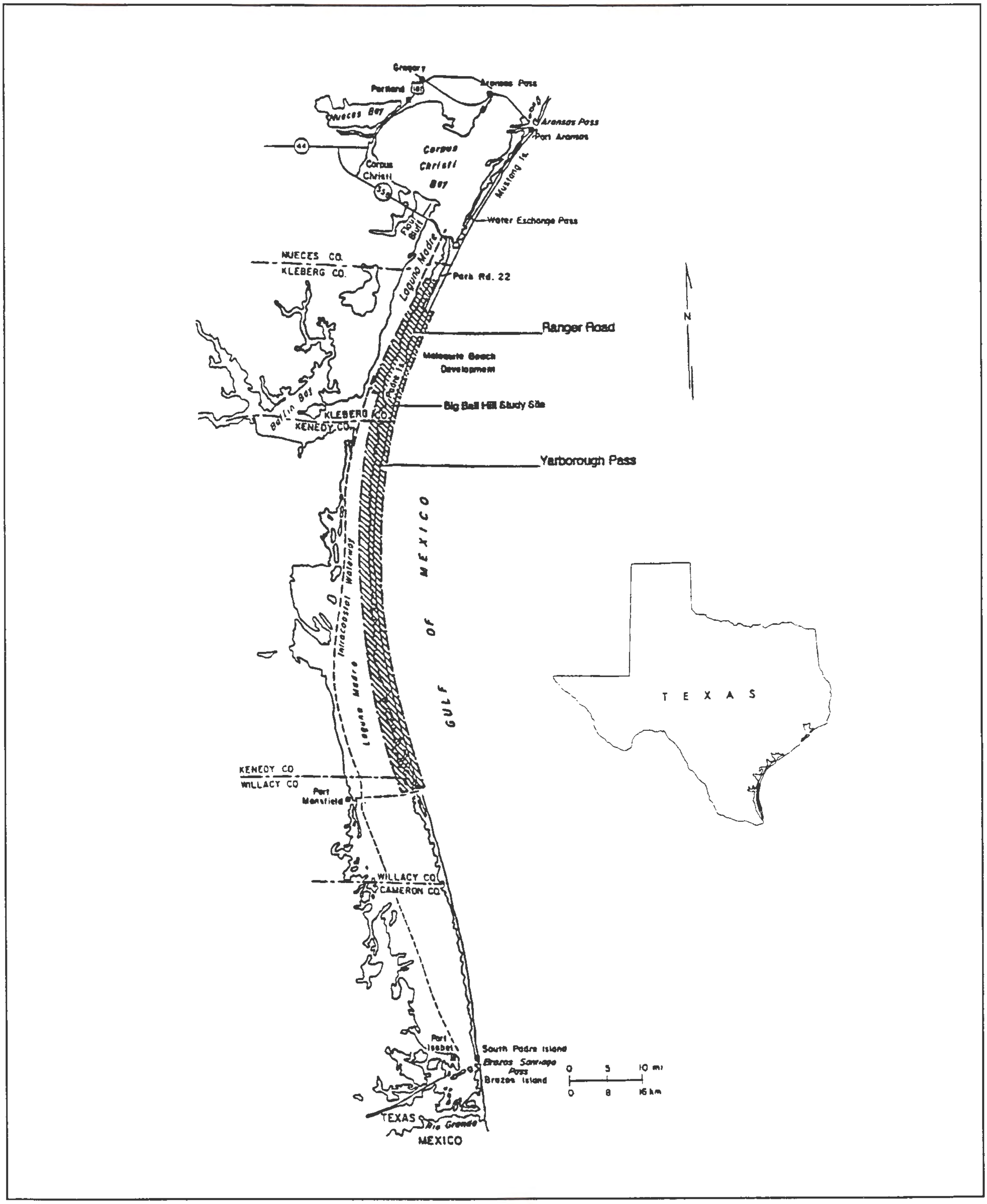

Figure 1. Map of Padre Island National Seashore (modified from Weise and Whire, 1980) showing some localities mentioned in text. Inset shows the location of Padre Island National Seashore in Texas as the darkened island off the lower, Texas coast.

MATERIALS AND METHODS

The study was conducted from May 1996 to May 1997 at Big Ball Hill, Ranger Road, and 1.6 km north of Yarborough Pass on PINS. Four 500 meter transects were placed in the coppice dunes (*CD*), leeward side of the foredunes (*LSFD*), barrier flat (*BF*), and tidal flat (*TF*) habitats at Big Ball Hill. Major habitats were initially designated according to the Geology and Natural Environments of Padre Island National Seashore map of Weise and White (1980). These sites were then ground-truthed for accuracy and transects were established using a Magellan GPS Navigator. Each transect was subdivided into 10 meter intervals. Numbered, fluorescent flags marked the boundary of each separate interval within a transect. Transects included the maximum amount of each habitat in a specific locality. As a result, the transects were not necessarily a straight line. However, the inclusion of some ecotonal areas was unavoidable in the *LSFD*, *BF*, and *TF* communities.

