Cooperative National Park Resources Studies Unit

ARIZONA

TECHNICAL REPORT NO. 30

SMALL MAMMAL INVENTORY OF
CHIRICAHUA NATIONAL MONUMENT
COCHISE COUNTY, ARIZONA

by Douglas K. Duncan

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COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT
University of Arizona/Tucson - National Park Service

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SMALL MAMMAL INVENTORY OF CHIRICAHUA NATIONAL MONUMENT COCHISE COUNTY, ARIZONA

Douglas K. Duncan

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ABSTRACT

Live trapping was done at Chiricahua National Monument, Cochise County, Arizona, from 1984 to 1986 to determine the small mammal species present and vegetation associations (Brown, Lowe, and Pase 1979) in which they occurred. Twenty six of the 34 small mammal species (orders Insectivora, Lagomorpha, and Rodentia) listed in the monuments' most recent mammal checklist (Lanning n.d.) were found. One additional species was added to the list.

Further work should concentrate on documenting the occurrence of additional species, developing a vegetation type map, and establishing permanent survey plots.

INTRODUCTION

Chiricahua National Monument (CHIR) was established on April 18, 1924, primarily because of its unique geological features. Over time, however, people have also recognized that the monument contains a diverse biota. This diversity is due to the variety of landforms present in CHIR and the two origins of the vertebrate fauna. CHIR exists where species with Rocky Mountain origins reach their southernmost limits (near the United States-Mexico border) and species of Mexican origin are at their northern limits. Consequently, the Chiricahua Mountains are renowned for the number of vertebrate species found there, especially birds. The mammalian fauna is diverse also: Cockrum (1985), for example, lists 97 mammal species that are, may be, or have been found in the Chiricahua Mountain region.

Because knowledge was lacking on the monument's mammals, a "Natural Resources Basic Inventory" was given the highest priority of resources management research projects for Chiricahua National Monument (Chiricahua National Monument 1983). The objectives of this research project were:

(1) determine species of vertebrates occurring in the monument;
(2) establish relative densities and ecological distributions for these species, especially for endangered, rare, and peripheral species; and
(3) provide this information to the monument staff in a usable form.

Mammalian studies of CHIR and the surrounding Chiricahua Mountains are limited. Steiner (1975) reported on bedding and nesting material gathered by rock squirrels (*Spermophilus variegatus*) from observations made at the monument. The most recent work at the monument is Lanning's (1976*a*, 1976*b*) study of coatimundis (*Nasua nasua*). Little additional work has been done in the monument, although checklists of, and studies in the Chiricahua Mountains are available. Cahalane (1939) and Maza (1965) composed lists of mammals found in the Chiricahua Mountains through field work, analysis of museum specimens, and observation. Mammal checklists have been compiled for the Chiricahua region by Cockrum and Justice (1958), Cockrum and Petryszyn (1978), Lanning (n.d.), and Cockrum (1985).

Risser (1963) studied coatis in the Chiricahuas and in the Huachuca Mountains. Cockrum and Ordway (1959) reported on bats in the Chiricahuas. Additional work on bats has been done in the Cave Creek-Portal area. There are two student reports on mammals. The first was done by Welch (1957) for the Arizona Game and Fish Department on *Food Habits Analysis of Predatory Animals Collected in the Chiricahua Mountains*. The second report was for

the University of Arizona Mammalogy class by R. G. Yoder (1958) on *The Chiricahua Fox Squirrel*.

My research identified relative densities and distributions, using live trapping, for the 19 species of nocturnal rodents found in CHIR. Because all animals are dependent on vegetation, I associated the relative density and distribution of the rodents with the vegetation types found within the monument. The monument's vegetation has been classified by Roseberry and Dole (1939), Moir (1974), and Reeves (1976). Following Brown and Lowe (1974*b*), Reeves lists 10 vegetation types which are found on the monument. For further discussion on vegetation types and communities in the Southwest, see Brown and Lowe (1974*a*, 1980) and Brown Lowe, and Pase (1979). Based on vegetation analysis performed by me, I classified the vegetation in CHIR according to the scheme presented in Brown, Lowe, and Pase (1979). Fifteen vegetation types were identified. Trapping was conducted in 14 of these types. More than one plot was trapped in some types to sample differing elements of each type (e.g., slope and elevation).

The information in this report will inform monument staff about the rodent species and relative numbers that can be expected to be found in particular areas of CHIR. The report also will provide basic ecological information which is currently lacking.

