Terrestrial Mammals of the Riparian Corridor in Big Bend National Park[1]

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Abstract.--Thirty species of terrestrial mammals inhabit riparian habitats in Big Bend National Park (BBNP), but only one species (the beaver, *Castor canadensis*) is restricted to these areas. Major changes in the vegetation during the past 30 years, involving an increase in basal and canopy cover, have resulted in the elimination of at least one species (*Dipodomys ordii*) from the river corridor as well as increased abundance and distribution for two other species (*Sigmodon hispidus* and *Peromyscus leucopus*). Compared to the other major plant communities in BBNP, the rodent fauna of the riparian community has lower evenness, richness, and diversity indices (based on the Shannon-Weaver Index). Human use and trespass livestock grazing are the major impacts acting upon the natural riparian communities in BBNP today.

INTRODUCTION

Mammalian studies of the Big Bend area began with general surveys (Bailey 1905; Johnson 1936; Borell and Bryant 1942; and Taylor *et al.* 1944) designed to identify and document the varied fauna of the area. After the park was established, the perspective of mammalian research changed somewhat and in recent years studies have concentrated on mammalian autecology and synecology (Porter 1962; Dixon 1958; and Easterla 1973). Most mammalian studies have focused on the mammals of the montane woodland and desert grassland habitats. There have been no comprehensive studies of riparian mammals. Baccus (1971) investigated the distribution of rodents in the park with respect to the major physical features, focusing on the effects of the elimination of grazing on the vegetation and the rodent populations. He also described the similarities and dissimilarities of the rodent faunas of the woodland, grassland, and desert shrub communities; however, he divided the fauna of the Rio Grande floodplain between the desert shrub and grassland communities and did not consider the riparian corridor as a unique habitat.

DESCRIPTION OF THE RIPARIAN CORRIDOR

Floodplain or riparian vegetation exists wherever periodic flooding occurs along the Rio Grande in BBNP. These riparian communities vary from areas a few meters (m) wide to areas extending inland a distance of one kilometer (km); furthermore, adjacent arroyos and creeks may carry enough surface or ground water to produce a similar floodplain environment. Topography along the river includes (1) sheer wall canyons (i.e., Santa Elena and Mariscal canyons which rise to elevations of 366 m) with few areas of alluvial deposits; (2) long deep canyons (i.e., Boquillas Canyon) where the walls do not rise abruptly and where larger areas of alluvial deposits occur; and (3) areas of broad flat floodplain with extensive alluvial deposits.

Denyes (1956) recognized three plant associations along the Rio Grande floodplain: (1) the riverbank association, consisting of mesquite (*Prosopis juliflora*), seep willow (*Baccharis* sp.), willow (*Salix gooddingi*), or cottonwood (*Populus palmeri*), located adjacent to areas of exposed silt and coarse gravel at the water's edge; (2) the *Baccharis* association, composed of dense stands of seep willow; and (3) the mesquite association, consisting of a thin line of extensive mesquite trees or an extensive area of several different plant forms. We have found these three associations to be somewhat altered from Denyes' description and, although difficult to document, our general impression is that significant vegetation changes have occurred

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in the riparian habitats of BBNP over the past 30 years. The major change is associated with the tremendous increase of salt cedar (*Tamarix chinensis*) along the river. The *Baccharis* association, mentioned by Denyes (1956) as common in the fine sandy loam soils along the river, is recognizable today only at a few places (for example, Black Dike) and appears to have been replaced by a mixed mesquite-salt cedar-bermuda grass (*Cynodon dactylon*) association. Similarly, salt cedar also appears to be replacing native cottonwood and willow trees at many places.

MAMMALIAN FAUNA OF THE RIPARIAN CORRIDOR

Thirty species of terrestrial mammals have been either collected or observed in the riparian habitats of BBNP. These are listed below in checklist fashion with their current status (C = common; U = uncommon; R = rare; E = previously present, but no longer occurs; P = possibly occurs) in the park.

