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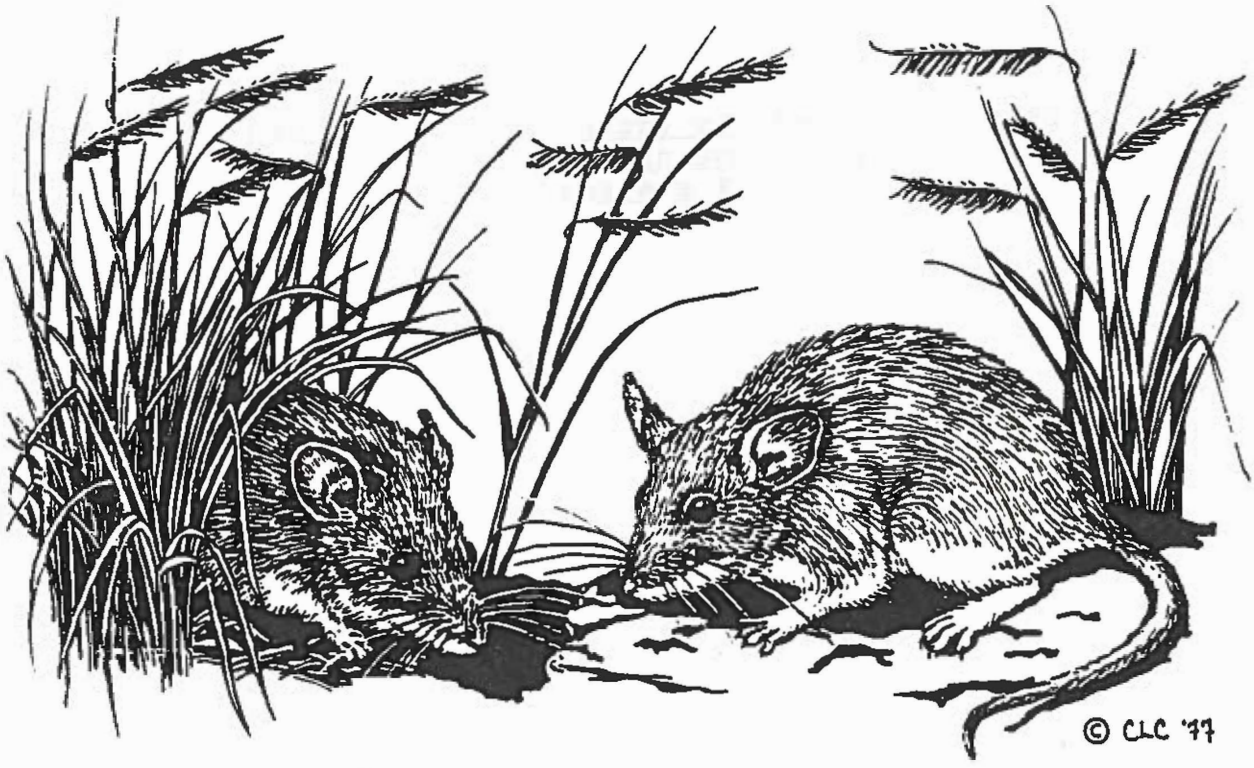

Small Mammal Inventory Progress Report

by

Douglas K. Duncan

1988

San Pedro Technical Report Number 1

Small Mammal Inventory of the Upper San Pedro River Valley, Cochise County, Arizona
Progress Report

Douglas K. Duncan
San Pedro Project Office
San Simon Resource Area
Safford District
Bureau of Land Management

1988

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ABSTRACT

The purpose of this study was to determine small mammal relative densities, species distribution, and habitat breadth on the upper San Pedro River. Snap traps and live traps were used to capture small mammals. Vegetation sampling was conducted on the trapping plots. Twenty five small mammal species were collected and five others were observed. Eight species that have been recorded in the area were not found. We identified 25 vegetation types. Additional study should concentrate on searching for species not yet found, expanding sample size, collecting information on bats and larger mammals, and refining vegetation maps.

INTRODUCTION

For an continental area its size, the southwestern United States has the largest number of mammal subspecies in the world (Hall 1982) and second largest number of species in the United States (Simpson 1964). The large number of species and subspecies found here is due to two factors. First, the discontinuity of habitat types, and second, is that many northern, southern, eastern, and western species reach their range limits in this area. This is especially true in southeastern Arizona for Rocky Mountain and Madrean species.

The mammals on the upper San Pedro River valley were inventoried from December 1986 to August 1987 for relative density, species distribution, and habitat breadth. Vegetation on the inventory plots was also sampled. The methods we utilized follow Anderson and Ohmart (1984). This mammal inventory was designed to provide baseline information to be used in the planning process for the Proposed San Pedro Riparian National Conservation Area and for long-term monitoring. We collected 25 small mammal species and observed five others. Of the species that have been recorded here recently, eight were not found by us. We identified 25 vegetation types that follow Brown et al.'s system (1979). Additional inventories and studies should be conducted to search for species not found, to expand the data base, to document bats and larger mammals, and to refine the current vegetation maps.

STUDY AREA

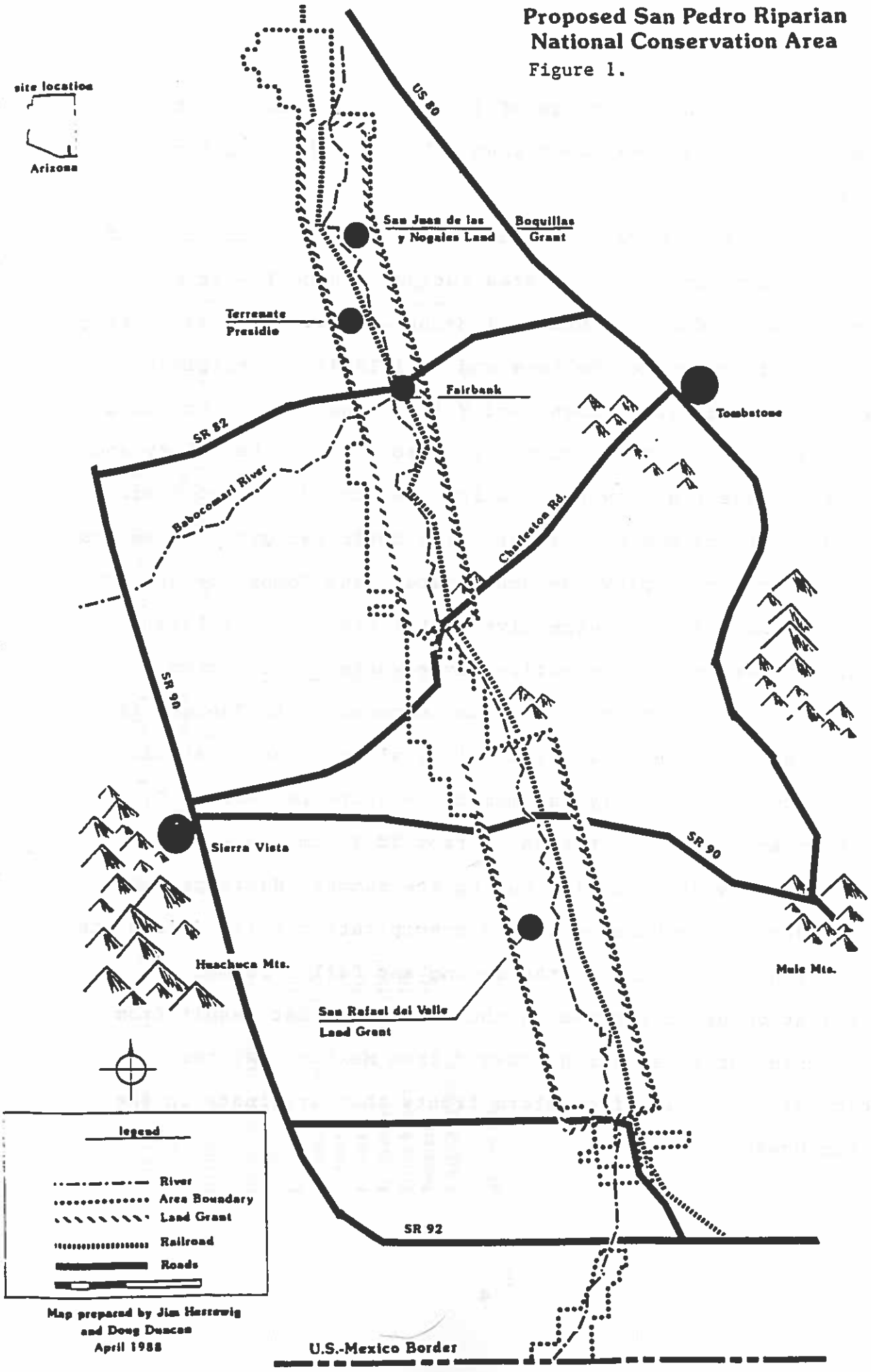
The Proposed San Pedro Riparian National Conservation Area was acquired by the Bureau of Land Management in March 1986 to provide long-term management and protection for riparian, biological, cultural, and other resource values. The area is located in Cochise County, Arizona in the upper San Pedro River valley (Figure 1). Most of the river from the United States-Mexico Border to St. David is in the 55 kilometer long area and contains 18,000 hectares. Much of the remaining sections are privately owned.

The San Pedro River originates in the Sierra de los Ajos and Sierra Mariquita about 30 km south of the US-Mexico Border near Cananea (Arizona Water Commission/United States Department of Interior 1977), and empties into the Gila River 240 km to the north. The major tributary of the upper San Pedro is the Babocomari River which originates in the Sonoita grasslands. Flow in the San Pedro is intermittent except for a few small sections with permanent flow except during extreme drought.

The upper San Pedro River valley has a warm temperate climate (Brown et al. 1979; Brown 1982). Minimum temperature is the main determinant of the major climatic zones (Brown et al. 1979). Brown et al. describe a warm temperate climate as having "freezing temperatures of short duration but generally occurring every year during winter months." "Potential growing season

Proposed San Pedro Riparian National Conservation Area

Figure 1.



over 200 days with an average of less than 125-150 days being subject to temperatures lower than 0 C or to chilling fogs" (pg. 4).

Stations that have recorded precipitation and minimum and maximum temperatures in this area include Apache Powder Company, Benson, Bisbee, Coronado National Memorial, Ft. Huachuca, Flying H Ranch, and Tombstone (Sellers and Hill 1974). Precipitation only was recorded at Fairbank and Y lightning Ranch. Freezing temperatures are common occurrences (Table 1) in the valley and are most frequent at lower elevation stations due to cold air drainage (Sellers and Hill 1974). The potential growing seasons at Apache Powder Company, Benson, Bisbee, and Tombstone are 205, 199, 247, and 238 days respectively (Sellers and Hill 1974). The growing season in the entire river valley varies from 180-240 days. Mean monthly minimum temperature in January is at or below 0 C for the desert and valley slopes (Hansen et al. 1979). July mean monthly maximum temperature is near 32 C.

Mean annual precipitation is from 32-37 cm (Hansen et al. 1979) with ~70% of it coming during the summer (Hastings and Turner 1965). The balance of the precipitation falls during the winter with dry seasons in the spring and fall. Summer precipitation usually comes as thunderstorms that result from the movement of moist air northward from Mexico. Winter precipitation results from storm fronts that originate in the Pacific Ocean.

Table 1. Climatological data for the upper San Pedro River valley. From Sellers and Hill 1974.

Station	years operated	mean annual # days freezing or below	mean annual precipitation	January daily mean minimum temperature (C)	June daily mean maximum temperature (C)
Apache Powder Company	1931-72	91	31.50 cm	-2.3	36.1
Benson	•	80	28.98	-1.4	35.5
Bisbee	1931-61	37	41.17	0.9	31.8
Coronado National Memorial	1955-70	63	50.80	-0.1	32.6
Fairbank	1941-70	nd	29.08	nd	nd
Ft. Huachuca	1954-70	36	37.19	1.2	32.0
Flying H Ranch	1948-58	51	50.44	0.7	32.5
Tombstone	1941-10	46	32.44	0.9	34.8
Y Lightning Ranch	•	nd	32.36	nd	nd

nd = no data

Vegetation biomes within the area are Semidesert Grassland, Chihuahuan Desertscrub, Interior Southwestern Riparian Deciduous Forest and Woodland, Interior Southwestern Swamp and Riparian Scrub, Chihuahuan Interior Marshland, and Agriculture (Brown et al. 1979). Occurring nearby in the Huachuca Mountains are Madrean Montane Conifer Forest, Madrean Evergreen Forest and Woodland, and Interior Chaparral (Brown and Lowe 1980). Most of the area is Chihuahuan Desertscrub. Southwestern deserts such as the Chihuahuan have evolved from the ecologically diverse Madro-Tertiary Geoflora and are the most recently developed vegetation type in the Southwest (Lowe and Brown 1982). The Chihuahuan Desert has expanded and continues to expand into Semidesert Grassland in this area (Hastings and Turner 1965, Brown 1982). Because Semidesert Grassland and Chihuahuan Desertscrub are closely related, desert areas that have been cleared and reseeded have reverted to grassland (Arizona Water Commission/United States Department of Interior 1977). The most important vegetation type, Interior Southwestern Riparian Forest and Woodland, is the main reason the Proposed San Pedro Riparian National Conservation Area was acquired. These forests are relicts of the wetter Tertiary period when mixed deciduous forests were more widespread (Lowe and Brown 1982). This vegetation along the river is one of the few healthy desert riparian systems remaining in the Southwest (Hoffman 1982) and is the rarest forest type in North America (Arizona Nature Conservancy n.d.).