Floristic and trapping transects at Big Ball Hill were established in May 1996. An initial line-intercept vegetation survey (Brower et al., 1990; Sutherland, 1996) was conducted in May 1996. The first small mammal survey was conducted in July. The interval between the vegetation survey and the initial survey of small mammals was considered crucial in minimizing disturbance to mammals in the communities and allowing vegetative recovery after establishing the transects. Small mammals were trapped at Big Ball Hill in November 1996 and March 1997. A transect survey conducted in September was converted into a diversity sample because of inclement weather.

Mammalian population density surveys were conducted over two consecutive 24-hr periods. Total trap nights during each survey was 400 (total of 1200 trap nights during the course of the study). Sherman live traps were utilized in population density and diversity surveys. One trap was placed at each numbered flag along transects. Traps were baited with dry oatmeal at dusk. Transect lines were surveyed at dawn and any mammals captured were removed, dorsally marked with a Niadizol D dye mixture, and released. All traps were closed during the day to avoid inadvertent captures of mammals and other small vertebrates. Two individuals of each sampled species from the Big Ball Hill area were prepared as standard museum skin and skull vouchers (special permit issued by Paul Eubank, Environmental Protection Specialist, National Park Service, PINS). Vouchers were deposited in the vertebrate collection of Texas A&M University, Kingsville.

Diversity surveys were conducted over 24-hr periods and consisted of a total of 200 trap nights per survey (total of 800 trap nights). Diversity surveys were conducted during September, January, February, and May. The first diversity survey (September) was conducted along transects of Big Ball Hill by placing a Sherman live trap at each numbered flag. The second diversity survey was conducted at two locations: along Ranger Road of PINS (which corresponds to Baccus and Horton's (1974) Notraf site) and 1.6 km north of Yarborough Pass of PINS (which corresponds to Baccus and Horton's (1974) Shell site). Trapping transects consisted of two parallel lines of 50 Sherman traps placed perpendicular to the beach that extended westward from the first noticeable beach vegetation. The diversity survey was conducted because of concern over a lack of mammalian diversity recorded at Big Ball Hill. Other diversity surveys (February and May) were conducted utilizing two parallel lines of 33 Sherman traps set at the first noticeable beach vegetation and extending westward at the Ranger Road, Big Ball Hill, and Yarborough Pass sites. This method allowed comparisons of mammalian diversity at these sites.

Because we attempted to correlate the occurrence of small mammals with specific plants, dominant vegetation close to capture sites was recorded. An estimate of vegetative coverage was recorded for all capture sites.

Population numbers were estimated by calculating Lincoln-Petersen indices of mark-recapture data from Big Ball Hill. Ninety-five percent confidence limits were calculated for each population estimate (Sutherland, 1996). Because individuals could not be positively identified, the Lincoln-Petersen index was deemed to be an appropriate algorithm. Simpson's and Shannon-Weaver diversity indices were calculated (Brower et al., 1990; Davis and Winstead, 1980).

RESULTS

No small mammals were collected from the *TF* transect, and *D. compactus* dominated mammalian communities at most localities (transects of Big Ball Hill, Ranger Road, and Yarborough Pass) during the July, September, and November surveys and at some localities (Big Ball Hill and Yarborough Pass) during the May 1997 survey.

Population estimates were calculated for *D. compactus* from the *CD*, and *LSFD* communities of the Big Ball Hill Region. Population estimates of *D. compactus* in the *CD* community were 31 (± 24 – 49) in July 1996; 10 (± 7 – 14) in November 1996; and 27 (± 15 – 1313) in March 1997. The inflated confidence limits of the March estimate likely result from the absence of previously marked animals obtained in the recapture survey (Sutherland, 1996). The July and November estimates are well within confidence limits. A single population estimate of *D. compactus* within the *LSFD* community was obtained for the March survey. The kangaroo rat population estimate was 31 (± 16 – 98). Previous survey attempts in the *LSFD* resulted in no recaptured animals and biased surveys. The pygmy mouse (*Baiomys taylori*) was captured only once on the *LSFD* and *BF* transects and the fulvous harvest mouse (*Reithrodontomys fulvescens*) was captured only once on the *BF* transect during the March survey. Reliable population estimates were impossible to obtain for these species.