- Pouched Mammals - Order Marsupialia
  - Opossum - Family Didelphidae
    - Virginia Opossum *Didelphis virginiana* - P
- Lagomorphs - Order Lagomorpha
  - Hares and Rabbits - Family Leporidae
    - Desert Cottontail *Sylvilagus audubonii* - C
    - Black-tailed Jack Rabbit *Lepus californicus* - U
- Rodents - Order Rodentia
  - Squirrels - Family Sciuridae
    - Texas Antelope Squirrel *Ammospermophilus interpres* - R
    - Mexican Ground Squirrel *Spermophilus mexicanus* - R
    - Spotted Ground Squirrel *Spermophilus spilosoma* - U
  - Pocket Gophers - Family Geomyidae
    - Yellow-faced Pocket Gopher *Pappogeomys castanops* - C
  - Pocket Mice - Family Heteromyidae
    - Silky Pocket Mouse *Perognathus flavus* - U
    - Desert Pocket Mouse *Perognathus penicillatus* - C
    - Nelson's Pocket Mouse *Perognathus nelsoni* - R
    - Ord's Kangaroo Rat *Dipodomys ordii* - E
    - Merriam's Kangaroo Rat *Dipodomys merriami* - C
  - Beaver - Family Castoridae
    - Beaver *Castor canadensis* - U
  - New World Rats and Mice - Family Cricetidae
    - Cactus Mouse *Peromyscus eremicus* - U
    - White-footed Mouse *Peromyscus leucopus* - C
    - Deer Mouse *Peromyscus maniculatus* - R
    - Hispid Cotton Rat *Sigmodon hispidus* - C
    - Southern Plains Woodrat *Neotoma micropus* - C
  - New World Porcupines - Family Erethizontidae
    - Porcupine *Erethizon dorsatum* - R
- Carnivores - Order Carnivora
  - Dogs and Relatives - Family Canidae
    - Coyote *Canis latrans* - C
    - Gray Fox *Urocyon cinereoargenteus* - U
  - Raccoons - Family Procyonidae
    - Ringtail *Bassariscus astutus* - U
    - Raccoon *Procyon lotor* - C
  - Weasels and Relatives - Family Mustelidae
    - Striped Skunk *Mephitis mephitis* - U
    - Western Spotted Skunk *Spilogale gracilis* - R
    - Hog-nosed Skunk *Conepatus mesoleucus* - R
  - Cats - Family Felidae
    - Mountain Lion *Felis concolor* - R
    - Bobcat *Felis rufus* - U
- Even-toed Ungulates - Order Artiodactyla
  - Peccaries - Family Tayassuidae
    - Collared Peccary (Javelina) *Dicotyles tajacu* - U
  - Deer - Family Cervidae
    - Mule Deer *Odocoileus hemionus* - U

During 1975-1976, we sampled small rodents at 18 different sites along the riparian corridor. Each site was trapped (using Sherman live traps) a total of 720 trap nights resulting in 12,960 trap nights for the entire river corridor. A total of 1,292 rodents representing two families (Heteromyidae and Cricetidae) were captured as follows (number trapped in parentheses): Family Heteromyidae: *Perognathus penicillatus* (896); *Perognathus nelsoni* (2); *Perognathus flavus* (5); *Dipodomys merriami* (65). Family Cricetidae: *Peromyscus leucopus* (162); *Peromyscus eremicus* (19); *Sigmodon hispidus* (70); *Neotoma micropus* (73). *Perognathus penicillatus* was overwhelmingly the most abundant small rodent in the riparian habitats and, for this reason, the total density of heteromyid rodents was greater than that of cricetid rodents. The three other heteromyid rodents were relatively rare along the river, although *D. merriami* was common at a few sites. Densities of the four species of cricetid rodents were more similar to one another than the densities of the heteromyid species. *Peromyscus leucopus* was the most common cricetid and *P. eremicus* the least common; *Sigmodon hispidus* and *Neotoma micropus* occurred in about equal numbers.

Borell and Bryant (1942) also found *Perognathus penicillatus* to be the most abundant rodent in the riparian corridor. However, comparing our data with that of Borell and Bryant (1942) for three other species (*Dipodomys ordii*, *Peromyscus leucopus*, and *Sigmodon hispidus*) reveals that significant changes in abundance and distribution have occurred in these species over the past 30 years. These

differences correlate with major vegetative changes associated with the cessation of extensive livestock grazing. Early accounts (Taylor *et al.* 1944; Sperry 1938) describe the vegetation along the river as open and severely over-grazed. However, since ranching activities ceased at the inception of the park, plant densities seem to have increased greatly so that at several places (e.g., Johnson Ranch) mesquite forests now occur where the river bottom was once open and sparsely vegetated. Extensive fields of grass also occur today at sites (e.g., Smoky Creek and Coyote) which formerly were cultivated and farmed.