METHODS

We gathered information on mammal distribution and abundance on the upper San Pedro River valley by vegetation type; via trapping, field observations (direct and from sign), and from the literature (Cockrum 1960, Burt and Grossenheider 1976, Hall 1981, Davis 1982, Hoffmeister 1986).

Trapping

Small mammals were collected at 49 different sites and in 24 vegetation types. Legal descriptions of the transects are detailed in the Appendix. All but one vegetation type was trapped at least once.

Trapping procedure followed the methods of Anderson and Ohmart (1984). Trapping grids consisted of two parallel lines 50 feet apart with 15 trapping stations per line, 50 feet apart. Every trapping station had two mouse snap traps (Museum Specials) and one rat snap trap (Victor) that were nailed to the ground. In addition, we placed 10 wire type live traps 75 feet apart, halfway between the snap trap lines. Although live traps were not used by Anderson and Ohmart (1984), we used them in an attempt to get a more representative catch of species or individuals that are less susceptible to snap traps. All traps were baited with a peanut butter and oats mixture. This bait differed from Anderson and Ohmart's (1984) in that we did not need ant repellent (dimethyl pthalate). Each grid was trapped for three consecutive nights. The grid was set up mid day the

first day; checked and rebaited on the mornings of the second and third days; and checked and removed the fourth day. When ants did remove too much bait from the traps during the day, we rebaited traps on the afternoons of the second and third days. Live trapped rodents were sexed, aged, measured and given a uniquely identifiable toe clip before being released near the station where they were trapped.

The three Victorio Agricultural plots were trapped one night each. These plots had one line with 33 stations of three mouse traps (99 traps total). Rodent relative densities are expressed as catch per unit effort. Absolute densities could not be determined because the exact area trapped cannot be ascertained with snap trapping (Kepner 1978). Relative densities are expressed as number of rodents caught per 300 trap nights (90 snap traps and 10 live traps each night for three nights). Only first captures were counted.

Voucher specimens will be placed at the Collection of Mammals, Department of Ecology and Evolutionary Biology, University of Arizona, and at the San Pedro Project Office.

Vegetation

Vegetation was measured following Anderson and Ohmart's (1984) methods. There were variations between our methods and theirs because their plots were longer to accommodate bird censusing. For more detail on the vegetation measurements refer to Anderson and Ohmart (1984).

Tree counts. All trees and large shrubs were counted in an area of 100 by 700 feet. The area censused was the length of the transect (700 ft.) and to 25 ft. on either side of both transect lines (100 ft.). Only perennial plants at least five feet tall with a canopy diameter greater than five feet were counted. Two or more shrubs with diameters of less than 5 ft. are counted as one shrub when the sum of their diameters was 5 ft. or more (e.g. 5 shrubs, each with a diameter of 1 ft. would be counted as one shrub). Results are expressed as number of trees per hectare.

Foliage density. Foliage density (Foliage Height Diversity, FHD) measurements were done similarly to Anderson and Ohmart (1984). FHD is a measure of the vertical distribution of foliage. Measurements were taken during the growing season or when they were not, a leafless plant's leaf cover was estimated as if it were in the growing season.

Sampling was done at eight points, four on each side of the plot. Sampling points were two steps in from the trapping lines at 50, 250, 450, and 550 feet (stations 2, 6, 10, 12). The distance in feet to the nearest green leafy vegetation that will cover at least half of a 9 by 16 inch foliage board was measured at heights of 1/2, 2, 5, 10, 15, 20, 25, 30, 40, 50, 60, and 70 feet. Maximum distance measured to vegetation was 50 ft. because rodents do not range much farther. The plant species measured were also recorded, with an individual plant used only once for each height.

We were concerned about obtaining an adequate FHD sample size as our transects were shorter than Anderson and Ohmart's (1984). The following equation (Avery 1975) was used to determine the adequate sample size for a plot: $(ts/E)(ts/E) = n$; where t is the Student's t value, s is the standard deviation, E is the desired half-width of the confidence interval (we used 0.1), and n is the required sample size. FHDs calculated from the measurements at each sampling point pair (e.g. 50 ft.) were used in the equation. Randomly chosen trap stations were sampled when more than four samples were needed. When more than 11 additional samples (15 total) were needed, points halfway between the trapping stations were chosen randomly. Each plot's FHD index was determined following Anderson and Ohmart (1984).

Patchiness is derived from foliage density measurements and quantifies horizontal diversity (Anderson and Ohmart 1986) and was calculated using Anderson and Ohmart's (1984) method.

Microhabitat data. The percent cover of plant species, litter, and dead vegetation was estimated at three heights (0-1/2', 1/2'-2', >2') in a 1 meter square area around each trap station (Anderson and Ohmart 1984). Annuals were recorded in 1% increments and all else in 5% increments. Each height can have more than 100% cover if two or more species overlap.

Vegetation type. Classifying vegetation on the upper San Pedro River was difficult because it is located near the western boundary of the Chihuahuan desert and the eastern boundary of

the Sonoran desert. In addition, desert grassland and riparian elements are also present. A map of vegetation types was developed according to Brown et al.'s (1979) vegetation classification system.

We used the association (third digit right of the decimal) level of Brown et al.'s (1979) system as the basic vegetation type. They describe an association as a "community of specific dominants" (page 1). A series is the second digit right of the decimal and refers to a community of generic dominants. The first digit right of the decimal represents a biome or regional formation, and "refers to a subcontinental unit that is a major biotic community" (Brown et al. 1979:4). The third digit left of the decimal refers to type of vegetation as either upland (100), wetland (200), or other (300).

RESULTS

Trapping

We collected 25 species of small mammals and observed at least five others (Tables 2 and 3). We sampled 49 different sites (Table 4) once each. We captured 1,083 small mammals once in 14,100 trap nights (TN), for a trapping success of 7.75%. There were 29 multiple captures for a total of 1,112 captures, and a total trapping success of 7.89%. The number of animals captured on a plot ranged from 2 to 89 and the number of species from 1 to 9.

Non mammals captured in snap and live traps included 4 unidentified birds (probably black-throated sparrows, Amphispiza bilineata), 2 Bewick's wrens (Thryomanes bewickii), 1 yellow-breasted chat (Icteria virens), 3 green-tailed towhees (Pipilo chlorurus), 5 brown towhees (P. fuscus), 1 Abert's towhee (P. aberti), 1 black-throated sparrow, 3 Couch's spadefoot toads (Scaphiopus couchi), 4 Woodhouse's toads (Bufo woodhousei), 1 tree lizard (Urosaurus ornatus), 6 western whiptails (Cnemidophorus tigris), and 2 giant spotted whiptails (C. burti). Five gophers (Thomomys bottae) were caught in gopher traps (Victor).

Deer mice (Peromyscus maniculatus) were trapped most frequently (18.2% of total catch) and occurred in more vegetation types (19 of 24) than any other small mammal (Table 5). Other abundant species included Arizona cotton rats

Table 2. Mammals collected (FAMILIES).
Nomenclature follows Hoffmeister (1986).

FAMILY, species	Common name
SORICIDAE	
Notiosorex crawfordi	Desert shrew
VESPERTILIONIDAE	
Antrozous pallidus	Pallid bat
LEPORIDAE	
Sylvilagus audubonii	Desert cottontail
SCIURIDAE	
Ammospermophilus harrisii	Harris' antelope squirrel
Spermophilus variegatus	Rock squirrel
GEOMYIDAE	
Thomomys bottae	Botta's pocket gopher
HETEROMYIDAE	
Perognathus intermedius	Rock pocket mouse
P. penicillatus	Desert pocket mouse
P. baileyi	Bailey's pocket mouse
P. hispidus	Hispid pocket mouse
Dipodomys ordii	Ord's kangaroo rat
D. merriami	Merriam's kangaroo rat
MURIDAE	
Reithrodontomys montanus	Plains harvest mouse
R. megalotis	Western harvest mouse
R. fulvescens	Fulvous harvest mouse
Peromyscus eremicus	Cactus mouse
P. maniculatus	Deer mouse
P. leucopus	White-footed mouse
P. boylii	Brush mouse
Onychomys leucogaster	Northern grasshopper mouse
O. torridus	Southern grasshopper mouse
Sigmodon arizonae	Arizona cotton rat
S. ochrognathus	Yellow-nosed cotton rat
Neotoma albigula	White-throated wood rat
Mus musculus	House mouse

Table 3. Mammals observed.

FAMILY, species	Common name
VESPERTILIONIDAE	
Myotis spp.	Myotis bats
LEPORIDAE	
Lepus californicus	Black-tailed jack rabbit
L. alleni	Antelope jack rabbit
SCIURIDAE	
Spermophilus tereticaudus	Round-tailed ground squirrel
ERITHIZONTIDAE	
Erithizon dorsatum	Porcupine

Table 4. Rodent trapping plots and their vegetation types.

Plot	Vegetation type	Brown et al. 1979
Cienega 1	*Prosopis juliflora velutina*-*Distichlis stricta*-*Scirpus* edge	223.231-243.311-243.321
Cienega 2	*D. stricta*	243.311
Curtis Windmill 1	*Populus fremontii*-*Salix*	223.211
Curtis Windmill 2	*P. j. velutina*	223.231
Terrenate 1	*Haplopappus tenuisectus*-Mixed Scrub	143.164
Terrenate 2	Mixed Chihuahuan Scrub	153.262
Charleston Heights 1	Mixed Grass-mixed Scrub	143.155
Charleston Heights 2	Mixed Grass-mixed Scrub	143.155
Hereford 1	*Sporobolus wrightii*-*P. j. velutina*	143.142
Hereford 2	*P. fremontii*-*Salix*	223.211
Wolf Ranch	Old Ag/*Salsola kali*	300
Garden Canyon Wash	*P. fremontii*-*Salix*	223.211
Victorio	*S. wrightii*	143.141
Victorio Ag 1	Old Ag/*Zea*	300
Victorio Ag 2	Old Ag/*Zea*	300
Victorio Ag 3	Old Ag/*Avena fatua*	300
East Gravel Pit	*P. j. velutina*	223.231
Escapule Wash	*Chilopsis linearis*-*Senecio longilobus*	233.212
Escapule Upland	Mixed Chihuahuan Scrub	153.262
Charleston	*S. wrightii*-*P. j. velutina*	143.142
Charleston Narrows	*P. fremontii*-*Salix*	223.211
Pipeline Intersection	*Hilaria mutica*-*P. j. velutina*	143.122

Table 4 continued.

Plot	Vegetation type	Brown et al. 1979
Cienega Hill	Mixed Chihuahuan Scrub	153.262
Boquillas Ruins 1	Atriplex canescens	153.272
Boquillas Ruins 2	P. j. velutina	153.243
East State Route 90 #1	H. mutica-mixed Scrub	143.123
East State Route 90 #2	Mixed Chihuahuan Scrub	153.262
Clifford Wash Riparian	Tamarix chinensis-mixed Deciduous	233.221
Clifford Wash Upland	H. tenuisectus-P. j. velutina	143.163
Hereford-Palominas Roads East	Acacia neovernicosa	153.221
Hereford-Palominas Roads West	Mixed Grass-P. j. velutina	143.152
Contention Creosote	A. neovernicosa-Larrea divaricata	153.222
Contention Mesquite	P. j. velutina	223.231
Lindsey Ranch	Muhlenbergia porteri-A. neovernicosa	143.156
Donnet-Fry	P. j. velutina-Zinnia pumila-Mixed Grass	143.166
Land 1	Severely Overgrazed P. j. velutina	143.167
Land 2	L. divaricata-Flourensia cernua	153.213
Wolf Ranch 2	Old Ag/Medicago hispida-S. kali	300
West State Route 90	S. wrightii	143.141
State Route 90 Bridge	P. fremontii-Salix	223.211
*** Fairbank 1	P. j. velutina	223.231
Fairbank 2	P. j. velutina	223.231

Table 4 continued.

Plot	Vegetation type	Brown et al. 1979
Hereford 1	S. wrightii-P. j. velutina	143.142
Hereford 2	S. wrightii-P. j. velutina	143.142
Curtis Windmill 3	Mixed Chihuahuan Scrub	153.262
Curtis Windmill 4	Mixed Chihuahuan Scrub	153.262
Lewis Springs 1	P. fremontii-Salix	223.211
Lewis Springs 2	S. wrightii-P. j. velutina	143.142
Lewis Springs 3	A. neovernicosa	153.221

*** = plots trapped by McMahon Nov.-Dec. 1986

Table 5. Total number caught, percentage of total caught, and vegetation type occurrence. After Kepner (1978).