STUDY AREA

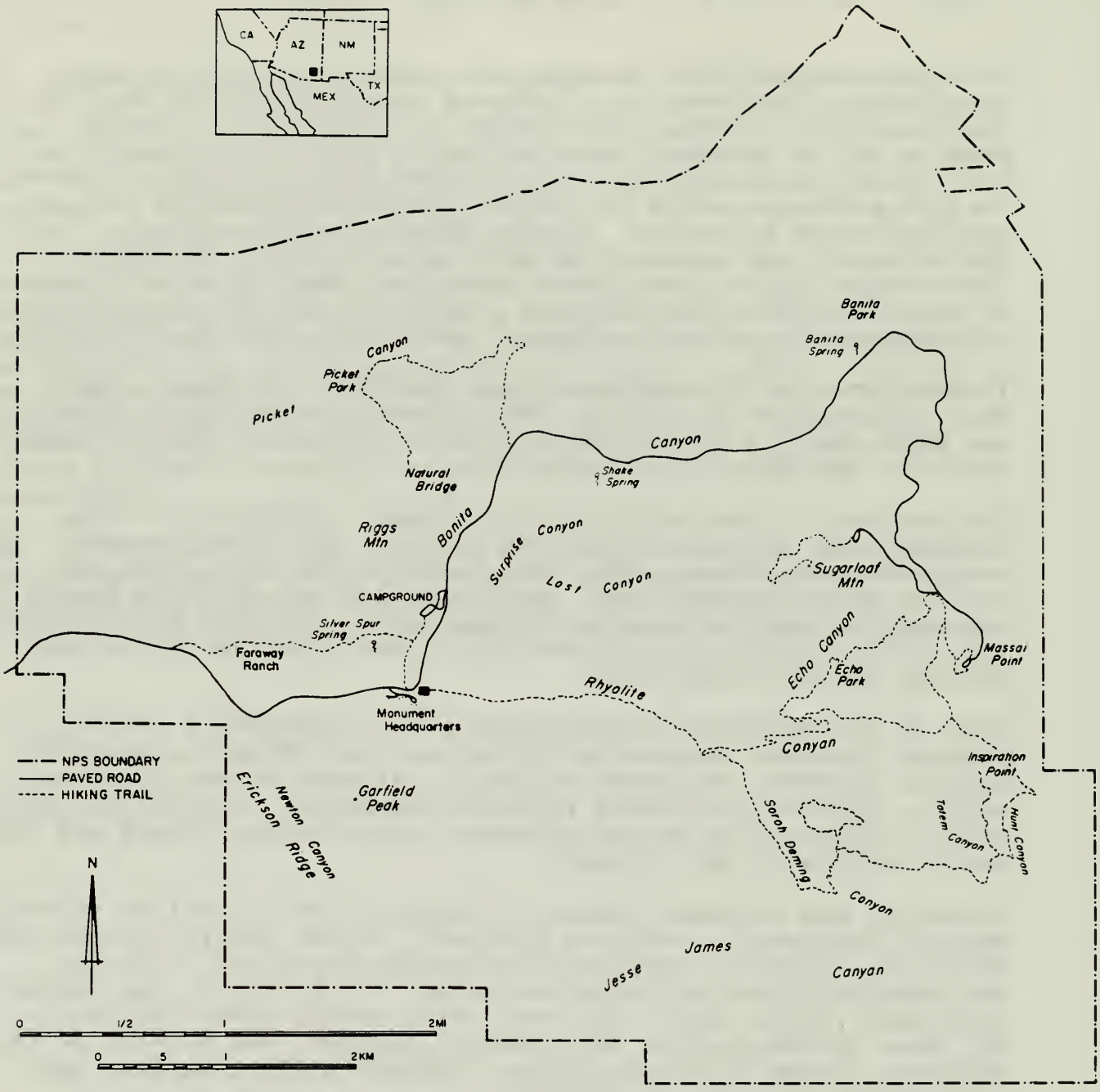
When first established in 1924, Chiricahua National Monument encompassed 1735 hectares. CHIR was enlarged to 4308 ha when administrative control was transferred from the U.S. Forest Service to the National Park Service in 1938. Two subsequent land additions in 1978 and 1985 brought the size of the monument to 4750 hectares. CHIR is located in the northwestern part of the Chiricahua Mountains, Cochise County, Arizona (Figure 1). Elevations in the monument range from 1550 meters near the entrance to 2400 m near Timber Mountain. Vegetation is grassland at low elevations, Madrean (e.g., oak-pine) at mid elevations, and pine-Douglas fir (*Pseudotsuga menziesii*) at high elevations.

Temperatures at Chiricahua National Monument are mild, with a mean temperature of 14.6° C. Mean annual precipitation is 45.2 cm, with almost half the precipitation falling in July and August (Sellers and Hill 1974) (Table 1).

The monument's topography is very rugged, consisting of deep canyons with rhyolite cliffs and plateaus above the canyons. The canyon bottoms, sides, and ridge tops are all very rocky and provide many microhabitats. Bonita Canyon and Rhyolite Canyon are the two main canyons in the monument. Rhyolite Canyon drains into Bonita Canyon, which eventually opens towards the Sulphur Springs Valley to the west.

Many of the ephemeral watercourses in the monument's canyons support riparian communities of Arizona ash (*Fraxinus velutina*), Arizona sycamore (*Platanus wrightii*), Arizona walnut (*Juglans major*), Fremont cottonwood (*Populus fremontii*), and willow (*Salix* spp.). In addition to the ephemeral watercourses, there are five small springs in the monument.

Biomes of the monument include: Madrean Montane Conifer Forest, Madrean Evergreen Forest and Woodland, Relict Conifer Forest and Woodland, Interior Chaparral, Semidesert Grassland, Interior Southwestern Riparian Deciduous Forest and Woodland, and Madrean Marshland (Brown, Lowe, and Pase 1979, Reeves 1976) (Table 2). For more information on the history, geology, and climate of the monument, refer to Enlows (1955), Jackson (1970), Sellers and Hill (1974), and Reeves (1976).



CHIRICAHUA NATIONAL MONUMENT

Figure 1. Chiricahua National Monument and its location shown on inset.

Table 1. Climatological data for Chiricahua National Monument, Cochise County, Arizona: 1931-1972. (Sellers and Hill 1974).

	Temperature (°C)				Precipitation (cm)		
	mean		record			record	
	max	min	max	min	mean	max	min
January	12.4	-1.4	26.7	-18.4	3.4	9.1	0
February	14.8	-0.8	26.5	-14.0	2.2	6.6	0
March	17.2	0.2	29.2	-12.0	2.9	10.2	0
April	22.8	4.2	32.4	-5.2	1.0	5.0	0
May	27.4	8.4	36.6	-4.4	0.5	2.7	0
June	32.2	12.8	41.3	3.2	1.8	7.5	0
July	31.6	15.2	40.0	9.2	10.5	15.5	4.6
August	29.6	15.0	36.6	9.1	11.8	27.3	1.5
September	28.4	12.4	37.4	2.8	4.1	11.9	0
October	24.1	7.6	31.8	-6.2	1.9	6.2	0
November	17.2	2.4	25.6	-10.0	1.8	5.8	0
December	13.2	-0.8	26.2	-12.0	3.3	14.3	0
Average	21.5	5.5	-	-	3.5	-	-

Table 2. Vegetation types in Chiricahua National Monument, Cochise County, Arizona, 1985-86. After Brown, Lowe, and Pase (1979).

Classification number	Description
100	Upland Vegetation
120	Forest and Woodland Formation
122	Cold Temperate Forests and Woodlands
122.6	Madrean Montane Conifer Forest Biome
122.61	Douglas Fir-Mixed Conifer Series
122.611	*Pseudotsuga menziesii* Association
122.612	*P. menziesii*-Mixed Conifer Association
122.62	Pine Series
122.623	*Pinus ponderosa*-Mixed Conifer Association
123	Warm Temperate Forests and Woodlands
123.3	Madrean Evergreen Forest and Woodland Biome
123.31	Encinal Series
123.311	Mixed *Quercus* Association
123.316	*Quercus* spp.-*Pinus cembroides-Juniperus* spp. Association
123.318	*J. deppeana* Association
123.32	Oak-Pine Series
123.322	*Quercus* spp.-*Pinus leiophylla* Association
123.323	*Quercus* spp.-*Pinus engelmanii* Association
123.324	*Quercus* spp.-*Pinus* spp. Association
123.5	Relict Conifer Forest and Woodland Biome
123.52	Cypress Series
123.521	*Cupressus arizonica arizonica* Association
130	Scrubland Formation
133	Warm Temperate Scrublands
133.3	Interior Chaparral Biome
133.32	Manzanita Series

Table 2 (Continued).