Generally, cricetid rodents prefer habitats with considerable ground cover. Thus, the increased density of grass and cane (*Phragmites communis*) along the riparian corridor, as a result of the elimination of grazing, has served to substantially increase suitable habitat for these rodents. Two cricetines (*Sigmodon hispidus* and *Peromyscus leucopus*) exemplify this trend. Borell and Bryant (1942) collected only four specimens of *Sigmodon hispidus* along the river among the cane and cultivated fields around the Johnson Ranch. We recorded 70 cotton rats from 12 different localities along the river in areas where thick bermuda grass, cane, and fleabane (*Erigeron* sp.) were present. Similarly, Borell and Bryant (1942) reported taking a few *Peromyscus leucopus* along the river from one mile SW Boquillas and the Johnson Ranch. Our trapping records indicate that *P. leucopus* is now one of the most common rodents of the riparian corridor and this mouse occurs all along the river from the mouth of Santa Elena Canyon to Rio Grande Village.

Ord's kangaroo rat (*Dipodomys ordii*) is a species which apparently has completely disappeared from the riparian corridor during the past 30 years. This species was first reported from BBNP in 1939 by M. D. Bryant who described a distinct subspecies (*D. o. attenuatus*) from the mouth of Santa Elena Canyon. In 1944, Dr. William B. Davis (pers. comm.) collected two specimens from the type locality and another from the Johnson Ranch. There have been no additional specimens captured along the Rio Grande since then, although Baccus (1971) trapped at the mouth of Santa Elena Canyon, the Johnson Ranch, and other sites along the river. In over 13,000 trap nights along the river, including efforts at the type locality and the Johnson Ranch, we failed to capture a single *D. ordii*. Baccus (1971), however, did obtain a few specimens from Upper Tornillo Creek Bridge (16 km NE Panther Junction), and this apparently represents the only remaining population of this subspecies in BBNP.

In order to ascertain the status of *D. o. attenuatus*, we spent eight days (from 4 April 1976 to 12 April 1976) trapping at Upper Tornillo Creek Bridge and other places where this species had been previously collected. Initially, 70 traps were set on both the east and west side of Upper Tornillo Creek. Later, the number of traps was increased to 110 on the west side and 160 on the east side. The traps were set out in various soil and vegetation types ranging from deep sand-sparse burro-brush (*Hymenoclea monogyra*), to packed sand-mesquite and gravelly-creosote (*Larrea divaricata*) flats. A total of 18 *D. ordii* and 21 *D. merriami* were caught during the first two nights of trapping. Thirty traps were also set at Lower Tornillo Creek Bridge and 120 were placed along Terlingua Creek where it enters the mouth of Santa Elena Canyon. Most of the Lower Tornillo Creek area was a creosote flat with clumps of catclaw (*Acacia greggii*) and lechuguilla (*Agave lechuguilla*) next to the creek bed. The dry creek bed itself was very rocky and surrounded a small knoll of deep sand covered with little vegetation. Eight traps were placed on this knoll and 22 in the surrounding flats adjacent to the creek bed. A single *D. ordii* was captured on the knoll and nine *D. merriami* were captured on the flats. At Terlingua Creek, the traps were placed in a sandy area and 10 *D. merriami* were captured.

A trapping grid established at Upper Tornillo Creek consisted of 10 lines of 40 traps per line with each trap 18 m apart; each line was 36 m apart. With regard to vegetation and soil, three distinct habitats (designated A, B, and C) were delineated on the grid. Habitat A was on the first floodplain stage adjacent to the creek and consisted of a very open area of deep sandy soil with burro-brush and a few desert willow (*Chilopsis linearis*) comprising the dominant vegetation. Habitat B included the second floodplain stage and consisted of a sandy but more compact soil with a moderate cover of vegetation including creosote, whitethorn (*Acacia constricta*), mesquite, burro-brush, grass, and prickly pear (*Opuntia* sp.). Habitat C was located on a bench about 3-4 m above habitats A and B. The soil was very compact and the vegetation moderate to thick. Typical desert vegetation, consisting of clumps of mesquite, prickly pear, allthorn (*Koeberlinia spinosa*), creosote, and tasajillo (*Opuntia leptocaulis*) were interspersed throughout habitat C.

The total number of captures of *D. ordii* and *D. merriami* for each of the 10 trap lines is presented in Table 1. The percentage of captures of *D. ordii* for each of the three habitat types was as follows: habitat A, 66.1%; habitat B, 30.6%; habitat C, 3.2%. Thus, *D. ordii* was most common in the deep,

Table 1.--Four day capture totals by trap line for *Dipodomys ordii* and *Dipodomys merriami* at Upper Tornillo Creek Bridge.