Species	# caught	% of total	# vegetation types in which occurred
N. crawfordi	1	0.1	1
S. audubonii	2	0.2	2
A. harrisii	4	0.4	2
S. variegatus	1	0.1	1
Perognathus	79	7.3	13
intermedius	14	1.3	1
penicillatus	51	4.7	11
baileyi	13	1.2	3
hispidus	1	0.1	1
D. ordii	2	0.2	2
D. merriami	157	14.5	16
Reithrodontomys	104	9.6	13
montanus	12	1.1	4
megalotis	79	7.3	10
fulvescens	13	1.2	6
Peromyscus	443	40.9	21
eremicus	124	11.4	8
maniculatus	197	18.2	19
leucopus	121	11.2	8
boylii	1	0.1	1
O. leucogaster	14	1.3	5
O. torridus	20	1.8	7
S. arizonae	166	15.1	7
S. ochrognathus	1	0.1	1
N. albigula	82	7.6	16
M. musculus	7	0.6	1
Total	1,083		24

(Sigmodon arizonae), 15.1%; Merriam's kangaroo rat (Dipodomys merriami), 14.5%; cactus mice (Peromyscus eremicus), 11.4%; and white-footed mice (Peromyscus leucopus), 11.2%. Table 6 and Figure 2 illustrate the densities for the most common rodents for each vegetation type. There were 18 other mammal species trapped ranging in number from one individual (0.1%, for five species) to 82 (7.6%, for one species) animals (Table 5). The number trapped refers to first captures only. The mammal occurrence per vegetation types (associations) were: Merriam's kangaroo rats in 16 of the 24 types, white-throated wood rats (Neotoma albigula) in 16 types, desert pocket mice (Perognathus penicillatus) in 11, and western harvest mice (Reithrodontomys megalotis) in 10 (see Tables 5 and 7).

The relative densities for desert shrews (Notiosorex crawfordi), desert cottontails (Sylvilagus audubonii), Harris' antelope squirrel (Ammospermophilus harrisii), and rock squirrels (Spermophilus variegatus) are probably much higher than the trapping data indicates as these species are not susceptible to the trapping methods used.

Table 7 details the small mammal relative densities for each vegetation type. The Cienega 1 plot was edge habitat consisting of bulrush-velvet mesquite-saltgrass (Scirpus olneyi-Prosopis juliflora velutina-Distichlis stricta) (243.321-223.231-243.311 in Brown, Lowe, and Pase 1979) associations and had the highest mammal relative density of 71 individuals per 300 TN.

Table 6. Most common small mammals trapped. Number per 300 trap nights (total number trapped). After Kepner 1978.

	Vegetation types							
Mammals	143.122	143.123	143.141	143.142	143.152	143.155	143.156	143.163
D. merriami	6.0 (6)	0	0	2.0 (10)	7.0 (7)	0.5 (1)	0	10.0(10)
P. eremicus	0	0	0	0	0	16.0 (32)	0	0
P. maniculatus	8.0 (8)	1.0 (1)	1.0 (2)	8.6 (43)	1.0 (1)	0	1.0 (1)	7.0 (7)
P. leucopus	0	5.0 (5)	8.5 (17)	0	0	0	0	0
S. arizonae	0	11.0 (11)	6.0 (12)	10.6 (53)	0	0	0	0

Mammals	143.164	143.166	143.167	153.213	153.221	153.222	153.243	153.262
D. merriami	1.0 (1)	5.0 (5)	1.0 (1)	5.0 (5)	5.0 (10)	8.0 (8)	19.0 (19)	5.2 (31)
P. eremicus	21.0 (21)	0	0	0	0	0	3.0 (3)	4.3 (26)
P. maniculatus	0	0	7.0 (7)	1.0 (1)	5.5 (11)	0	1.0 (1)	3.3 (20)
P. leucopus	0	0	0	0	0	0	0	0.3 (2)
S. arizonae	0	0	0	0	0	0	0	0

Mammals	153.272	223.211	223.231	233.212	233.221	243.311	243.321	300
D. merriami	29.0 (29)	0	1.8 (9)	0	5.0 (5)	0	0	0
P. eremicus	0	2.2 (13)	4.0 (20)	0	6.0 (6)	0	3.0 (3)	0
P. maniculatus	0	0	0.6 (3)	11.0 (11)	11.0 (11)	5.0 (5)	8.0 (8)	9.0 (27)
P. leucopus	0	0	0.2 (1)	0	18.0 (18)	15.0 (15)	41.0 (41)	0
S. arizonae	0	0	1.2 (6)	0	0	1.0 (1)	11.0 (11)	24.0 (72)

Figure 2a, common rodent density.

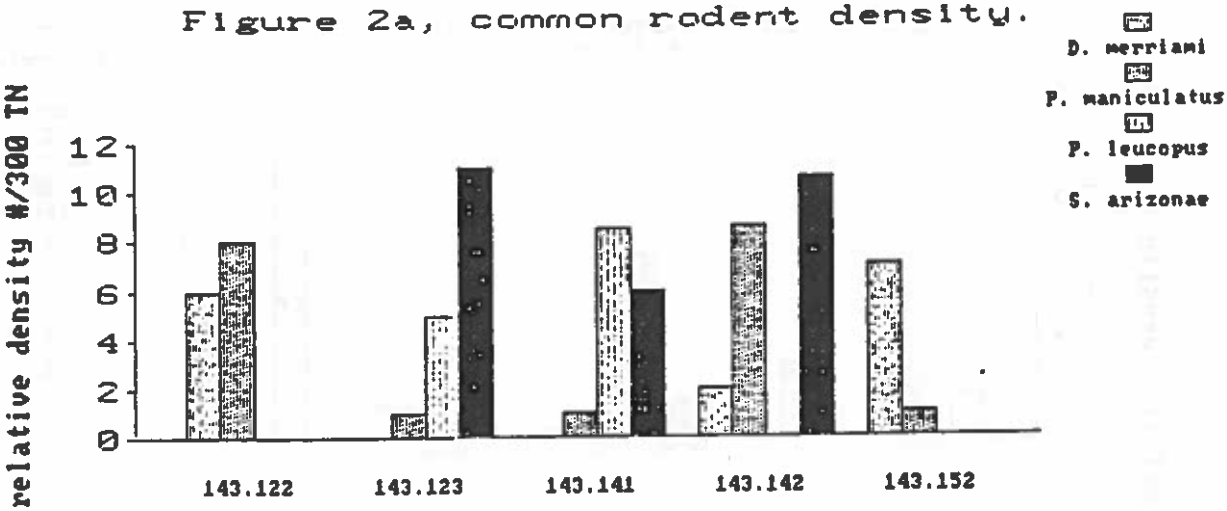


Figure 2b, common rodent density.

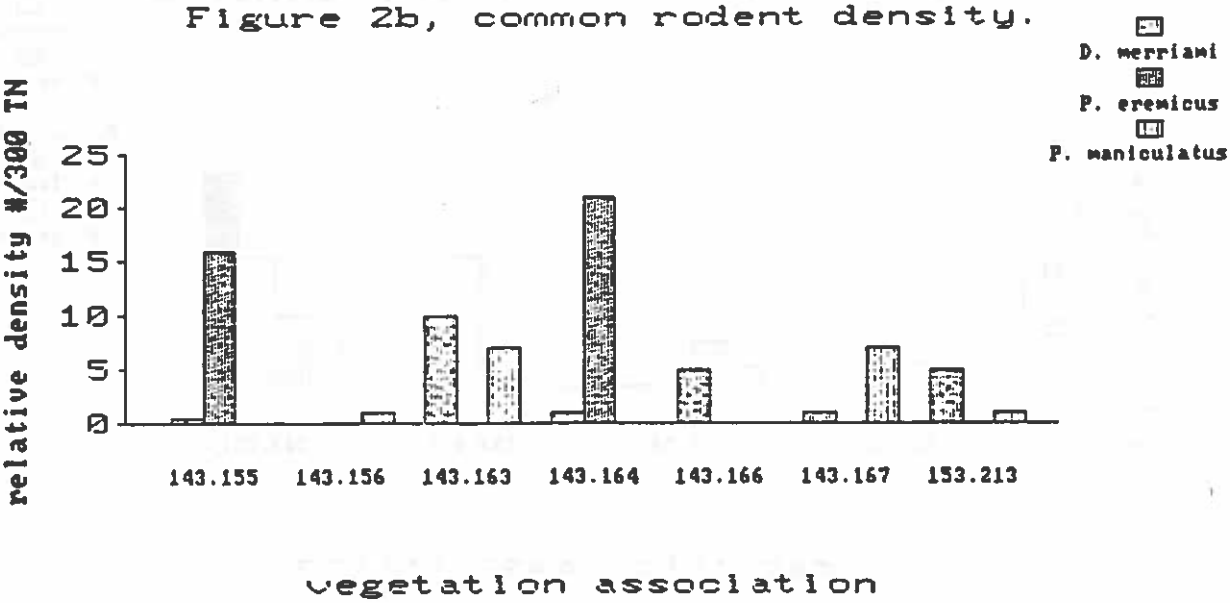


Figure 2c, common rodent density.

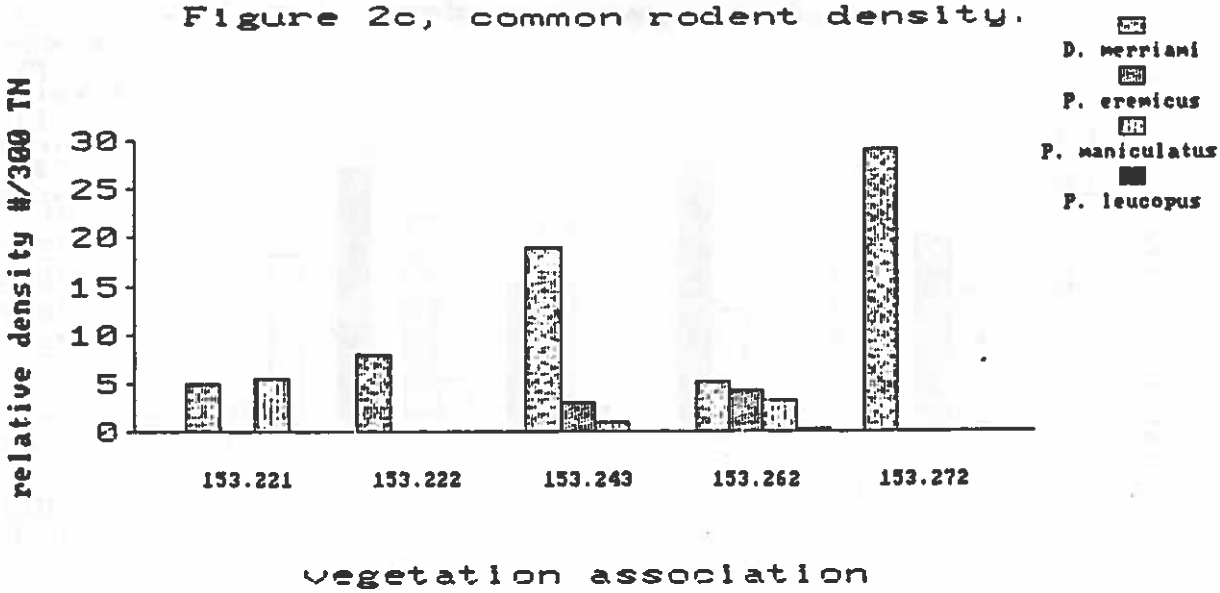


Figure 2d, common rodent density.

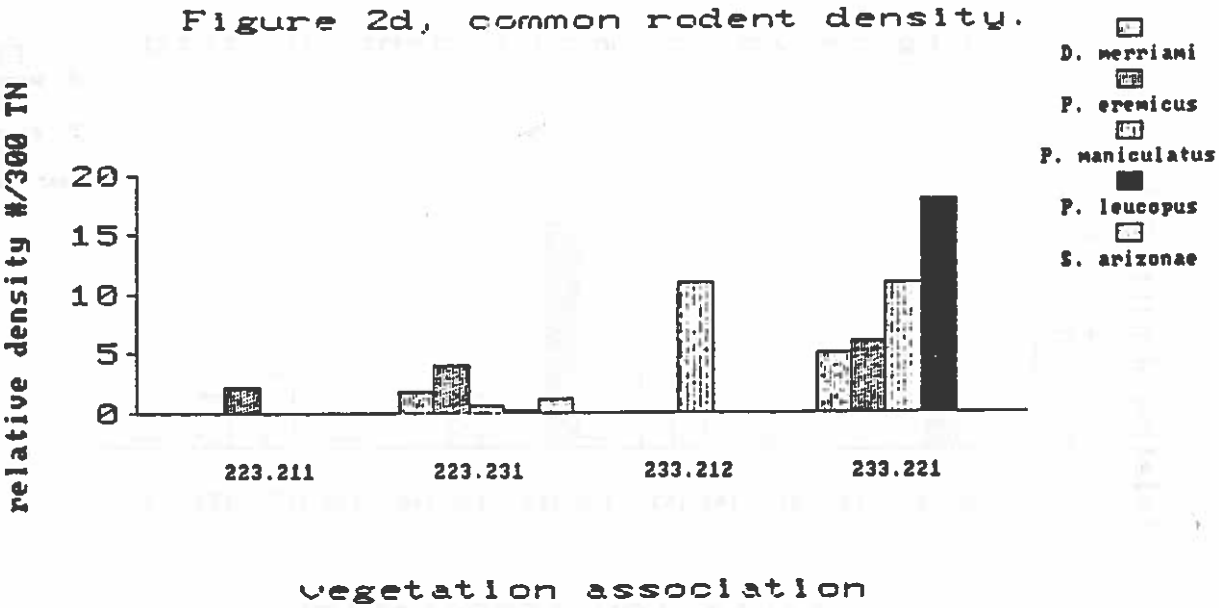


Figure 2e, common rodent density.