Simpson's diversity index was calculated once (March) for mammals on Big Ball Hill. The diversity value was 0.18. *Dipodomys compactus* was the only species collected during July, November, February, March, and May surveys. Diversity indices for Ranger Road were higher. A community diversity value of 0.67 was obtained in January and a value of 0.50 was obtained in February. Likewise, mammalian diversity was higher at Yarborough Pass. Diversity values of 0.55 and 0.60 were obtained for surveys conducted in January and February, respectively. Only *D. compactus* was collected at Ranger Road and Yarborough Pass localities in May. However, diversity at Ranger Road and Yarborough Pass was consistently higher than at Big Ball Hill.

Estimated community diversity also was higher at the Ranger Road and Yarborough Pass localities than at Big Ball Hill whenever data were subjected to analysis utilizing the Shannon-Weaver index. The estimated diversity value for March at Big Ball Hill was 0.18. January and February values for Ranger Road were 0.51 and 0.27, respectively. Values of 0.30 and 0.29 were obtained during these same months at Yarborough Pass.

It proved difficult to correlate mammalian species with specific vegetation at Big Ball Hill. During the initial survey (July), *D. compactus* was captured as often in *CD* transect intervals containing no vegetation (20 captures) as intervals containing *Croton punctatus* (Gulf croton), *Uniola paniculata* (sea oats), and *Ipomoea* sp. (morning glory) (16 captures). Kangaroo rats were trapped in intervals with ground cover ranging from 0 to 30 percent. The two individuals captured in the LSFD were in intervals containing 10 and 70 percent vegetative coverage. Dominant plants in these intervals were *U. paniculata* and *Heterotheca subaxillaris* (camphor weed).

Kangaroo rat abundance in vegetated intervals of the *CD* transect increased during the November survey. Nine kangaroo rats were captured in bare intervals and 12 were captured in vegetated intervals. Kangaroo rats were found in intervals ranging from 0 to 40 percent plant coverage. Dominant plants associated with *D. compactus* within the coppice dunes in November included the aforementioned species and *Oenothera drummondii* (beach evening primrose). A single *D. compactus* was captured in LSFD habitat in an interval of seventy percent vegetative coverage dominated by *H. subaxillaris*.

Kangaroo rats increased in vegetated intervals during the final population census (March). In the coppice dunes, *D. compactus* was captured in 16 vegetated intervals and only four barren intervals. Dominant plants were the same as in former surveys, but percent cover ranged only from zero to 10 percent. This may have been due to removal of dead vegetation by heavy rainfall prior to the final survey. In March, kangaroo rats were only trapped in vegetated intervals on the foredune transect (18 captures). The *LSFD* plant community was dominated by *C. punctatus*, *U. paniculata*, *O. drummondii*, *Paspalum monostachyum* (Gulf dune paspalum), and *Schizachyrium scoparium* var. *littoralis* (seacoast bluestem). Kangaroo rats were found in intervals ranging from 12.5 to 75 percent vegetative coverage.

One *Reithrodontomys fulvescens* was captured at Big Ball Hill along the *BF* transect during the March survey. Dominant vegetation along the transect included *S. scoparium*, *P. monostachyum*, and *Borrichia frutescens* (bushy sea-oxeye). *Reithrodontomys fulvescens* was obtained in intervals with vegetative coverage of 100 percent. *Baiomys taylori* also was collected in the *BF* and *LSFD* transects during March. The pygmy mouse was associated with *S. scoparium* and 100 percent ground cover in the *BF* transect, whereas *Baiomys* was associated with *S. scoparium* var. *littoralis* and *H. subaxillaris* and 73 percent vegetative coverage in the *LSFD* transect.

DISCUSSION

Two reliable population estimates of *D. compactus* were obtained for the coppice dunes of Big Ball Hill. The July estimate of 31 kangaroo rats along the 500 meter transect seemed to be conservative, and the November estimate of 10 individuals indicated that the population may have declined.

The decline in kangaroo rat numbers within the coppice dunes may have resulted from movement of *D. compactus* into the foredune community or a decline due to mortality. Although there was no evidence to support the latter possibility, some evidence of the initial hypothesis may be inferred from the increased activity of *D. compactus* within the foredune community during March. The estimated population of gulf coast kangaroo rats along the *LSFD* transect was 31 (± 16 – 98). No marked individuals were obtained during the initial capture and marking survey of the foredune community in March.

Although we obtained *R. fulvescens* on the *BF* transect and *B. taylori* on the *BF* and *LSFD* transects during the March mark-recapture survey at Big Ball Hill, the number of captures was too low for reliable estimates. Inasmuch as these species were not captured in previous surveys of the Big Ball Hill communities, their abundance in these communities may be low.

Both of our community diversity estimates for Big Ball Hill during March (Shannon-Weaver and Simpson's) were lower than the mammalian diversity found at Ranger Road and Yarborough Pass in January and February. A concurrent diversity survey of Big Ball Hill in February resulted in the capture of only *D. compactus*. Our community diversity estimates of Ranger Road and Yarborough Pass also were lower than those reported by Baccus and Horton (1979). This undoubtedly resulted from the inability to accurately survey *S. spilosoma* during most of our trapping sessions and the absence of *S. hispidus* from all localities during our survey.