Habitat type	Trap line	Total captures	*D. ordii* captures	*D. merriami* captures	Percent *D. ordii*	Percent *D. merriami*
A	1	29	25 (40.3)[1]	4 (5.8)[1]	86.2	13.8
	2	20	16 (25.8)	4 (5.8)	80.0	20.0
	3	11	3 (4.8)	8 (11.6)	27.3	72.7
	4	10	5 (8.1)	5 (7.2)	50.0	50.0
B	5	18	7 (11.3)	11 (15.9)	38.9	61.1
	6	11	1 (1.6)	10 (14.5)	9.1	90.0
	7	8	5 (8.1)	3 (4.3)	62.5	37.5
	8	19	0	19 (27.5)	0.0	100.0
C	9	5	0	5 (7.2)	0.0	100.0
	10	0	0	0	0.0	0.0

[1]Represent percent of total catch of *D. ordii* or *D. merriami* in a particular trap line.

sandy and sparsely vegetated areas of the first floodplain stage and decreased in number in habitats away from the creek bottom. The percentage of captures of *D. merriami* for each of the three habitat types was: habitat A, 11.6%; habitat B, 50.7%; and habitat C, 37.7%. Thus, *D. merriami* was more generally distributed throughout the three habitats but was much less common in habitat A where *D. ordii* dominated. *D. merriami* seemed to prefer areas where the soil was more compact or gravelly and the vegetative cover was greater.

Dr. William B. Davis trapped at the Johnson Ranch and the mouth of Santa Elena Canyon in the early 1940's and his description of the vegetation there is completely different from what these areas are like today. According to Davis (pers. comm.), the river bank at the Johnson Ranch was a very open sandy area and was used as a river crossing point for Mexicans and cattle. The mouth of Santa Elena Canyon, according to Davis, was also a sandy, open area with a considerable growth of *Baccharis*. Davis collected Ord's kangaroo rat at both of these locations. Today, the Johnson Ranch and the mouth of Santa Elena Canyon are more like mesquite forests with very little open terrain. In over 1,500 trap nights at these two locations, not a single *D. ordii* was captured, although 15 *D. merriami* (two at Johnson Ranch and 13 at the mouth of Santa Elena Canyon) were collected. In fact, after examining the entire riparian corridor in BBNP, the only place which seeminly had suitable habitat for *D. ordii* was the Gaughing Station. Trapping at this site (720 trap nights), however, produced 15 *D. merriami* and no *D. ordii*. *D. ordii attenuatus* now seems to be confined to the first and second floodplain stages of Tornillo Creek in BBNP and no longer occurs along the river or at the type locality.

Another mammal affected by vegetative changes in the riparian corridor is the beaver which, more than any other mammal in BBNP, is dependent on the riparian corridor for food and shelter. Beaver along the Rio Grande utilize a variety of plants including cane, seepwillow, willow, and cottonwood. Cottonwoods occur today only in park service nurseries at Rio Grande Village and Cottonwood Campground; salt cedars are rapidly replacing cottonwoods and willows at other sites. For example, the Gauging Station is one of the few areas where extensive stands of willow still exist, and these are currently being used as a food source by beavers. Nowhere along the river corridor is there any evidence of beaver using salt cedar. As a result, beavers are literally eating themselves out of "house and home" because they utilize willow saplings for food and leave only salt cedar saplings which they will not use. Taylor *et al.* (1944) reported a beaver population of approximately 100 individuals for the river corridor. However, conversations with park personnel and the evident lack of beaver sign along most of the river indicate the beaver population today is well below the figure reported by Taylor *et al.* (1944).

The Shannon-Weaver Index of Diversity (Odum 1971) was used to compare the rodent fauna of the riparian community with that of the woodland, grassland, and desert shrub communities in BBNP. This index reveals information concerning the stability of a community in terms of its fauna. Compared to the other plant communities, the riparian community has the lowest evenness, richness, and diversity

Table 2.--Shannon-Weaver Index of diversity for the terrestrial rodent fauna of the four major plant communities in BBNP.