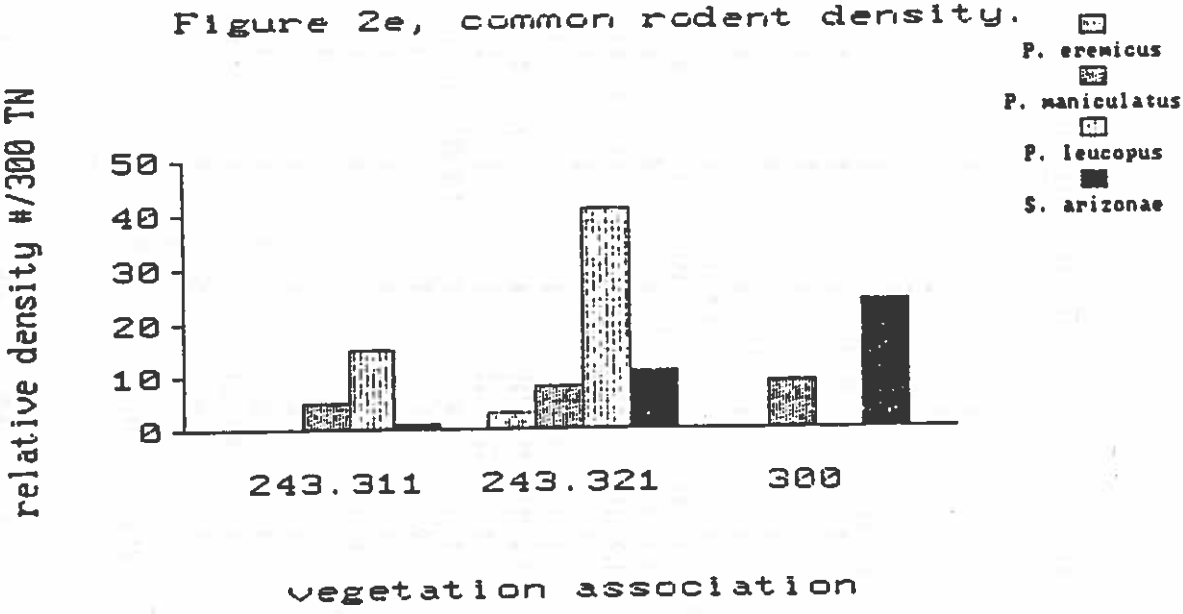


Table 7. Mammal relative densities (total # trapped) for each vegetation association.

	Association											
Mammals	143.122	143.123	143.141	143.142	143.152	143.155	143.156	143.163	143.164	143.166	143.167	153.313
N. crawfordi	0	0	0	0.2 (1)	0	0	0	0	0	0	0	0
S. audubonii	0	0	0	0	0	0.5 (1)	1.0 (1)	0	0	0	0	0
A. harrisii	0	0	0	0	0	0.5 (1)	0	0	0	0	0	0
S. variegatus	0	0	0	0	0	0	0	0	0	0	0	0
Perognathus	0	0	0	1.0 (5)	1.0 (1)	8.0 (16)	0	8.0 (8)	0	0	0	0
intermedius	0	0	0	0	0	7.0 (14)	0	0	0	0	0	0
penicillatus	0	0	0	1.0 (5)	1.0 (1)	0	0	8.0 (8)	0	0	0	0
baileyi	0	0	0	0	0	1.0 (2)	0	0	0	0	0	0
hispidus	0	0	0	0	0	0	0	0	0	0	0	0
D. ordii	0	0	0	0	0	0	0	0	0	1.0 (1)	0	0
D. merriami	6.0 (6)	0	0	2.0 (10)	7.0 (7)	0.5 (1)	0	10.0 (10)	1.0 (1)	5.0 (5)	1.0 (1)	5.0 (5)
Reithrodontomys	0	9.0 (9)	8.5 (17)	6.4 (32)	0	3.0 (6)	1.0 (1)	3.0 (3)	0	0	0	0
montanus	0	0	0	1.6 (8)	0	0	0	1.0 (1)	0	0	0	0
megalotis	0	9.0 (9)	8.5 (17)	4.8 (24)	0	3.0 (6)	0	0	0	0	0	0
fulvescens	0	0	0	0	0	0	1.0 (1)	2.0 (2)	0	0	0	0
Peromyscus	8.0 (8)	6.0 (6)	9.5 (19)	8.6 (43)	1.0 (1)	15.0 (32)	1.0 (1)	7.0 (7)	21.0 (21)	0	7.0 (7)	1.0 (1)
eremicus	0	0	0	0	0	16.0 (32)	0	0	21.0 (21)	0	0	0
maniculatus	8.0 (8)	1.0 (1)	1.0 (2)	8.6 (43)	1.0 (1)	0	1.0 (1)	7.0 (7)	0	0	7.0 (7)	1.0 (1)
leucopus	0	5.0 (5)	8.5 (17)	0	0	0	0	0	0	0	0	0
boylii	0	0	0	0	0	0	0	0	0	0	0	0
O. leucogaster	0	0	0	0.2 (1)	1.0 (1)	0	0	1.0 (1)	0	0	0	0
O. torridus	0	0	0	0.2 (1)	1.0 (1)	0.5 (1)	2.0 (2)	0	0	0	0	0
S. arizonae	0	11.0 (11)	6.0 (12)	10.6 (53)	0	0	0	0	0	0	0	0
S. ochrognathus	0	0	0	0	0	0.5 (1)	0	0	0	0	0	0
M. albigula	0	1.0 (1)	0	1.2 (6)	0	1.0 (2)	1.0 (1)	0	2.0 (2)	0	0	1.0 (1)
M. musculus	0	0	0	0	0	0	0	0	0	0	0	0
Relative density	14.0	27.0	24.0	30.4	11.0	30.5	6.0	29.0	24.0	6.0	8.0	7.0
# caught	14	27	48	152	11	61	6	29	24	6	8	7
# trap nights	300	300	600	1500	300	600	300	300	300	300	300	300
# plots	1	1	2	5	1	2	1	1	1	1	1	1
% success	4.7	9.0	8.0	10.1	3.7	10.2	2.0	9.7	8.0	2.0	2.7	2.3
# species	2	5	4	10	5	10	5	6	3	2	2	3

Table 7 continued.

	Association											
Mammals	153.221	153.222	153.243	153.262	153.272	223.211	223.231	233.212	233.221	243.311	243.321	300
N. crawfordi	0	0	0	0	0	0	0	0	0	0	0	0
S. audubonii	0	0	0	0	0	0	0	0	0	0	0	0
A. harrisii	0	0	0	0	3.0 (3)	0	0	0	0	0	0	0
S. variegatus	0	0	0	0	0	0	0.2 (1)	0	0	0	0	0
Perognathus	0	2.0 (2)	4.0 (4)	0.7 (4)	2.0 (2)	0.3 (3)	4.8 (24)	3.0 (3)	7.0 (7)	1.0 (1)	0	0
intermedius	0	0	0	0	0	0	0	0	0	0	0	0
penicillatus	0	2.0 (2)	4.0 (4)	0.5 (3)	2.0 (2)	0.3 (2)	2.8 (14)	3.0 (3)	7.0 (7)	0	0	0
baileyi	0	0	0	0.2 (1)	0	0	2.0 (10)	0	0	0	0	0
hispidus	0	0	0	0	0	0	0	0	0	1.0 (1)	0	0
D. ordii	0.5 (1)	0	0	0	0	0	0	0	0	0	0	0
D. merriami	5.0 (10)	8.0 (8)	19.0 (19)	5.2 (31)	29.0 (29)	0	1.8 (9)	0	5.0 (5)	0	0	0
Reithrodontomys	0	0	0	0.7 (4)	0	0.7 (4)	1.6 (8)	1.0 (1)	2.0 (2)	4.0 (4)	7.0 (7)	2.0 (6)
montanus	0	0	0	0	0	0	0	0	0	1.0 (1)	2.0 (2)	0
megalotis	0	0	0	0.5 (3)	0	0.7 (4)	1.6 (8)	0	1.0 (1)	3.0 (3)	4.0 (4)	0
fulvescens	0	0	0	0.2 (1)	0	0	0	1.0 (1)	1.0 (1)	0	1.0 (1)	2.0 (6)
Peromyscus	5.5 (11)	0	4.0 (4)	7.9 (48)	0	12.3 (73)	4.8 (24)	11.0 (11)	35.0 (35)	20.0 (20)	52.0 (52)	9.0 (9)
eremicus	0	0	3.0 (3)	4.3 (26)	0	2.2 (13)	4.0 (20)	0	6.0 (6)	0	3.0 (3)	0
maniculatus	5.5 (11)	0	1.0 (1)	3.3 (20)	0	6.2 (37)	0.6 (3)	11.0 (11)	11.0 (11)	5.0 (5)	8.0 (8)	9.0 (9)
leucopus	0	0	0	0.3 (2)	0	3.7 (22)	0.2 (1)	0	18.0 (18)	15.0 (15)	41.0 (41)	0
boylii	0	0	0	0	0	0.2 (1)	0	0	0	0	0	0
O. leucogaster	1.0 (2)	0	0	1.5 (9)	0	0	0	0	0	0	0	0
O. torridus	0	4.0 (4)	0	0.2 (2)	1.0 (1)	0	1.6 (8)	0	3.0 (3)	0	0	0
S. arizonae	0	0	0	0	0	0	1.2 (6)	0	0	1.0 (1)	11.0 (11)	24.0 (72)
S. ochrognathus	0	0	0	0	0	0	0	0	0	0	0	0
M. albigula	4.5 (9)	1.0 (1)	3.0 (3)	3.2 (19)	4.0 (4)	1.8 (11)	3.2 (16)	0	4.0 (4)	1.0 (1)	1.0 (1)	0
M. musculus	0	0	0	0	0	0	0	0	0	0	0	2.3 (7)
Relative density	16.5	15.0	30.0	19.4	39.0	15.3	19.0	15.0	56.0	27.0	71.0	37.3
# caught	33	15	30	116	39	91	95	15	56	27	71	112
# trap nights	600	300	300	1800	300	1800	1500	300	300	300	300	900
# plots	2	1	1	6	1	6	5	1	1	1	1	5
% success	5.5	5.0	10.0	6.5	13.0	5.1	6.3	5.0	18.6	9.0	23.7	13.4
# species	5	4	5	11	5	7	10	3	9	7	8	4

White-footed mice (41/300 TN), Arizona cotton rats (11/300), and deer mice (8) were the most frequently captured rodents in this vegetation type. The Cienega 1 plot had an area of dense bulrush bounded by areas of saltgrass and dense mesquite. This plot had a great deal of edge, and provided dense cover and perennial water. The greatest non-edge density of 59/300 TN were found in the saltcedar (Tamarix chinensis)-mixed deciduous association (233.221). This vegetation type provided large amounts of cover. Densities for all vegetation types ranged from 6.0-71.0 (Figure 3). The vegetation types with the lowest densities (6.0) were the bush muhly (Muhlenbergia porteri)-whitethorn (Acacia neovernicosa)(143.156) and velvet mesquite-zinnia (Zinnia pumila)-mixed grass (143.166) associations. Association 143.156 had moderate amounts of cover because of the bush muhly, but this is not reflected in higher relative densities or species numbers. Association 143.166 had large open areas between the mesquites. Kangaroo rats were the only mammals caught in this type. Overall small mammal density during the study was 23.0 individuals/300 TN.

The number of species found in a vegetation type ranged from 2 to 11 (Figure 3). Two species were found in tobosa (Hilaria mutica)-velvet mesquite (143.122), mesquite-zinnia-mixed grass, and severely overgrazed mesquite (143.167) associations. Eleven species were captured in the mixed Chihuahuan scrub association (153.262).

Figure 3a, density and species #.