Classification number	Description
133.322	*Arctostaphylos pungens* Association
140	Grassland Formation
143	Warm Temperate Grasslands
143.1	Semidesert Grassland Biome
143.11	Grama Grass-Scrub Series
143.114	*Bouteloua* spp.-Mixed Grass-Mixed Scrub Association
143.13	Curlymesquite Grass-Scrub Series
143.131	*Hilaria belangeri*-Mixed Scrub Association
200	Wetland Vegetation
220	Forest Formation
223	Warm Temperate Swamp and Riparian Forests
223.2	Interior Southwestern Riparian Deciduous Forest and Woodland Biome
223.22	Mixed Broadleaf Series
223.222	*Platanus wrightii* Association
240	Marshland Formation
243	Warm Temperate Marshlands
243.5	Madrean Marshland Biome
243.51	Rush Series

METHODS

To systematically study rodent populations in CHIR, trapping was employed (Figure 2). Pace transects were used to study vegetation types within the trap plots.

TRAPPING

All trapping was done after the last quarter and before the first quarter of the moon, using folding aluminum Sherman live traps, 8 x 8.5 x 23 cm in size. All trap nights on each plot were done consecutively. Snap traps were used by the Mammalogy Class (see below). The bait was a peanut butter-rolled oats mixture. A space was cleared of litter and vegetation where the trap was placed to attract rodents and locate the station. Traps were set in late afternoon, checked in the morning, and kept closed during the day (except as noted). One trap was set at each station. Trapped nocturnal rodents were identified to species, and given a uniquely identifiable toe clip. After other pertinent information was collected, the rodents were released near the point of capture.

Population estimates were made using linear regression (DeLury 1947, Hayne 1949, Olding 1979, Petryszyn 1982). With this method, the x-axis is the total number of individuals caught, and the y-axis is the number of new individuals caught for one day. The x-intercept of a line fitted to the data points is the estimated population size. Dr. Yar Petryszyn (pers. commun.), Assistant Curator of the University of Arizona Mammal Museum, has collected 10 years of data which illustrate that accurate estimates of rodent populations with linear regression are obtained after two nights of trapping.

1984.

Two plots near Bonita Campground (impact and control) were sampled in August for three nights each. Two plots were trapped in an attempt to quantify any effects the campground may have on nocturnal rodent populations. Each plot had 5 rows and 10 stations per row. The 50 traps were spaced 15 m apart. Trapping procedures followed the previously discussed methods. These plots, however, were checked at night.

1985

Four plots were sampled from April to June (Bonita Park, entrance north, entrance south, Sea Captain). These plots had 8 rows with

SC= Sea Captain
MR-BP= Mine Road-Bonita Park
BCI = Bonita Campground Impact
BCC= Bonita Campground Control
EN= Entrance North
ES = Entrance South
SM = Sugarloaf Mtn.

NBTH = Natural Bridge Trail Head
CB= China Boy
BP= Bonita Park
ENT= Entrance
numbers correspond to numbered plots in the appendix
Broken lines designate Natural Areas

Figure 2. Map of trapping plot locations at Chiricahua National Monument, Arizona, 1984-86.

8 stations in each row. As before, the traps were spaced 15 m apart. Three of the plots were trapped during five nights; the remaining plot was trapped for four nights.

Mammalogy Class Field Trip

On September 14-16, 1985, the University of Arizona Mammalogy class took a trip to the monument to learn field techniques. The group set live traps for two nights near the Sugarloaf parking area and at Bonita Park. In addition, all students set snap traps near the monument entrance on the night of the 14th. Smaller groups set snap traps near the Sea Captain (7 persons), the Natural Bridge Trail Head (5), and the China Boy (6) on the night of the 15th.

Live traps were set in 20 lines. The lines were 15 m apart and each line had five traps. The traps were also 15 m apart. Each night on a particular line, a total of 100 live traps were set out on each plot. Live traps were set late in the afternoon. These traps were checked and picked up the following morning.

Snap trap grids were set up with 15 m spacing. Each student set out one line that contained approximately 25 snap traps. The traps included both Victor rat traps and Museum Special mouse traps. Snap traps were set out in the late afternoon, checked and reset during the night, and then checked and picked up in the morning.

1986

I live-trapped on 21 plots during May-September (Appendix). Each plot was trapped once on three consecutive nights. For each plot, a grid was established with 2 rows and 16 stations on each row, 15 m apart. Traps were set 15 m apart. This configuration kept the trap grid within one vegetation type, reducing biases caused by censusing more than one habitat type with the same grid. Another advantage of the method is that it allows many areas to be sampled with the same effort as an 8 row, 8 station, 5 night procedure (Dr. E. Lendell Cockrum, University of Arizona, pers. commun.).

PACE TRANSECTS

Using a pace transect, I sampled vegetation on each 1986 plot. Each point (pace) was recorded as either rock, bare/litter, or live plant. Then, all plants at each point were tallied and recorded to species. Pace transects were done on both rows of the grid. The raw data was then converted to percentages of frequency.

Even though I recorded all plant species on the pace transect, only dominant plant species were used to determine vegetation types, as per Roseberry and Dole (1939), Reeves (1976), and Brown, Lowe, and Pase (1979). As noted in the introduction, I used the vegetation types (associations) of Brown, Lowe, and Pase (1979). As a control, the vegetation type of each plot was determined by the pace transects and then compared to the results of Roseberry and Dole (1939), Moir (1974), and Reeves (1976). I trapped in each vegetation type at least once, except for Silver Spur Meadow (Marshland Formation). The meadow was too small to accommodate a trap grid. In an attempt to sample differing elevation, slope, exposure, topography, and plant species associations within a vegetation type, some types were trapped more than once.

RESULTS

TRAPPING

I caught 18 of the 24 nocturnal rodent species listed on Lanning's (n.d.) checklist (Table 3). I caught one species not on Lanning's list, the pinyon mouse (*Peromyscus truei*). In addition, 15 other mammal species were sighted (Table 4).