Baccus and Horton (1979) and Harris (1988) reported *S. hispidus* as a common resident of PINS and stated that cotton rats could be found in dense vegetation within the dunes and other areas. Despite dense vegetation and ephemeral ponds within our *BF* transect, we obtained no *S. hispidus* from the Big Ball Hill area. In addition, Baccus and Horton (1979) obtained cotton rats from foredune habitat at Ranger Road and Yarborough Pass but, despite multiple surveys, we captured no *S. hispidus* in this habitat type at either locality.

Yzaguirre (1974) obtained the white-footed mouse (*P. leucopus*) at a location that must have been no farther than 0.8 km south of our Big Ball Hill locality, but no *P. leucopus* were captured at any locality during our study. Yzaguirre (1974) reported the white-footed mouse from his foredune and low coastal sands communities. The foredune community of Yzaguirre (1974) is synonymous with our *LSFD* community and his low coastal sands community is equivalent to our *BF* community.

The absence of *P. leucopus* from the area may indicate a decline of mammalian richness in these communities. However, Yzaguirre (1974) captured no fulvous harvest mice or pygmy mice during his survey. If this is considered, community richness at Big Ball Hill is equal to or greater than that reported by Yzaguirre (1974).

The low community diversity of Big Ball Hill and associated areas during the present study might have been the result of below average rainfall during most of the research year (NOAA data obtained from the Internet). Precipitation was below average for a six-month-period (January to June) prior to and during the initial mammalian survey of June 1996. Above average precipitation occurred during August 1996, but declined to below normal during September to February 1997. Above average precipitation occurred during March, April, and May.

However, mammalian diversity at Ranger Road and Yarborough Pass was always higher than at Big Ball Hill until all three communities experienced a decline in diversity in May. This decline might have been a sampling artifact due to rainy conditions encountered during this trapping survey and a consequent reduction of mammalian activity. It is most likely that mammalian diversity is low within all major communities of PINS.

The vegetative composition and coverage in each community type of PINS determines the presence or absence of some mammalian species. For instance, *D. compactus* was found only in the coppice dune and foredune communities of PINS and was associated with rather sparsely vegetated areas. This is in agreement with distributions of the gulf coast kangaroo rat as reported by Baccus and Horton (1979), Harris (1988), and Baumgardner (1991). Movement into the LSFD community of Big Ball Hill may have been a natural dispersal movement of younger animals, but may have been due also to the greater abundance of seed plants, such as sea oats and other gramineous and herbaceous species, in this area during the winter and early spring. Kangaroo rats were not found in the more densely vegetated *BF* community at Big Ball Hill and, consequently, were barred from the adjacent *TF* habitat to the west, although the latter community contained low-growing, sparse vegetation. It is unlikely that *D. compactus* could persist in the *TF* community of Big Ball Hill because of periodic inundation of this community.

The fulvous harvest mouse and pygmy mouse prefer dense vegetation. Harvest mice construct nests within the infloresences and stems of grasses, brush, and trees, whereas pygmy mice travel within an area by utilizing runways and construct nests underneath rocks or within burrows. *Reithrodontomys fulvescens* was obtained only from the *BF* transect and *B. taylori* was taken from the *LSFD* and *BF* communities at Big Ball Hill. At Ranger Road and Yarborough Pass, fulvous harvest mice were obtained within the coppice dunes. However, vegetative coverage in the coppice dune community was much higher at these two localities than at Big Ball Hill. Pygmy mice were found only within the barrier flat communities of Ranger Road and Yarborough Pass. Our results correspond to those reported by Baccus and Horton (1979) for these two species.

Diversity values of the mammalian communities sampled during our study were low. A community which has a high diversity value is thought to contain more microhabitats and, hence, be more stable (Hair, 1980). Therefore, mammalian communities on PINS may contain fewer microhabitats and be less stable. In addition, some mammalian species on PINS, such as *D. compactus*, *R. fulvescens*, and *B. taylori*, are restricted to only a few suitable habitats. These distributional constraints also contribute to the fragile nature of mammalian communities on PINS.

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It was through the efforts of Horn Professor J Knox Jones, as director of Academic Publications, that Texas Tech University initiated several publications series including the Occasional Papers of the Museum. This and future editions in the series are a memorial to his dedication to excellence in academic publications. Professor Jones enjoyed editing scientific publications and served the scientific community as an editor for the Journal of Mammalogy, Evolution, The Texas Journal of Science, Occasional Papers of the Museum, and Special Publications of the Museum. It is with special fondness that we remember Dr. J Knox Jones.

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