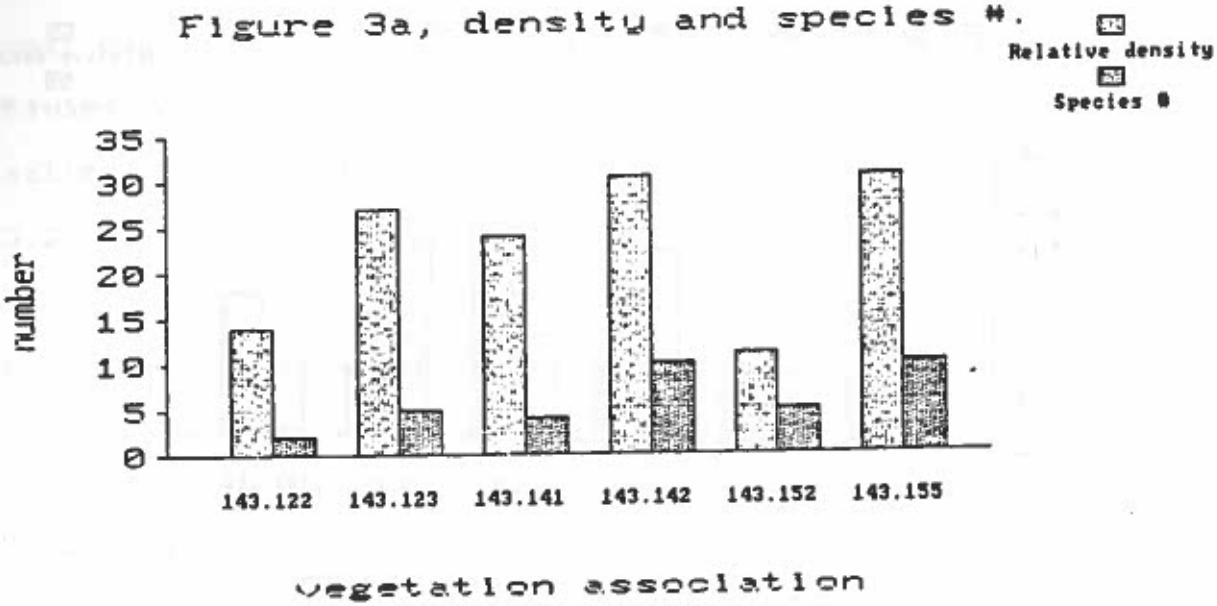


Figure 3b, density and species #.

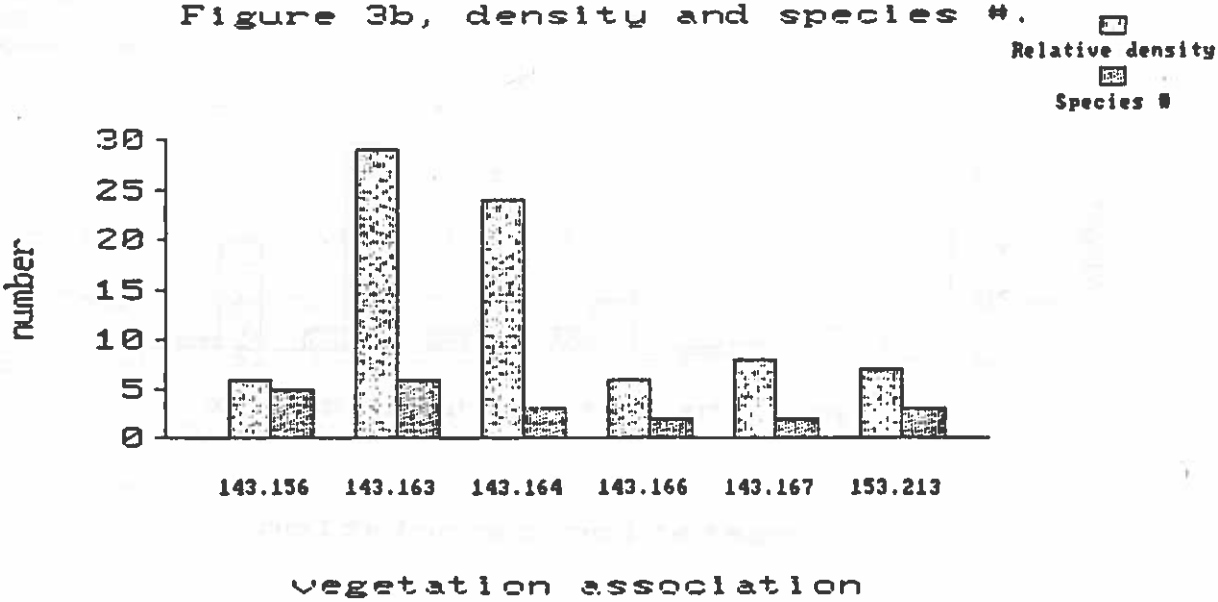


Figure 3c, density and species #.

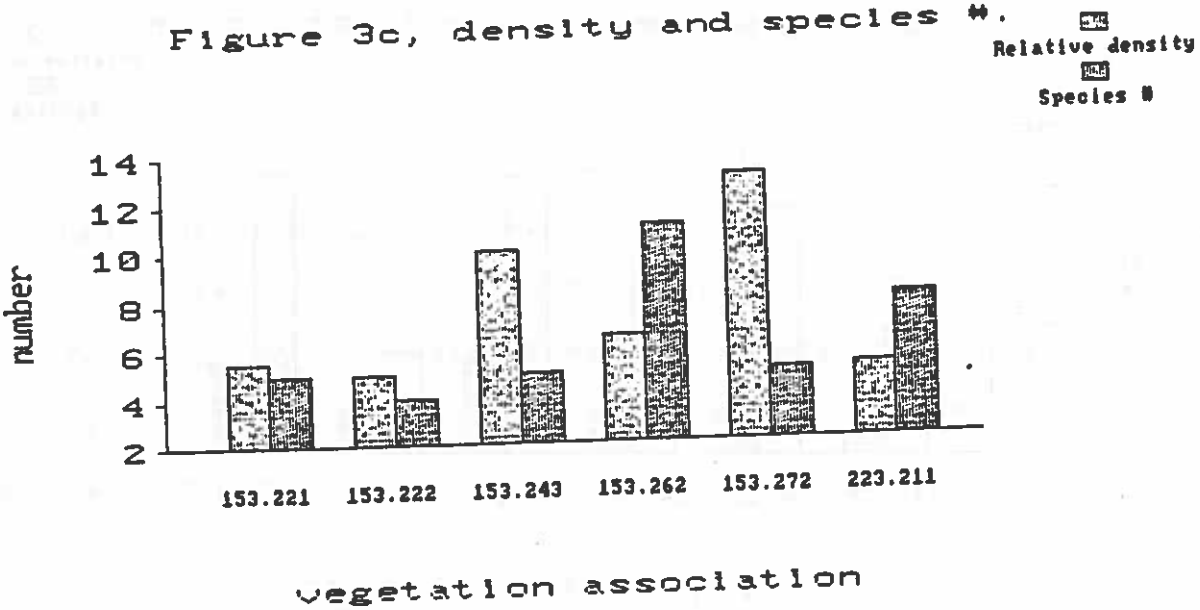
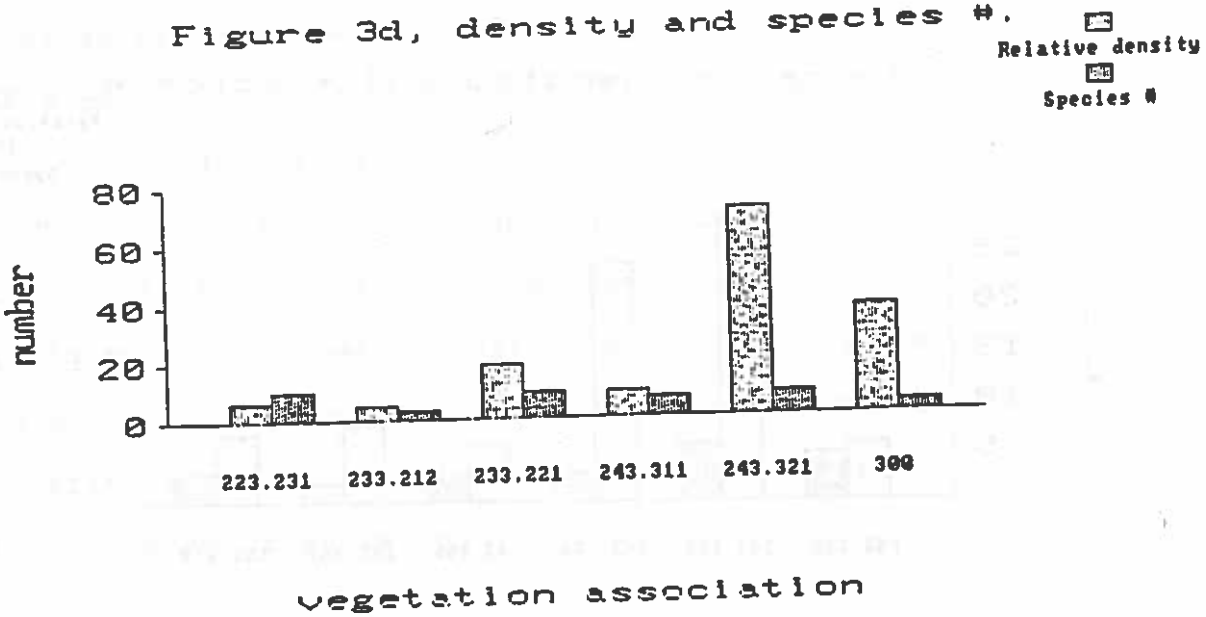


Figure 3d, density and species #.



The following vegetation series had the highest small mammal densities (Table 8): threesquare-mesquite-saltgrass (243.32-223.23-243.31) series edge (71/300 TN); saltcedar disclimax series, 233.22 (56.0); saltbush (Atriplex) series, 153.27 (39.0); agriculture, 300.00 (37.3); and mesquite series, 153.24 (30.0). The most numerous mammals in a non-edge series were white-footed mice (18/300 TN), deer mice (11), and Merriam's kangaroo rat (7). The lowest density of 7.0/300 TN was found in the creosote (Larrea divaricata)-tarbush (Flourensia cernua) series, 153.21. The number of species trapped in a series varied from 14 in the mixed grass-scrub (143.15) to three in the mixed narrowleaf (233.21). Deer mice and white-thrcated wood rats were trapped in 15 of 16 series and Merriam's kangaroo rat in 11 (Figure 3).

Chihuahuan Interior Marshland (243.3) biome had the highest small mammal density (49/300 TN) and Interior Southwestern Riparian Deciduous Forest and Woodland (223.2) had the lowest (16.9)(Table 9). The most abundant rodents in 243.3 were white-footed mice (28/300 TN), deer mice (6.5), and Arizona cotton rats (6.0). Semidesert Grassland (143.1) had the most species with 19, and Agriculture (300.0) had the fewest species with four. Deer mice were captured in six biomes, and western harvest mice (Reithrodontomys montanus), fulvous harvest mice (R. fulvescens), cactus mice, white-footed mice, and white-throated wood rats in five.

Table 8. Small mammal densities in each vegetation series.

	Vegetation series							
Mammals	143.12	143.14	143.15	143.16	153.21	153.22	153.24	153.26
N. crawfordi	0	0.1 (1)	0	0	0	0	0	0
S. audubonii	0	0	0.5 (2)	0	0	0	0	0
A. harrisii	0	0	0.3 (1)	0	0	0	0	0
S. variegatus	0	0	0	0	0	0	0	0
Perognathus	0	0.7 (5)	4.3 (17)	2.0 (8)	0	0.7 (2)	4.0 (4)	0.7 (4)
intermedius	0	0	3.5 (14)	0	0	0	0	0
penicillatus	0	0.7 (5)	0.3 (1)	2.0 (8)	0	0.7 (2)	4.0 (4)	0.5 (3)
baileyi	0	0	0.5 (2)	0	0	0	0	0.2 (1)
hispidus	0	0	0	0	0	0	0	0
D. ordii	0	0	0	0.3 (1)	0	0.3 (1)	0	0
P. merriami	3.0 (6)	1.4 (10)	2.0 (8)	4.3 (17)	5.0 (5)	6.0 (18)	19.0 (19)	5.2 (31)
Reithrodontomys	4.5 (9)	7.0 (49)	1.8 (7)	0.8 (3)	0	0	0	0.7 (4)
montanus	0	1.1 (8)	0	0.3 (1)	0	0	0	0
megalotis	4.5 (9)	5.9 (41)	1.5 (6)	0	0	0	0	0.5 (3)
fulvescens	0	0	0.3 (1)	0.5 (2)	0	0	0	0.2 (1)
Peromyscus	7.0 (14)	8.8 (62)	8.5 (34)	8.8 (35)	1.0 (1)	3.7 (11)	4.0 (4)	9.1 (48)
eremicus	0	0	8.0 (32)	5.3 (21)	0	0	3.0 (3)	4.3 (26)
maniculatus	4.5 (9)	6.4 (45)	0.5 (2)	3.5 (14)	1.0 (1)	3.7 (11)	1.0 (1)	3.3 (20)
leucopus	2.5 (5)	2.4 (17)	0	0	0	0	0	0.5 (2)
boylii	0	0	0	0	0	0	0	0
O. leucogaster	0	0.1 (1)	0.3 (1)	0	2.0 (2)	0.7 (2)	0	1.5 (9)
O. torridus	0	0.1 (1)	1.0 (4)	0	0	1.3 (4)	0	0.2 (1)
S. arizonae	5.5 (11)	9.4 (65)	0	0	0	0	0	0
S. ochrognathus	0	0	0.3 (1)	0	0	0	0	0
N. albigula	0.5 (1)	0.9 (6)	0.8 (3)	0.5 (2)	1.0 (1)	3.3 (10)	3.0 (3)	3.2 (19)
M. musculus	0	0	0	0	0	0	0	0
Total	20.5	28.6	19.5	16.5	9.0	16.0	30.0	19.3
# caught	41	200	78	66	69	48	30	116
# trap nights	600	2100	1200	1200	300	900	300	1800
# plots	2	7	4	4	1	3	3	6
% success	6.8	9.5	6.5	5.5	3.0	5.3	10.0	6.4
# species	6	11	14	8	4	7	5	11

Table 8 continued.