1984

The capture results for the Bonita Campground plots are very poor because of trap disturbance by skunks. The skunk population was high that year, and many skunks frequented the campground (pers. obs.). An average of 82% of the traps were disturbed on the control plot. One cactus mouse (*Peromyscus eremicus*) was captured on the impact plot. One western harvest mouse (*Reithrodontomys megalotis*), one cactus mouse, and one yellow-nosed cotton rat (*Sigmodon fulviventer*) were captured on the control plot. The cotton rat was captured by hand.

1985

Bonita Park and Entrance North plots were sampled for five nights and Entrance South and the Sea Captain plots were sampled for four nights. The most numerous rodents on these plots were cactus mice, white-throated wood rats (*Neotoma albigula*), and brush mice (*Peromyscus boylii*) (Table 5). Brush mice were also captured on the largest number of plots (3).

Mammalogy field trip

The number of captures and trap nights are approximate due to incomplete student field notes and tentative identifications of the rodents by the students (Table 6). Nearly all of the species caught during the field trip had been caught during the 1984 and 1985 field seasons. The pinyon mouse (*Peromyscus truei*) is the only species that had not been captured before. It is also not listed on the most recent mammal checklist (Lanning n.d.), though it should be (Cockrum 1960). Most of the rodents captured on the second night of live trapping were new captures. Many of the rodents caught on the first night were collected to make voucher specimens.

Table 3. Mammal species list for Chiricahua National Monument, Cochise County, Arizona, 1984-86. + denotes captured or seen, - denotes presence not substantiated during this study. Nomenclature follows Hoffmeister (1986).

FAMILY, species	Common name	+/-
SORICIDAE		
Notiosorex crawfordi	desert shrew	+
PHYLLOSTOMATIDAE		
Choeronycteris mexicana	long-tongued bat	-
Leptonycteris sanborni	Sanborn's long-nosed bat	-
VESPERTILIONIDAE		
Myotis velifer	cave myotis	-
M. auriculus	southwestern myotis	-
M. thysanodes	fringed myotis	-
M. volans	long-legged myotis	-
M. californicus	California myotis	-
M. leibii	small-footed myotis	-
Lasionycteris noctivagans	silver-haired bat	-
Pipistrellus hesperus	western pipistrelle	+
Eptesicus fuscus	big brown bat	-
Lasiurus borealis	red bat	-
L. cinereus	hoary bat	-
Idionycteris phyllotis	Allen's lappet-browed bat	+
Plecotus townsendii	Townsend's big-eared bat	-
Antrozous pallidus	pallid bat	-
MOLOSSIDAE		
Tadarida brasiliensis	American free-tailed bat	-
T. macrotis	big free-tailed bat	-

Table 3 (Continued).

FAMILY, species	Common name	+/-
LEPORIDAE		
Sylvilagus floridanus	eastern cottontail	+
S. audubonii	desert cottontail	+
Lepus californicus	black-tailed jack rabbit	+
SCIURIDAE		
Eutamias dorsalis	cliff chipmunk	+
Ammospermophilus harrisii	Harris' antelope squirrel	-
Spermophilus variegatus	rock squirrel	+
S. spilosoma	spotted ground squirrel	-
Sciurus nayaritensis	Mexican fox squirrel	+
GEOMYIDAE		
Thomomys bottae	Botta's pocket gopher	+
HETEROMYIDAE		
Perognathus flavus	silky pocket mouse	+
P. 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. spectabilis	banner-tailed kangaroo rat	-
D. merriami	Merriam's kangaroo rat	+
MURIDAE		
Reithrodontomys montanus	plains harvest mouse	+
R. megalotis	western harvest mouse	+
R. fulvescens	fulvous harvest mouse	+

Table 3. (Continued).

FAMILY, species	Common name	+/-
MURIDAE (Contd.)		
Peromyscus eremicus	cactus mouse	+
P. maniculatus	deer mouse	+
O. torridus	southern grasshopper mouse	+
P. leucopus	white-footed mouse	+
P. boylii	brush mouse	+
P. truei	pinyon mouse	+
P. difficilis	rock mouse	+
Baiomys taylori	northern pygmy mouse	-
Onychomys leucogaster	northern grasshopper mouse	+
Sigmodon arizonae	Arizona cotton rat	+
S. fulviventer	fulvous cotton rat	+
S. ochrognathus	yellow-nosed cotton rat	+
Neotoma albigula	white-throated wood rat	+
N. mexicana	Mexican wood rat	+
ERETHIZONTIDAE		
Erethizon dorsatum	porcupine	-
CANIDAE		
Canis latrans	coyote	-
Urocyon cinereoargenteus	gray fox	+
URSIDAE		
Ursus americanus	black bear	+
PROCYONIDAE		
Procyon lotor	raccoon	+
Nasua nasua	coati	+

Table 3. (Continued).

FAMILY, species	Common name	+/-
Bassariscus astutus	ringtail	+
MUSTELIDAE		
Mustela frenata	long-tailed weasel	-
Taxidea taxus	badger	+
Spilogale gracilis	spotted skunk	-
Mephitis mephitis	striped skunk	+
M. macroura	hooded skunk	+
Conepatus mesoleucus	hog-nosed skunk	-
FELIDAE		
Felis concolor	mountain lion	+
F. rufus	bobcat	-
TAYASSUIDAE		
Tayassu tajacu	collared peccary	+
CERVIDAE		
Odocoileus hemionus	mule deer	-
O. virginianus	white-tailed deer	+

Population estimates were determined using linear regression (Table 7). The most numerous rodents were brush mice, cactus mice, rock mice (*P. difficilis*), deer mice (*P. maniculatus*), and white-throated wood rats. The most widespread rodents were brush mice (in 12 of 21 plots), cactus mice and white-throated wood rats (6 plots), deer mice (5 plots), and rock mice (4 plots).

Vegetation types of the 21 plots are shown in Table 8. Sampling procedures for trapping rodents were conducted at least once in all but one vegetation type. In one type, four plots were sampled. The vegetation associations with the highest populations of rodents were Douglas Fir (# 122.611 in Brown, Lowe, and Pase 1979) with an estimate of 27.5 animals per plot, Mixed Oak (123.311) with 25.8, Douglas Fir-Mixed Conifer (122.612) with 21.2, and Ponderosa Pine-Mixed Conifer (122.623) with 17.8. The most species recorded were nine in Grama-Mixed Grass-Mixed Scrub (143.114), and four in Alligator Juniper (*Juniperus deppeana*) (123.318). Brush mice were caught in 9 of the 14 vegetation types; white-throated wood rats were caught in five (Table 9).