Parameters	Communities			
	Riparian[1]	Desert-shrub[2]	Grassland[2]	Woodland[2]
Diversity ($\bar{H}$)	1.157	2.008	2.249	1.849
Evenness (e)	.465	.783	.793	.771
Richness (d)	1.523	1.854	2.912	1.596
No. of Species	12	13	17	11

[1]Data from Schmidly *et al.* (1976a, table 20, p. 94).

[2]Data from Baccus (1971, table 10, p. 49).

indices (Table 2). In particular, the evenness value (0.465) for the riparian community is considerably lower than that of the other communities, indicating that one or two species tend to dominate the rodent fauna of this community. This is evident when examining the total catch figures along the riparian corridor. The two dominant species of the riparian community are *Perognathus penicillatus*, with a total of 924 individuals or 67.7% of the total catch, and *Peromyscus leucopus*, with a total of 162 individuals or 11.9% of the total catch. The grassland is the most diverse community, having the highest diversity, evenness, and richness indices as well as the greatest number of species (17). The desert-shrub, although it only has 13 species (one more than the riparian community), is a more diverse community because it has a more even distribution, which is indicated by the fact that the dominant species (*Perognathus penicillatus*) in this community accounts for only 38.6% of the total catch as compared to 67.7% for the riparian community.

IMPACTS IN THE RIPARIAN CORRIDOR

In recent years, many riparian areas along the Rio Grande have been impacted by human activity. Around El Paso and Presidio, man has destroyed or greatly altered natural riparian natural habitats through water salvage, cultivation and grazing. The International Boundary and Water Commission is presently considering a boundary restoration project along the Rio Grande from Fort Quitman (Hudspeth County) to Presidio (Presidio County). This project would straighten the channel of the river and result in the virtual destruction of riparian habitats along this stretch of the Rio Grande.

Human use (floating and camping) and trespass livestock grazing are the major impacts acting upon the natural riparian communities in BBNP today. In 1975 the Rio Grande accounted for 49% of the total backcountry use (in man-days) in BBNP (Ditton *et al.* 1976). Twenty-five percent of this use was float trips on the Rio Grande and 24% involved camping at primitive sites along the River Road. Schmidly *et al.* (1976b) used correlation analysis to investigate the relationship among human use, impacts, and biological parameters (i.e., rodent fauna and vegetation) at 18 riparian sites in BBNP. Their results revealed a positive and significant relationship between total subjective human impact ratings and annual camping use by site (man-days). However, the extent of human impact did not correlate significantly with rodent densities or vegetative parameters at the 18 sampling sites. Thus, correlation analysis revealed that site impacts have occurred as a result of recreational use, but not to the point where ecological conditions, as indicated by the biological health of the rodent fauna and vegetation, are in jeopardy (Schmidly *et al.*1976b).

Domestic mammals also occur in the riparian corridor and pose a major problem. The increase in grasses over the past 30 years has provided forage that is not available in the same quantity or quality across the river in Mexico. As a result, trespass livestock from Mexico are invading the riparian corridor in increasing numbers. Grazing by trespass livestock is a constant feature of almost all riparian sites and is not confined to one particular region or section of the river. Should this grazing activity continue to increase, it could have dangerous repercussions on the existing vegetation of the riparian corridor. Hence, dealing with the livestock problem may prove more difficult for park managers than dealing with human use and impacts which tend to be concentrated in some areas and virtually absent in others.

CONCLUSIONS

Analysis of small mammals, vegetation,

and impacts along the Rio Grande in BBNP has led to five important conclusions: (1) Major vegetative changes (including the replacement of cottonwoods and willows by salt cedar as well as a tremendous increase in basal and canopy cover) have occurred over the past 30 years. (2) These vegetational changes have resulted in an alteration of the rodent fauna so that certain species which were once rare in riparian habitats (i.e., cricetids such as *Sigmodon hispidus* and *Peromyscus leucopus*) have increased their numbers and ranges along the river, whereas other rodents which were once common (i.e, *Dipodomys ordii*) no longer exist in the riparian corridor. (3) The increase in vegetative cover, especially grasses, has caused a reinvasion of domestic livestock (trespass livestock from Mexico) into the riparian corridor and this may have potentially serious repercussions on the vegetation. (4) Impacts at certain riparian sites have occurred as a result of recreational use, but not to the point where ecological conditions are in jeopardy. Human impacts seem to be confined to areas of convenient access. (5) The riparian community (as revealed by Shannon-Weaver Index) is less stable than the other major communities in BBNP and possibly would be more susceptible to greater oscillations resulting from increased impacts (either human or livestock).

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