Mammals	Vegetation series						
	153.27	223.21	233.21	233.22	242.31	243.32	300
N. crawfordi	0	0	0	0	0	0	0
S. audubonii	0	0	0	0	0	0	0
A. harrisii	3.0 (3)	0	0	0	0	0	0
S. variegatus	0	0.2 (1)	0	0	0	0	0
Perognathus	2.0 (2)	0.3 (2)	4.8 (24)	7.0 (7)	1.0 (1)	0	0
intermedius	0	0	0	0	0	0	0
penicillatus	2.0 (2)	0.3 (2)	2.8 (14)	7.0 (7)	0	0	0
baileyi	0	0	2.0 (10)	0	0	0	0
hispidus	0	0	0	0	1.0 (1)	0	0
D. ordii	0	0	0	0	0	0	0
D. merriami	29.0 (29)	0	1.8 (9)	5.0 (5)	0	0	0
Reithrodontomys	0	0.7 (4)	1.6 (8)	1.0 (1)	4.0 (4)	6.0 (6)	0
montanus	0	0	0	0	1.0 (1)	2.0 (2)	0
megalotis	0	0.7 (4)	1.6 (8)	1.0 (1)	3.0 (3)	4.0 (4)	0
fulvescens	0	0	0	0	0	0	0
Peromyscus	0	12.3 (73)	4.8 (24)	35.0 (35)	20.0 (20)	52.0 (52)	9.0 (27)
eremicus	0	2.2 (13)	4.0 (20)	6.0 (6)	0	3.0 (3)	0
maniculatus	0	6.2 (37)	0.6 (3)	11.0 (11)	5.0 (5)	8.0 (8)	9.0 (27)
leucopus	0	3.7 (22)	0.2 (1)	18.0 (18)	15.0 (15)	41.0 (41)	0
boylii	0	0.2 (1)	0	0	0	0	0
S. leucogaster	0	0	0	0	0	0	0
S. torridus	0.2 (1)	0	1.6 (8)	3.0 (3)	0	0	0
S. arizonae	0	0	1.2 (6)	0	1.0 (1)	11.0 (11)	24.0 (72)
S. ochrognathus	0	0	0	0	0	0	0
M. albigula	4.0 (4)	1.8 (11)	3.2 (16)	4.0 (4)	1.0 (1)	1.0 (1)	2.3 (7)
M. fusculus	0	0	0	0	0	0	0
Total	39.0	15.2	19.9	56.0	27.0	71.0	37.3
# caught	39	91	95	56	27	71	112
# trap nights	300	1800	1500	300	300	300	900
# plots	1	6	5	1	1	1	5
% success	13.0	5.1	6.3	18.7	9.0	23.7	12.4
# species	5	8	10	9	7	8	4

Table 9. Small mammal densities in each vegetation biome. Number per 300 TN. (Total number trapped).

	Biome					
Mammal	143.1	153.2	223.2	233.2	243.3	300.0
N. crawfordi	0.1(1)	0	0	0	0	0
S. audubonii	0.1(2)	0	0	0	0	0
A. harrisii	0.1(1)	0.3(3)	0	0	0	0
S. variegatus	0	0	0.1(1)	0	0	0
Perognathus	1.7(30)	1.0(12)	2.4(26)	5.0(10)	0.5(1)	0
intermedius	0.8(14)	0	0	0	0	0
penicillatus	0.8(14)	0.9(11)	1.5(16)	5.0(10)	0	0
baileyi	0.1(2)	0.1(1)	0.9(10)	0	0	0
hispidus	0	0	0	0	0.5(1)	0
D. ordii	0.1(1)	0.1(1)	0	0	0	0
D. merriami	2.4(41)	8.5(102)	0.8(9)	2.5(5)	0	0
Reithrodontomys	4.0(68)	0.4(4)	1.1(12)	1.5(3)	5.5(11)	2.0(6)
montanus	0.5(9)	0	0	0	1.5(3)	0
megalotis	3.3(56)	0.3(3)	1.1(12)	0.5(1)	3.5(7)	0
fulvescens	0.2(3)	0.1(1)	0	1.0(2)	0.5(1)	2.0(6)
Peromuscus	8.5(145)	5.4(64)	8.8(97)	23.0(46)	36.0(72)	9.0(27)
eremicus	3.1(53)	2.4(29)	3.0(33)	3.0(6)	1.5(3)	0
maniculatus	4.1(70)	2.8(33)	3.6(40)	11.0(22)	6.5(13)	9.0(27)
leucopus	1.3(22)	0.2(2)	2.1(23)	9.0(18)	28.0(56)	0
boylii	0	0	0.1(1)	0	0	0
O. leucogaster	0.2(3)	0.9(11)	0	0	0	0
O. torridus	0.3(5)	0.5(6)	0.7(8)	1.5(3)	0	0
S. arizonae	4.5(76)	0	0.5(6)	0	6.0(12)	24.0(72)
S. ochrognathus	0.1(1)	0	0	0	0	0
N. albigula	0.7(12)	3.1(37)	2.5(27)	2.0(4)	1.0(2)	0
M. musculus	0	0	0	0	0	2.3(7)
Total	22.7	20.0	16.9	35.5	49.0	37.3
# caught	386	240	186	71	98	112
# trap nights	5100	3600	3300	600	600	900
# plots	17	12	11	2	2	5
% success	7.6	6.7	5.6	11.8	16.3	12.4
# species	19	13	12	9	9	4

Upland vegetation types (100) had the most species (19), and Agriculture (300) the least with four (Table 10). Fulvous harvest mice, deer mice, and Arizona cotton rats were found in all three major vegetation types. Agriculture had a density of 37.3/300 TN and Uplands had 21.4/300 TN. The most abundant rodents found in the agriculture fields were Arizona cotton rats (24/300 TN) and deer mice (9/300 TN). We captured 72 Arizona cotton rats in three days on the Wolf Ranch plot which consisted of dense Russian thistle (Salsola kali).

As part of the herptile inventory in the upper San Pedro River valley, Troy Corman had nine pit trap arrays set out in which desert shrews were captured. These arrays were opened starting 11 June and all were closed 8 September 1987. Each night an array was operated, it counted as one trap night. Shrews still alive in the traps were released, so the number captured (Table 11) may represent multiple captures. At any rate, it appears that desert shrews are not uncommon on the upper San Pedro River valley and are most numerous in the cottonwood (Populus fremontii)-willow (Salix spp.) riparian zone.

Literature Records

Cockrum (1960), Hall (1981), Davis (1982), and Hoffmeister (1986) were reviewed for records of mammal occurrence on or near the upper San Pedro River valley (Table 12). Several species listed have no specific records near the upper San Pedro River

Table 10. Small mammal densities in upland, wetland, and agricultural vegetation types. Number per 300 TN. (total # caught).

Species	Types		
	Upland (100)	Wetland (200)	Agricultural (300)
N. crawfordi	- (1)	0	0
S. audubonii	0.1 (2)	0	0
A. harrisii	0.1 (4)	0	0
S. variegatus	0	0.1 (1)	0
Perognathus	1.5 (42)	2.5 (37)	0
intermedius	0.5 (14)	0	0
penicillatus	0.9 (25)	1.7 (26)	0
baileyi	0.1 (3)	0.7 (10)	0
hispidus	0	0.1 (1)	0
D. ordii	0.1 (2)	0	0
D. merriami	4.9 (143)	0.9 (14)	0
Reithrodontomys	2.4 (72)	1.7 (26)	2.0 (6)
montanus	0.3 (9)	0.2 (3)	0
megalotis	2.0 (59)	1.3 (20)	0
fulvescens	0.1 (4)	0.2 (3)	2.0 (6)
Peromyscus	7.2 (209)	14.4 (215)	9.0 (27)
eremicus	2.8 (82)	2.8 (42)	0
maniculatus	3.6 (103)	5.0 (75)	9.0 (27)
leucopus	0.8 (24)	6.5 (97)	0
boylii	0	0.1 (1)	0
O. leucogaster	0.5 (14)	0	0
O. torridus	0.4 (11)	0.7 (11)	0
S. arizonae	2.6 (76)	1.2 (18)	24.0 (72)
S. ochrognathus	- (1)	0	0
N. albigula	1.6 (49)	2.2 (33)	0
M. musculus	0	0	2.3 (7)
Total	21.6(626)	23.7 (355)	37.3(112)
# TN	8700	4500	900
# plots	29	15	5
% success	7.2	7.9	12.4
# species	19	15	4

Table 11. Desert shrews caught in herptile pit trap arrays. T. Corman (pers. commun. 1987).

Location	Habitat	# TN	# captures	#/300 TN
Lewis Bridge	cottonwood	90	28	93.3
Curtis Windmill	"	89	21	70.8
" "	mesquite-grass	89	18	60.7
Lewis Bridge	"	90	16	53.3
Fairbank	"	83	6	21.7
Hereford Bridge	sacaton	71	4	16.9
Lewis Bridge	"	90	5	16.7
Hereford Bridge	creosote/whitethorn	85	0	0
Curtis Windmill	" "	77	0	0

Table 12. Mammal occurrence records.

FAMILY, species	Common name	Records
SORICIDAE		
Notiosorex crawfordi	Desert shrew	Fairbank
PHYLLOSTOMATIDAE		
Macrotus californicus	California leaf-nosed bat	Tombstone
Choeronycteris mexicana	Long-tongued bat	RM 1, 2, 4
Leptonycteris sanborni	Sanborn's long-nosed bat	" 1, 2, 4
VESPERTILIONIDAE		
Myotis yumanensis	Yuma myotis	RM 1, 2, 4
M. velifer	Cave myotis	Fairbank, Boquillas Ranch, Hereford, State Route 92 and San Pedro (SP) River
M. auriculus	Southwestern myotis	10 miles SSE Ft. Huachuca, RM 1, 2, 4
M. thysanodes	Fringed myotis	RM 2, 4
M. volans	Long-legged myotis	" 2, 4
M. californicus	California myotis	" 1, 2, 4
M. leibii	Small-footed myotis	" 2, 4
Lasionycteris noctivagans	Silver-haired bat	" 2
Pipistrellus hesperus	Western pipistrelle	" 1, 2, 4
Eptesicus fuscus	Big brown bat	Benson, bridge 7.5 mi. S of St. David

Table 12 continued.

FAMILY, species	Common name	Records
Lasiurus borealis	Red bat	Benson
L. ega	Southern yellow bat	RM 2, 4
L. cinerea	Hoary bat	RM 2
Euderma maculatum	Spotted bat	RM 2
Idionycteris phyllotis	Allen's lappet-browed bat	RM 2
Plecotus townsendi	Townsend's big-eared bat	Hereford
Antrozous pallidus	Pallid bat	Fairbank, Boquillas Ranch, Hereford
MOLOSSIDAE		
Tadarida brasiliensis	American free-tailed bat	7.5 mi. S of St. David, Boquillas Ranch, SR 92 and SP River
T. femorasacca	Pocketed free-tailed bat	RM 1, 2, 4
T. macrotis	Big free-tailed bat	RM 2, 4
Eumops perotis	Western mastiff bat	Lewis Spring
LEPORIDAE		
Sylvilagus audubonii	Desert cottontail	SP River and US-Mex. Border, 0, 1.5, and 3 mi. N of Tombstone
Lepus californicus	Black-tailed jack rabbit	Fairbank
Lepus alleni	Antelope jack rabbit	near Land
SCIURIDAE		
Ammospermophilus harrisii	Harris' antelope squirrel	RM 1, 2, 4
Spermophilus variegatus	Rock squirrel	RM 1, 2, 4
S. spilosoma	Spotted ground squirrel	Tombstone, Fairbank, 0 and 3 mi. W of Hereford
S. tereticaudus	Round-tailed ground squirrel	Fairbank, 2 mi. S of Benson
Cynomys ludovicianus	Black-tailed prairie dog	SP River, 6 mi. SE of Ft. Huachuca, SP River and US-Mex. Border

Table 12 continued.