The population estimate for the Mixed Oak Association (123.316) was the smallest of all with 1.0 individuals per plot. Only one species was found in this and the Douglas Fir-Mixed Conifer Associations.

The greatest population for a vegetation series (second digit right of the decimal) was found in Douglas Fir-Mixed Conifer (122.61) with an estimate of 24.4 (Table 10). The next greatest estimate is 17.8 in the Pine Series (122.62). The series with both the lowest population estimate (2.2) and the fewest species (1) was Curly Mesquite-Scrub (143.13). The most species (9) were captured in the Grama Grass-Scrub Series (143.11). Brush mice occurred on six series.

The Madrean Montane Conifer Forest Biome (122.6), with 22.2 individuals, had the largest population estimate (Table 11). The biome with the smallest population estimate was Interior Southwestern Riparian Deciduous Forest and Woodland (223.2) with 3.0. The Semidesert Grassland (143.1) and Madrean Evergreen Forest and Woodland (123.3) Biomes had the most species, with nine and eight respectively. The Interior Southwestern Riparian Deciduous Forest and Woodland Biome had only one species, as did Relict Conifer Forest and Woodland (123.5). Brush mice were caught in five biomes.

Table 4. Additional mammal sightings at Chiricahua National Monument, Cochise County, Arizona, 1984-1986, number sighted.

Species	Location														
	NBTH	Ent	BP	Super	FR	BCG	NBT	EC	NW	SSM	RC	VC	BCRd	ERd	SA
Cottontail rabbits *Sylvilagus* spp.	-	4	-	-	-	1	-	-	-	-	-	-	22	2	1
Black-tailed jackrabbit *Lepus californicus*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Cliff Chipmunk *Eutamias dorsalis*	-	1	-	-	-	-	-	2	-	-	-	-	11	-	2
Rock squirrel *Spermophilus variegatus*	1	1	-	-	-	1	-	-	-	-	-	-	13	8	-
Mexican fox squirrel *Sciurus nayaritensis*	-	-	-	-	-	1	1	-	-	-	10	-	6	-	-
Gray fox *Urocyon cinereoargenteus*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Black bear *Ursus americanus*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Raccoon *Procyon lotor*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Coatimundi *Nasua nasua*	-	-	-	-	-	-	-	-	-	-	-	1	1	18	1
Striped skunk *Mephitis mephitis*	-	2	-	-	-	10	-	-	-	1	-	4	4	-	-
Mountian lion *Felis concolor*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
House cat *F. catus*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Collared peccary *Tayassu tajacu*	-	2	-	4	9	4	-	-	1	-	-	7	-	-	-
White-tailed deer *Odocoileus virginianus*	-	20	4	6	32	6	-	-	1	-	2	-	2	9	1

Locations

NBTH = Natural Bridge trail head
BP = Bonita Park
Super = Superintendents residence
NBT = Natural Bridge trail
Ent = entrance
FR = Faraway Ranch
BCG = Bonita Campground
EC = Echo Canyon
RC = Rhyolite Canyon
BCRd = Bonita Canyon Rd.
SA = service area
VC = Visitor's Center
NW = northwest corner
SSM = Silver Spur Meadow
ERd = entrance road

Table 5. Population estimates by linear regression, # and *r*, for each plot for 1985 trapping results, Chiricahua National Monument, Cochise County, Arizona.

Species		Plots			
		BP	EN	ES	SC
P. flavus	#	-	1.0[1]	-	-
	r	-	1.0000	-	-
P. hispidus	#	-	1.0[2]		-
	r	-	1.0000	-	-
R. fulvescens	#	-	5.2	-	
	r	-	0.7659	-	-
P. eremicus	#	10.0	-	14.0	-
	r	0.9268	-	0.9640	-
P. maniculatus	#	-	-	1.0[1]	-
	r	-	-	1.0000	-
P. boylii	#	12.5[1]	3.2	2.9	3.6
	r	0.9847	0.7807	0.9129	0.7794
O. leucogaster	#	-	13.6	-	-
	r	-	0.9176	-	-
S. arizonae	#	-	2.0[1]	-	-
	r	-	0.9128	-	-
S. ochrognathus	#	-	-	3.2[1]	-
	r	-	-	0.9820	-
N. albigula	#	-	2.0	17.9	-
	r	-	0.7906	0.9262	-
Total	#	20.0	28.2	40.5	3.6
	r	0.8459	0.9002	0.9599	0.7794

BP = Bonita Park
EN = entrance north
1 = data combined into 3 nights
2 = data combined into 2 nights
ES = entrance south
SC = Sea Captain
# = population estimate
r = correlation coefficient

Table 6. Number of captures made during the University of Arizona Mammalogy class field trip in September 1985, Chiricahua National Monument, Cochise County, Arizona.

Species	Location							
					Sugarloaf		Bonita Park	
	Ent	SC	NBTH	CB	14th	15th	14th	15th
E. dorsalis	-	-	-	-	1	1	-	1
P. hispidus	1	-	-	-	-	-	-	-
R. montanus	1	-	-	-	-	-	-	-
R. megalotis	1	-	-	-	-	-	-	-
R. fulvescens	1	-	-	-	-	-	-	-
P. eremicus	6	3	-	-	2	4	3	1
P. leucopus	-	1	-	-	-	-	1	-
P. boylii	6	14	8	2	23	24	10	11
P. truei	-	-	1	-	3	3	-	-
P. difficilis	-	-	1	-	1	2	-	-
S. arizonae	7	-	-	-	-	-	-	-
N. albigula	4	-	-	-	2	5	-	-
N. mexicana	-	1	-	-	1	1	-	1
Total	27	19	10	2	33	40	14	14
# traps	487	162	125	156	100	100	100	100
% success	5.5	11.7	8.0	1.3	33.0	40.0	14.0	14.0
# species	8	4	3	1	7	7	3	4

Ent = entrance
SC = Sea Captain
NBTH = Natural Bridge trail head
CB = China Boy

Table 7. Population estimates by linear regression, # and *r*, 1986, Chiricahua National Monument, Cochise County, Arizona.