FAMILY, species	Common name	Records
GEOMYIDAE		
Thomomys bottae	Botta's pocket gopher	Fairbank, Hereford
HETEROMYIDAE		
Perognathus flavus	Silky pocket mouse	RM 1, 2, 4
P. intermedius	Rock pocket mouse	RM 1, 2, 4
P. penicillatus	Desert pocket mouse	Fairbank, SP River and US-Mex. Border, 0 and 5 mi. W of Hereford
P. baileyi	Bailey's pocket mouse	RM 2, 4
P. hispidus	Hispid pocket mouse	0 and 9 mi. W of Hereford
Dipodomys ordii	Ord's kangaroo rat	5 mi. W. Hereford
D. spectabilis	Banner-tailed kangaroo rat	Fairbank, 0 and 3 mi. W of Hereford
D. merriami	Merriam's kangaroo rat	Hereford, Tombstone, 0 and 1.25 mi. S of Fairbank
CASTORIDAE		
Castor canadensis	Beaver	SP River and US-Mex. Border
MURIDAE		
Reithrodontomys montanus	Plains harvest mouse	Fairbank, Hereford
R. megalotis	Western harvest mouse	Hereford, 0 and 1.25 mi. S of Fairbank
R. fulvescens	Fulvous harvest mouse	Fairbank, 9 mi. W of Hereford
Peromyscus eremicus	Cactus mouse	Fairbank
P. maniculatus	Deer mouse	Fairbank, SP River and US-Mex. Border
P. leucopus	White-footed mouse	Fairbank, Hereford, 1 mi. S of Benson, San Pedro River and US-Mex. Border
P. boylii	Brush mouse	RM 2, 4
Baiomys taylori	Northern pygmy mouse	5, 7, and 9 mi. W of Hereford
Onychomys leucogaster	Northern grasshopper mouse	Hereford, SP river and US-Mex. Border
O. torridus	Southern grasshopper mouse	Fairbank, Hereford, SP River and US-Mex. Border

Table 12 continued.

FAMILY, species	Common name	Records
Sigmodon arizonae	Arizona cotton rat	Fairbank, 0, 1, 2, 3, and 9 mi. W of Hereford
S. fulviventer	Fulvous cotton rat	0, 3, 5, and 7 mi. W of Hereford; 1 mi. E and 3 mi. S of Sierra Vista
S. ochrognathus	Yellow-nosed cotton rat	RM 2, 4
Neotoma albigula	White-throated wood rat	0 and 3 mi. W of Hereford; Fairbank, Tombstone
Ondatra zibethicus	Muskrat	Allen 1895, Mearns 1907
Mus musculus	House mouse	Benson, Fairbank
ERITHIZONTIDAE		
Erithizon dorsatum	Porcupine	RM 1, 2, 4
CANIDAE		
Canis latrans	Coyote	RM 1, 2, 4
C. lupus	Gray wolf	" 1, 2, 4
Vulpes macrotis	Kit fox	" 1, 2, 4
Urocyon cinereoargenteus	Gray fox	Fairbank
URSIDAE		
Ursus arctos	Grizzly bear	RM 1, 2, 3, 4
U. americanus	Black bear	RM 1, 2, 3, 4
PROCYONIDAE		
Procyon lotor	Raccoon	2 mi. S of Fairbank
Nasua nasua	Coati	RM 2, 4
Bassariscus astutus	Ringtail	2 mi. S of Fairbank
MUSTELIDAE		
Mustela frenata	Long-tailed weasel	Tombstone
Taxidea taxus	Badger	2 mi. S of Fairbank, SP River and US-Mex. Border
Spilogale gracilis	Western spotted skunk	RM 1, 2, 4
Mephitis mephitis	Striped skunk	" 1, 2, 4
M. macroura	Hooded skunk	Fairbank
Conepatus mesoleucus	Hog-nosed skunk	RM 1, 2, 4

Table 12 continued.

FAMILY, species	Common name	Record
FELIDAE		
Felis onca	Jaguar	" 1, 2, 4
F. concolor	Mountain lion	Babocomari
F. rufous	Bobcat	" , 5 mi. SE of Hereford
TAYASSUIDAE		
Tayassu tajacu	Collared peccary	RM 1, 2, 4
CERVIDAE		
Odocoileus hemionus	Mule deer	RM 1, 2, 3, 4
O. virginianus	White-tailed deer	" 1, 2, 3, 4
ANTILOCAPRIDAE		
Antilocapra americana	Pronghorn	RM 1, 3

1 = Cockrum 1960
2 = Hall 1981
3 = Davis 1982
4 = Hoffmeister 1986
RM = range maps

valley and are only shown on range maps (Cockrum 1960, Hall 1981, Hoffmeister 1986). Several species that formerly inhabited the area are on the threatened native wildlife list (Arizona Game and Fish Comm. 1982) and include the black-tailed prairie dog (Cynomys ludovicianus), grizzly bear (Ursus arctos), jaguar (Felis onca), and the Mexican gray wolf (Canis lupus). Hoffmeister (1986) suggests adding the red bat (Lasiurus borealis), spotted bat (Euderma maculatum), and beaver (Castor canadensis) to this list. A recent (1987) proposal adds the long-tongued bat (Choeronycteris mexicana), Sanborn's long-nosed bat (Leptonycteris sanborni), red bat, spotted bat, southern yellow bat (Lasiurus ega), and all bat roosts to the State list. In addition, the grizzly bear (threatened), jaguar (endangered), and Mexican gray wolf (endangered), are Federally listed threatened or endangered species.

Vegetation

We identified 25 different vegetation types (Table 13) in the upper San Pedro River valley. Vegetation types may be deleted or added with further investigation. All vegetation types were trapped except mixed grass-A. neovernicosa (143.157).

The six biomes we found are each characterized by a distinctive vegetation physiognomy. The Semidesert Grassland Biome (143.1) has 12 associations on the upper San Pedro River valley (Table 13). These associations are characterized by little overstory; large amounts of bare ground, rock, sand, and gravel (average = 62.6%, range 93.9-19.5% [see Methods for

Table 13. Vegetation types of the upper San Pedro River valley. After Brown, Lowe, and Pase (1979).

Brown et al. (1979) classification number	Description
100	Upland Vegetation
40	Grassland Formation
3	Warm Temperate Grasslands
.1	Semidesert Grassland Biome
.12	Tobosa Grass-scrub Series
.122	*Hilaria mutica-Prosopis juliflora velutina* Association
.123	*H. mutica*-mixed Scrub Association
.14	Sacaton-scrub Series
.141	*Sporobolus wrightii* Association
.142	*S. wrightii-P. j. velutina* Association
.15	Mixed Grass-scrub Series
.152	Mixed Grass-*P. j. velutina*
.155	Mixed Grass-mixed Scrub Association
.156	*Muhlenbergia porteri-Acacia neovernicosa* Association
.157	Mixed Grass-*A. neovernicosa* Association
.16	Shrub-scrub Disclimax Series
.163	*Haplopappus tenuisectus-P. j. velutina* Association
.164	*H. tenuisectus*-mixed Scrub Association
.166	*P. j. velutina-Zinnia pumila*-mixed Grass Association
.167	Severely Overgrazed *P. j. velutina* Association
50	Desertland Formation
3	Warm Temperate Desertlands
.2	Chihuahuan Desertscrub Biome
.21	Creosote-tarbush Series
.213	*Larrea divaricata-Flourensia cernua* Association
.22	Whitethorn Series
.221	*A. neovernicosa* Association
.222	*A. neovernicosa-L. divaricata* Association
.24	Mesquite Series
.243	*P. j. velutina* Association
.26	Mixed Scrub Series
.262	Mixed Chihuahuan Scrub Association
.27	Saltbush Series
.272	*Atriplex canescens* Association

Table 13 continued.

Brown et al. (1979) Classification number	Description
200	Wetland Vegetation
20	Forest Formation
3	Warm Temperate Swamp and Riparian Forest
.2	Interior Southwestern Riparian Deciduous Forest and Woodland Biome
.21	Cottonwood-willow Series
.211	*Populus fremontii*-*Salix* spp. Association
.23	Mesquite Series
.231	*P. j. velutina* Association
30	Swampscrub Formation
3	Warm Temperate Swamp and Riparian Scrub
.2	Interior Southwestern Swamp and Riparian Scrub Biome
.21	Mixed Narrowleaf Series
.212	*Chilopsis linearis*-*Senecio longilobus* Association
.22	Saltcedar Disclimax Series
.221	*Tamarix chinensis*-mixed Deciduous Association
40	Marshland Formation
3	Warm Temperate Marshlands
.3	Chihuahuan Interior Marshland Biome
.31	Saltgrass Series
.311	*Distichlis stricta* Association
.32	Threesquare Series
.321	*Scirpus olneyi* Association
300	Agriculture

microhabitat data]); varying amounts of litter (avg. = 18.3%, 52.2-1.0%); low FHD measurements (avg. = 0.1292, 0.4902-0.0249); and low patchiness index (PI) measurements (avg. = 0.0748, 0.1516-0.0257)(Table 14). All 17 plots in this biome had mesquite in the tree counts (avg. = 80.4/ha, 462-3). Several of the vegetation types in this biome formerly had more grass, but subsequently have been invaded by shrubs (mesquite, zinnia, burroweed [Haplopappus tenuisectus]), and now contain little or no grass. The Land 1 plot (143.167) has been severely overgrazed and eroded. Gophers have contributed to the erosion problem. Land 1 had the greatest percent bare ground, least tree density (13/ha), lowest FHD, and one of the lowest PI measurements. The Charleston plot had the least amount of bare ground, highest FHD, greatest tree density (489/ha), and highest PI. This plot was borderline on being included in this biome and was almost included in the Chihuahuan Desertscrub Biome (153.2).

The Chihuahuan Desertscrub Biome (153.2) is characterized by varying amounts of creosote, tarbush, whitethorn, mesquite, and saltbush. Twelve plots, in six associations, were trapped in this biome. These plots had little vegetative cover, tree density, FHD, and PI. Semidesert Grassland and Chihuahuan Desertscrub are the only biomes that are Upland (100) vegetation types.

Table 14. Vegetation measurements for each biome, with average, standard deviation, high, low.

Vegetation parameters	Biome 143.1	153.2	223.2	233.2	243.3	300.0
% bare ground,	62.6	82.8	42.5	56.7	32.2	58.2
rock, sand,	23.2	7.8	21.6	10.7	19.5	25.6
gravel	93.9	95.2	86.8	64.3	45.9	82.6
	19.5	68.8	14.1	49.1	18.4	17.5
Trees/ha	100	105	312	296	509	0
	116	100	237	245	311	0
	489	338	933	469	729	0
	18	13	64	122	289	0
FHD (H')	0.1292	0.1306	0.5370	0.2295	0.3386	0.1530
	0.1308	0.0836	0.1779	0.0066	0.2140	0.0845
	0.4902	0.2480	0.7567	0.2341	0.4899	0.2726
	0.0249	0.0249	0.2938	0.2248	0.1872	0.0249
Patchiness	0.0748	0.0676	0.1934	0.0674	0.1695	0.0373
(PI)	0.0329	0.0550	0.1288	0.0371	0.0862	0.0616
	0.1516	0.2221	0.4775	0.0936	0.2304	0.1150
	0.0257	0.0281	0.0790	0.0412	0.1085	0.0075
# plots	17	12	11	2	2	5

The next biome, 223.2, is Interior Southwestern Riparian Deciduous Forest and Woodland. This biome consists of the cottonwood-willow riparian zones and mesquite woodlands. We trapped 11 plots in the two associations in this biome. This biome is typified by high tree densities and the highest FHD and PI indices of any biome.

Interior Southwestern Swamp and Riparian Scrub (233.2) is the next biome that we identified. We trapped two plots, each in a separate vegetation association. This biome contains the Tamarix chinensis-mixed deciduous association (233.221). We trapped nine mammal species on our one saltcedar plot. The other association in this biome is desert willow (Chilopsis linearis)-threadleaf groundsel (Senecio longilobus)(233.212).

Two plots we trapped in the St. David Cienega were the only plots in the Chihuahuan Interior Marshland Biome (243.3). Plots in this biome had the greatest amount of cover, greatest tree density, and second highest FHD and PI indices.

The sixth biome is Agriculture (300.0). All current and former agricultural fields were included in this biome without further classification. Vegetative cover was variable in this biome. The plot with the most cover was an old field that was mostly covered by dead Russian thistle. This plot, by the San Pedro Ranch House, had the highest rodent biomass found to date in our inventories. We caught 72 Arizona cotton rats here, with an average weight of ~150 g. This plot is also adjacent to one of the best riparian areas along the river.

DISCUSSION

The vegetation associations that provided the most cover had the highest densities of small mammals. The Atriplex canescens association (153.272) was an exception, however, because it did not have much cover (85.9% bare ground). This association had a high density because 29 Merriam's kangaroo rats were caught on the one plot. All three main vegetation types (upland, wetland, agriculture) are represented in the five associations with the highest densities. If it wasn't for the one plot (Wolf Ranch) where 72 Arizona cotton rats were captured, the density for agriculture would be 11.0 instead of 37.3. Vegetation associations with little cover had the lowest small mammal densities.

Mixed grass-mixed shrub was trapped twice (10 mammal species) and Tamarix chinensis-mixed deciduous was trapped once (9 mammal species) and represent truly diverse communities. The other associations also found to have many species were trapped at least five times. The chance of finding additional species is greatly enhanced when more areas and traps are used.

We captured a single individual of two different rodent species that we did not expect to find because the habitat present in the upper San Pedro River valley is limited or marginal. One nursing female brush mouse (Peromyscus boylii) was caught on the Charleston Narrows plot (223.211). Brush mouse habitat is generally higher elevations in rocky chaparral (Burt and Grossenheider 1976, Hoffmeister 1986). Occasionally,

they have been found at lower elevations in riparian habitats (Hoffmeister 1986). The Charleston Narrows plot is along the river bank and is rocky. The only other mammals caught here were two white-throated wood rats. Hoffmeister (1986) reports that brush mice are rarely taken in the same area with either cactus mice or white-footed mice. Since neither of the other two Peromyscus species were taken, it is possible that a small population of brush mice occurs here.