Plots		Dipodomys ordii	Dipodomys merriami	Reithrodontomys montanus	Reithrodontomys megalotis	Peromyscus eremicus	Peromyscus maniculatus	Peromyscus boylii	Peromyscus difficilis	Onychomys torridus	Sigmodon arizonae	Sigmodon ochrognathus	Neotoma albigula	Neotoma mexicana	Total
1	#	8.8*	-	-	-	5.1*	3.7*	-	-	1.0*	-	-	4.0	-	21.6*
	r	0.9986	-	-	-	0.9986	0.6547	-	-	1.0	-	-	0.7746	-	0.9767
2	#	-	-	-	-	21.1	3.2*	-	-	-	-	-	2.0	-	25.8
	r	-	-	-	-	0.9939	0.9820	-	-	-	-	-	1.0	-	0.9976
3	#	-	-	-	-	14.8	-	-	-	-	-	-	1.0*	-	12.9*
	r	-	-	-	-	0.7046	-	-	-	-	-	-	0.5	-	0.9820
4	#	-	-	-	-	-	-	16.1	-	-	-	-	-	-	16.1
	r	-	-	-	-	-	-	0.9136	-	-	-	-	-	-	0.9136
5	#	-	-	-	-	-	-	15.5	-	-	-	-	-	-	15.5
	r	-	-	-	-	-	-	0.9977	-	-	-	-	-	-	0.9977
6	#	-	-	-	-	4.3	1.0	4.2*	-	-	-	-	-	-	10.1
	r	-	-	-	-	0.9045	1.0	0.9958	-	-	-	-	-	-	0.9277
7	#	-	-	1.0	-	-	-	2.8	-	-	-	-	-	-	4.0
	r	-	-	0.5	-	-	-	0.8992	-	-	-	-	-	-	0.7071
8	#	-	-	-	-	-	-	-	-	1.0	-	3.3	-	-	4.3
	r	-	-	-	-	-	-	-	-	1.0	-	0.9045	-	-	0.9136
9	#	-	-	-	-	1.0*	2.0*	-	-	-	-	-	-	-	3.0*
	r	-	-	-	-	0.5	0.5	-	-	-	-	-	-	-	0.5
10	#	-	-	-	-	1.0*	-	-	-	-	-	-	1.0	-	2.0
	r	-	-	-	-	0.5	-	-	-	-	-	-	1.0	-	0.7071
11	#	-	1.0*	-	3.0*	-	-	-	-	3.3	1.0	-	-	-	10.2*
	r	-	1.0	-	0.5	-	-	-	-	0.7543	1.0	-	-	-	0.9221
12	#	-	-	-	-	-	-	3.8	-	-	-	-	-	-	3.8
	r	-	-	-	-	-	-	0.9525	-	-	-	-	-	-	0.9525

Table 7 (Continued).

Plots		Dipodomys ordii	Dipodomys merriami	Reithrodontomys montanus	Reithrodontomys megalotis	Peromyscus eremicus	Peromyscus maniculatus	Peromyscus boylii	Peromyscus difficilis	Onychomys torridus	Sigmodon arizonae	Sigmodon ochrognathus	Neotoma albigula	Neotoma mexicana	Total
13	#	-	-	-	-	-	-	8.1	-	-	-	5.1*	-	-	16.0
	r	-	-	-	-	-	-	0.7313	-	-	-	0.9986	-	-	0.7746
14	#	-	-	-	-	-	-	-	-	-	-	-	1.0*	-	1.0*
	r	-	-	-	-	-	-	-	-	-	-	-	1.0	-	1.0
15	#	-	-	-	-	-	-	9.5	1.0	-	-	-	-	-	10.4
	r	-	-	-	-	-	-	0.9239	1.0	-	-	-	-	-	0.9407
16	#	-	-	-	-	-	-	17.8*	4.1	-	-	-	-	-	27.5*
	r	-	-	-	-	-	-	0.8253	0.9961	-	-	-	-	-	0.7552
17	#	-	-	-	-	-	-	5.2	2.0	-	-	-	-	-	7.2
	r	-	-	-	-	-	-	0.9810	0.7071	-	-	-	-	-	0.9281
18	#	-	-	-	-	-	-	21.2	-	-	-	-	-	-	21.2
	r	-	-	-	-	-	-	0.8296	-	-	-	-	-	-	0.8296
19	#	-	-	-	-	-	-	-	-	-	-	-	2.2	-	2.2
	r	-	-	-	-	-	-	-	-	-	-	-	0.9045	-	0.904
20	#	-	-	-	-	-	1.0	5.2	-	-	-	-	-	1.0*	7.2
	r	-	-	-	-	-	1.0	0.9810	-	-	-	-	-	0.5	0.9281
21	#	-	-	-	-	-	-	2.3*	14.9	-	-	-	-	-	17.8
	r	-	-	-	-	-	-	0.8660	0.9930	-	-	-	-	-	0.9769
Total															
	#	8.8*	1.0*	1.0	3.0	48.9	11.7*	115.4	21.8	5.5	1.0	8.1	11.1	1.0*	247.7
	r	0.9669	1.0	0.5	0.5	0.9315	0.8660	0.9216	0.9955	0.8165	1.0	0.9999	0.9758	0.5	0.9347
# plots		1	1	1	1	6	5	12	4	3	1	2	6	1	21

* = 2 nights combined
1 = using combined data

Table 8. 1986 plot vegetation types, Chiricahua National Monument, Cochise County, Arizona.

Plot #	Sample[1] Brown, Lowe, and Pase (1979) associations		Sample[1] Roseberry & Dole (1939)	Map Roseberry & Dole (1939)
1	Bouteloua spp.-Mixed Grass-Mixed Scrub	143.114	Grassland	Grassland
2	Mixed Quercus	123.311	Woodland-Grass	Woodland
3	Juniperus deppeana	123.318	Pinyon-Juniper-Cypress	Pinyon-Juniper-Cypress
4	Quercus spp.-Pinus spp.	123.324	Pinyon-Juniper-Cypress	Pinyon-Juniper-Cypress
5	Arctostaphylos pungens	133.322	Pinyon-Juniper-Cypress	Pinyon-Juniper-Cypress
6	Bouteloua spp.-Mixed Grass-Mixed Scrub	143.114	Woodland-Grass	Woodland-Grass
7	Quercus spp.-Pinus engelmanii	123.323	Pine	Woodland
8	Juniperus deppeana	123.318	Pinyon-Juniper-Cypress	Pinyon-Juniper-Cypress
9	Platanus wrightii	223.222	Pinyon-Juniper-Cypress	Woodland
10	Bouteloua spp.-Mixed Grass-Mixed Scrub	143.114	Semi-Desert Chaparral	Grassland
11	Bouteloua spp.-Mixed Grass-Mixed Scrub	143.114	Grassland	not mapped
12	Quercus spp.-Pinus spp.	123.324	Pine	Pine
13	Quercus spp.-Pinus leiophylla	123.322	Pine	Pine
14	Quercus spp.-Pinus cembroides-Juniperus spp.	123.316	Woodland Chaparral	Woodland
15	Arctostaphylos pungens	133.322	Pinyon-Juniper-Cypress	Transition Chaparral
16	Pseudotsuga menziesii	122.611	Douglas Fir	Pine-Douglas Fir
17	Quercus spp.-Pinus spp.	123.324	Pinyon-Juniper-Cypress	Douglas Fir
18	Pseudotsuga menziesii-Mixed Conifer	122.612	Pine-Douglas Fir	Pine
19	Hilaria belangeri-Mixed Scrub	143.131	Grassland	not mapped
20	Cupressus arizonica arizonica	123.521	Pinyon-Juniper-Cypress	Pinyon-Juniper-Cypress
21	Pinus ponderosa-Mixed Conifer	122.623	Pine-Douglas Fir	Pine-Douglas Fir

1 = vegetation type as determined by vegetation sampling

Table 9. Average population estimates for each vegetation association, 1986, Chiricahua National Monument, Cochise County, Arizona.

Mammals	Vegetation Associations[1]													
	122.611	122.612	122.623	123.311	123.316	123.318	123.322	123.323	123.324	123.521	133.322	143.114	143.131	223.222
D. ordii	0	0	0	0	0	0	0	0	0	0	0	2.2	0	0
D. merriami	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0
R. montanus	0	0	0	0	0	0	0	1.0	0	0	0	0	0	0
R. megalotis	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0
P. eremicus	0	0	0	21.1	0	7.4	0	0	0	0	0	2.6	0	1.0
P. maniculatus	0	0	0	3.2	0	0	0	0	0	1.0	0	1.2	0	2.0
P. boylii	17.8	21.2	2.3	0	0	0	8.1	2.8	8.4	5.2	12.5	1.1	0	0
P. difficillis	4.1	0	14.9	0	0	0	0	0	0.7	0	0.5	0	0	0
O. torridus	0	0	0	0	0	0.5	0	0	0	0	0	1.1	0	0
S. arizonae	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0
S. ochrognathus	0	0	0	0	0	1.7	5.1	0	0	0	0	0	0	0
N. albigula	0	0	0	2.0	1.0	0.5	0	0	0	0	0	1.3	2.2	0
N. mexicana	0	0	0	0	0	0	0	0	0	1.0	0	0	0	0
Total regression	27.5	21.2	17.8	25.8	1.0	8.6	16.0	4.0	9.0	7.2	13.0	11.0	2.2	3.0
# plots	1	1	1	1	1	2	1	1	3	1	2	4	1	1
# species	2	1	2	3	1	4	2	2	2	3	2	9	1	2

[1] See table 2 for descriptions of these associations.

Table 10. Average population estimates for each vegetation series, 1986, Chiricahua National Monument, Cochise County, Arizona.

	Series								
Mammals	122.61	122.62	123.31	123.32	123.52	133.32	143.11	143.13	223.22
D. ordii	-	-	-	-	-	-	2.2	-	-
D. merriami	-	-	-	-	-	-	0.3	-	-
R. montanus	-	-	-	0.2	-	-	-	-	-
R. megalotis	-	-	-	-	-	-	0.8	-	-
P. eremicus	-	-	9.0	-	-	-	2.6	-	1.0
P. maniculatus	-	-	0.8	-	1.0	-	1.2	-	2.0
P. boylii	20.0	2.3	-	7.2	5.2	12.5	1.1	-	-
P. difficillis	2.1	14.9	-	0.4	-	0.5	-	-	-
O. torridus	-	-	0.3	-	-	-	1.1	-	-
S. arizonae	-	-	-	-	-	-	0.3	-	-
S. ochrognathus	-	-	0.8	1.0	-	-	-	-	-
N. albigula	-	-	1.0	-	-	-	1.3	2.2	-
N. mexicana	-	-	-	-	1.0	-	-	-	-
Total	24.4	17.8	11.0	9.4	7.2	13.0	11.0	2.2	3.0
# plots	2	1	4	5	1	2	4	1	1
# associations	2	1	3	3	1	1	4	1	1
# species	2	2	5	4	3	2	9	1	2

VEGETATION TYPES

Following the system in Brown, Lowe, and Pase (1979), I identified 15 vegetation associations. These associations were in 10 series and seven biomes (Table 2). In 14 of these associations rodents were trapped. These associations were sampled for vegetation types using pace transects (Table 12). Table 13 gives the 20 most common plants on the trapping plots.

The Arizona Cypress Association (123.521) had the greatest percent plant cover with 99% and Grama-Mixed Grass-Mixed Scrub (143.114) had the least with 60% (Table 12). Alligator juniper and silverleaf oak (*Quercus hypoleucoides*) were found on more plots than any other plants (Table 13). The plants with the greatest overall percent cover were hairy grama (*Bouteloua hirsuta*) (7.9%) and silverleaf oak (7.0%).

Table 11. Average population estimates for each vegetation biome, 1986, Chiricahua National Monument, Cochise County, Arizona.

Mammals	Biome[2] 122.6	123.3	123.5	133.3	143.1	223.22
D. ordii	-	-	-	-	1.8	-
D. merriami	-	-	-	-	0.2	-
R. montanus	-	0.1	-	-	-	-
R. megalotis	-	-	-	-	0.6	-
P. eremicus	-	4.0	-	-	2.1	1.0
P. maniculatus	-	0.4	1.0	-	0.9	2.0
P. boylii	13.8	3.9	5.2	12.5	0.8	-
P. difficillis	6.3	0.2	-	0.5	-	-
O. torridus	-	0.1	-	-	0.9	-
S. arizonae	-	-	-	-	0.1	-
S. ochrognathus	-	0.9	-	-	-	-
N. albigula	-	0.4	-	-	1.4	-
N. mexicana	-	-	1.0	-	-	-
Total	22.2	10.1	7.2	13.0	9.2	3.0
# plots	3	9	1	2	5	1
# series	2	2	1	1	2	1
# species	2	8	3	2	9	2

[2] See table 2 for description of the vegetative associations that comprise these biomes.