On the hills east of Charleston Narrows, one juvenile yellow-nosed cotton rat (Sigmodon ochrognathus) was captured in the same live trap on two consecutive nights. This rat died the second night and was collected. As this was a juvenile and identification of young cotton rats are difficult, positive identification is pending till confirmed by Dr. Yar Petryszyn of the University of Arizona. Yellow-nosed cotton rats are found in similar habitat elsewhere, but the amount of habitat where we found them is less than 250 hectares. Yellow-nosed cotton rats usually live in grassy, rocky slopes in the oak belt (Hoffmeister 1963, 1986).

Rodents that have been recorded in the area but were not trapped or observed during the study include: spotted ground squirrel (Spermophilus spilosoma), black-tailed prairie dog, silky pocket mouse (Perognathus flavus), banner-tailed kangaroo rat (Dipodomys spectabilis), beaver, northern pygmy mouse (Baiomys taylori), fulvous cotton rat (Sigmodon fulviventer), and muskrat (Ondatra zibethicus).

Spotted ground squirrels were not found in the area, but they have been recorded at Fairbank, Tombstone, and Hereford (Cockrum 1960). In southeastern Arizona these ground squirrels inhabit areas of mesquite and Acacia (Hoffmeister 1986).

Prairie dogs were probably exterminated in this area around 1900 (Hoffmeister 1986). They have been recorded on the San Pedro River at the Mexican Border and six miles southeast of Ft. Huachuca (Cockrum 1960). Prairie dogs may be able to exist in habitats available on the upper San Pedro River valley.

Silky pocket mice have been recorded in the foothills of the Huachuca Mountains and are shown as possibly occurring in this area on range maps (Cockrum 1960, Burt and Grossenheider 1976, Hall 1981, Hoffmeister 1986). These pocket mice require grassy areas in which to live (Burt and Grossenheider 1976, Hoffmeister 1986) and might be found in the tobosa grass-scrub series (143.12). Further trapping should be conducted in these areas from spring through fall because these pocket mice are dormant in the winter (Hoffmeister 1986).

We did not observe banner-tailed kangaroo rats or their conspicuous mounds in this area though Troy Corman (pers. commun.) reported seeing a large kangaroo rat near the Hereford-Palominas road intersection in 1986. We found what may be an old mound 1.9 km east of the Donnet-Fry Ranch near our Donnet-Fry plot (vegetation association 143.166). These kangaroo rats prefer grassy areas between 3500 and 4000 feet elevation but are also found in Chihuahuan desertscrub (Hoffmeister 1986). Perhaps with continued trapping, banner-tailed kangaroo rats

will be found within the area even though the type of grassy areas they prefer are not present. Dr. E. Lendell Cockrum and Petryszyn (pers. commun. 1987) believe the chances of finding these kangaroo rats and northern pygmy mice are low because their preferred habitats are not present.

Although beavers once occurred along the San Pedro River (Cockrum 1960, Hall 1981, Davis 1982, Hoffmeister 1986), they are now absent; probably due to trapping and changing of the river's flow regime. Beaver should be able to survive here today with a dependable water supply and minimal human disturbance. This has been demonstrated in other parts of Arizona (Hoffmeister 1986).

Northern pygmy mice are found in dense grass (Burt and Grossenheider 1976, Hoffmeister 1986) and have been captured in galleta (Hilaria jamesii), grama (Bouteloua), sacaton (Sporobolus), mesquite, yucca (Yucca), and weeds (Hoffmeister 1986). Pygmy mice have been caught 5, 7, and 9 miles west of Hereford (Hall 1978). Pygmy mice might be found here during population highs. Further trapping in grassy areas, especially the tobosa-scrub series (143.12) might yield pygmy mice.

Fulvous cotton rats are found in a variety of grass-shrub habitats in association with muhly, three awn (Aristida), bermuda grass (Cynodon), and sacaton (Baker and Shump 1978). Although the above habitats are fairly common here, fulvous cotton rats have not been found. Previously, they have been caught 0, 3, 5, and 7 miles west of Hereford (Cockrum 1960) and further trapping near Hereford may document them.

cotton rats have not been found. Previously, they have been caught 0, 3, 5, and 7 miles west of Hereford (Cockrum 1960) and further trapping near Hereford may document them.

Muskrats were reported to live along the San Pedro River in the 1890's, but records after that time are not available (Allen 1895, Mearns 1907). Muskrats might be able to survive here if reintroduced. Their food items include grasses, roots, cattails (Typha), and the leaves and branches of seep willow (Baccharis glutinosa)(Hoffmeister 1986).

CONCLUSIONS AND RECOMMENDATIONS

We collected 25 and observed at least five other small mammals species from December 1986 to August 1987. We did not find eight rodent species that may or may have occurred here, but we did find two species that weren't expected. From the literature we identified 82 mammal species that do occur or have occurred in this area in recent history.

Deer mice were caught most frequently (18.2%) and in the most vegetation associations (19). Next in abundance were Arizona cotton rats (15.1%), Merriam's kangaroo rats (14.5%), cactus mice (11.4%), and white-footed mice (11.2%). An 'edge' (bulrush-velvet mesquite-saltgrass) had the highest recorded mammal density of any plot. The vegetation type (non-edge) with the greatest density was saltcedar-mixed deciduous (59/300 TN).

We identified 25 different vegetation associations that follow Brown et al.'s (1979) system and are within the upper San Pedro River valley. All but one association was trapped in. The vegetation on each plot was measured using the techniques of Anderson and Ohmart (1984).

Further inventory of mammals should be continued with emphasis on these points:

1) trapping areas likely to yield species not yet found;
2) trapping in all vegetation types to expand the data base with attention to winter and moon phase;
3) netting, searching, and shooting bats;
4) inventorying larger mammals;
5) and refining vegetation maps.

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APPENDIX
Legal descriptions of mammal trapping plots,
all in Cochise County, Arizona.

Cienega 1: T18S, R21E, Sect. 29, SW 1/4, NE 1/4; 3.2 km W and 3.8 km S of St. David Cemetary; 3690'.

Cienega 2: T18S, R21E, Sect. 29, W 1/2, E 1/2; 3.1 km W and 3.5 km S of St. David Cemetary; 3690'.

Curtis Windmill 1: T19S, R21E, Sect. 10, SE, NE; 6.1 km W of Curtis Windmill; 3730'.

Curtis Windmill 2: T19S, R21E, Sect. 9, W; 5.6 km W of Curtis Windmill; 3740'.

Curtis Windmill 3: T19S, R21E, Sect. 10, SE; 3.2 km W of Curtis Windmill; 3930'. ***

Curtis Windmill 4: T19S, R21E, Sect. 11, SE, NE; 1.0 km W of Curtis Windmill; 4010'. ***

Terrenate 1: T19S, R21E, Sect. 28, SE; 6.7 km W and 4.3 km N of Mays Hills; 3850'.

Terrenate 2: T19S, R21E, Sect. 28, SE; 6.8 km W and 4.5 km N of Mays Hills; 3850'.

Charleston Heights 1: T21S, R21E, Sect. 1, NW; 0.8 km S and 0.3 km E of Charleston Hills East; 4170'.

Charleston Heights 2: T21S, R21E, Sect. 1, NW; 0.7 km S and 0.1 km E of Charleston Hills East; 4280'.

Hereford 1: T23S, R22E, Sect. 9, NE; 0.8 km N and 1.1 km E of Hereford-Palominas roads intersection; 4260'.

Hereford 2: T23S, R22E, Sect. 9, NE; 1.0 km N and 1.3 km E of Hereford-Palominas roads intersection; 4240'.

Hereford 1: T23S, R22E, Sect. 4, NE, W; 1.9 km N of Hereford Rd. on dirt road; 4140'. ***

Hereford 2: T23S, R22E, Sect. 4, SE, W; 2.9 km N of Hereford Rd. on dirt road; 4150'. ***

Wolf Ranch: T22S, R22E, Sect. 5, E; 8.2 km S and 1.7 km E of Brunckow Hill; 4070'.

Garden Canyon Wash: T22S, R22E, Sect. 5, W; 8.9 km S and 1.0 km E of Brunckow Hill; 4120'.

Victorio: T24S, R22E, Sect. 8, SE, SE, SE; 1.9 km N of US-Mexico border; 4250'.

Victorio Ag 1: T24S, R22E, Sect. 17, SE, NW; 0.8 km N of US-Mexico border; 4270'.

Victorio Ag 2: T24S, R22E, Sect. 17, W; 1.0 km N of US-Mexico border; 4260'.

Victorio Ag 3: T24S, R22E, Sect. 17, SW; 0.6 km N of US-Mexico border; 4280'.

Charleston: T21S, R21E, Sect. 2, E, W; 0.9 km W and 1.5 km S of Charleston Hills East; 3950'.

Charleston Narrows: T21S, R21E, Sect. 2, NE; 0.5 km W and 0.8 km S of Charleston Hills East; 3930'.

East Gravel Pit: T22S, R22E, Sect. 21, NE, S; 8.6 km W and 1.0 km S of State Route (SR) 90 and US Highway 80 junction; 4190'.

Escapule Wash: T21S, R21E, Sect. 23, W, W, W; 2.9 km S and 3.0 km W of Brunckow Hill; 4150'.

Escapule Upland: T21S, R21E, Sect. 14, SW, SE; 1.8 km S and 2.4 km W of Brunckow Hill; 4130'.

Cienega Hill: T18S, R21E, Sect. 29, NE, SE; 2.4 km W and 3.4 km S of St. David Cemetary; 3730'.

Pipeline Intersection: T18S, R21E, Sect. 19, SW; 1.4 km W and 1.6 km S of St. David Cemetary; 3770'.

Boquillas Ruins 1: T19S, R21E, Sect. 20, NW, NE; 2.4 km N and 2.2 km W of Terrenate Presidio; 3770'.

Boquillas Ruins 2: T19S, R21E, Sect. 20, N, N; 2.4 km N and 1.9 km W of Terrenate Presidio; 3880'.

Hereford-Palominas Roads East: T23S, R22E, Sect. 9, SW, SE; 0.5 km E and 0.1 km N of Hereford-Palominas roads intersections; 4230'.

Hereford-Palominas Rds. W.: T23S, R22E, Sect. 8, S, S; 5.6 km E and 0.2 km N of Moson-Hereford roads intersection; 4280'.

East State Route 90 #1: T22S, R22E, Sect. 5, NE, NE, NE; 4.5 km N and 9.0 km W of SR 90-US 80 junction; 4130'.

E. SR 90 #2: T22S, R22E, Sect. 5, NE, NE; 4.3 km N and 9.0 km W of SR 90-US 80 junction; 4140'.

Clifford Wash Riparian: T18S, R21E, Sect. 32, SE, SE; 0.7 km W and 5.2 km S of St. David Cemetary; 3690'.

Clifford Wash Upland: T18S, R21E, Sect. 33, SE, SW; 5.2 km S of St. David Cemetary; 3750'.

Contention 1: T19S, R21E, Sect. 21, S, S, S; 1.1 km N and 0.4 km W of Terrenate Presidio; 3850'.

Contention 2: T19S, R21E, Sect. 21; 1.8 km N and 0.2 km W of Terrenate Presidio; 3850'.

Donnet-Fry: T21S, R21E, Sect. 25, NW, NW, NW; 1.3 km W and 3.8 km S of Brunckow Hill; 4180'.

Lindsey Ranch: T21S, R21E, Sect. 1, NE, SW, SW; 2.8 km S and 0.5 km E of Charleston Hills East; 4010'.

Lewis Spring 1: T22S, R22E, Sect. 5, NW, NW; 7.9 km S and 1.8 km E of Brunckow Hill; 4140'. ***

Lewis Spring 2: T22S, R22E, Sect. 31, SE, NE; 6.9 km S and 1.7 km E of Brunckow Hill; 4140'. ***

Lewis Spring 3: T22S, R22E, Sect. 32, SW, NW; 6.8 km S and 1.8 km E of Brunckow Hill; 4170'. ***

Fairbank 1: T20S, R21E, Sect. 10, NE, N, N; 5.3 km W and 0.7 km N of Mays Hills; 3860'. ***

Fairbank 2: T20S, R21E, Sect. 3, SE, SE, SE; 5.1 km W and 0.7 km N of Mays Hills; 3860'. ***

Land 1: T18S, R21E, Sect. 19, NE, NW, NW; 3.1 km W and 0.6 km S of St. David Cemetary; 3710'.

Land 2: T18S, R21E, Sect. 19, NW, NE, NE; 3.3 km W and 0.6 km S of St. David Cemetary; 3730'.

SR 90 Bridge: T22S, R22E, Sect. 6, NE, NE, E; 4.7 km S and 1.8 km E of Brunckow Hill; 4030'.

W. SR 90: T22S, R22E, Sect. 6, NE, NE; 4.6 km S and 1.5 km E of Brunckow Hill; 4050'.

Wolf Ranch 2: T22S, R22E, Sect. 6, NE, NE; 5.0 km S and 1.5 km E of Brunckow Hill; 4050'.

*** = McMahon's plots