Table 12. Average pace transect results for each vegetation association, 1986, Chiricahua National Monument, Cochise County, Arizona.

Associations[3]	% plant	% bare	% rock	% grass	% shrubs	% trees	# plots
122.611	96	2	2	0	18	82	1
122.612	69	22	9	4	7	89	1
122.623	73	25	2	0	13	87	1
123.311	80	18	3	39	16	45	1
123.316	77	14	10	3	47	50	1
123.318	64	27	9	67	10	24	2
123.322	61	31	8	37	10	55	1
123.323	82	15	3	2	6	94	1
123.521	99	1	0	1	10	89	1
133.322	7	14	14	0	52	48	2
143.114	60	27	13	68	24	7	4
143.131	90	3	6	80	20	0	1
223.222	89	6	5	15	16	69	1
Average	77	16	18	23	1	59	1.5

[3] See table 2 for descriptions of the associations.

Table 13. Twenty most common plants and the average percent cover determined by pace frequency transects on the 1986 trapping plots, Chiricahua national Monument, Cochise County, Arizona.

Plant	# plots	average % cover
Arctostaphylos pungens	11	4.5
Blepharoneuron tricholepis	11	5.3
Bouteloua curtipendula	6	2.1
B. hirsuta	9	7.9
Cupressus arizonica	10	6.1
Garrya wrightii	7	0.4
Hilaria belangeri	1	2.8
Juniperus deppeana	13	4.8
Nolina microcarpa	11	1.1
Pinus cembroides	7	2.5
P. leiophylla	9	3.3
P. ponderosa	4	2.3
Pseudostuga menziesii	5	4.2
Quercus arizonica	10	4.6
Q. emoryi	6	2.6
Q. hypoleucoides	13	7.0
Q. reticulata	8	7.8
Q. toumeyi	9	0.9
Rhus trilobata	7	0.8
Yucca	7	0.2

LISTED SPECIES NOT FOUND

I found only 23 of the 31 rodent species listed by Lanning (n.d.), (Table 4). For the remainder of this section, I discuss the probability of finding these 8 species at CHIR. One species, the porcupine (*Erithizon dorsatum*), certainly occurs in the monument, but I was not lucky enough to see one. The other seven species have limited habitat present in the monument or are on the edge of their range and might be found with further trapping. Some species may not be found, except during exceptional years of population highs.

Harris' antelope squirrel (*Ammospermophilus harrisii*) has been collected at the mouth of Pinery Canyon (Hoffmeister 1986). The preferred habitat of these ground squirrels is rocky areas within saltbush (*Atriplex*)-creosote bush (*Larrea divaricata*)-bursage (*Ambrosia* sp.) deserts (Hoffmeister 1986). The squirrels are also found in rocky areas of desert grassland which occurs in very small areas of the monument. Trapping or observation in these areas may confirm the presence of Harris' antelope squirrel.

The nearest recorded location to the monument for spotted ground squirrels (*Spermophilus spilosoma*) is Rucker Canyon (Hoffmeister 1986). These ground squirrels inhabit grassy areas and areas of mesquite (*Prosopis juliflora*) and *Acacia*. Their burrows are often found in dry, sandy washes (Hoffmeister 1986). Such habitats occur in a small section of the northwest corner of the monument.

Rock pocket mice (*Perognathus intermedius*) have been collected as near as Ft. Bowie (Hoffmeister 1986). The preferred habitat of rock pocket mice is rocky slopes of desert mountains. Occasionally, they are found in rocky chaparral and desert grassland adjacent to desertscrub (Hoffmeister 1986). These pocket mice may be found in CHIR during times of population highs since only marginal habitat is present within the monument.

A point 10 miles southeast of the monument (Hoffmeister 1986) is the nearest known locality for desert pocket mice (*Perognathus penicillatus*). Desert pocket mice are found most often in areas of sparse desert vegetation (Hoffmeister 1986). Areas with sparse grass cover on the monument's western edge may contain these pocket mice.

A location 12 miles south of Bowie is the closest recorded locality to the monument for Bailey's pocket mouse (*Perognathus baileyi*) (Hoffmeister 1986). The usual habitat for these pocket mice is desertscrub, though they have been found in grassy areas on the east side of the Chiricahua Mountains. Bailey's pocket

mice may also be found during population highs. The likelihood of finding any of the previous three *Perognathus* species in CHIR is, however, slim.

The conspicuous mounds of the banner-tailed kangaroo rat (*Dipodomys spectabilis*) are visible throughout the Sulphur Springs Valley, but no mounds or kangaroo rats were found within the monument. The grassy areas preferred by these kangaroo rats (Hoffmeister 1986) are found only in limited areas on the west side of the monument.

Northern pygmy mice (*Baiomys taylori*) have been caught six miles west of the El Coronado Ranch, in Turkey Creek (Hoffmeister 1986). Pygmy mice prefer areas of dense grass in which to live (Hoffmeister 1986). Areas of dense grass on the western edge of the monument are small and rare. Pygmy mice might be found during wet periods that cause an increase in dense grassy or weedy areas.

CONCLUSIONS AND RECOMMENDATIONS

The many vegetation types, the diversity of topographical and geological formations, and faunal origins are the factors responsible for the monument's diverse mammalian fauna. Animals, including nocturnal rodents, are dependent on the habitat in which they live. This project attempted to identify the rodent species and number of individual rodents present on plots in specific habitats. The procedures described in this report are useful tools. This report provides basic, ecological information which is lacking for Chiricahua National Monument.

I conducted this study to obtain information on the relative densities of small mammal species present in the monument and their distribution by vegetation type. Additional study should concentrate on:

(1) searching for species not found;
(2) constructing a map of vegetation types following Brown, Lowe, and Pase's (1979) system; and
(3) establishing a monitoring system using permanent plots.

A monitoring system would be relatively simple to establish. One of the 1986 trapping plot types could be set up in each vegetation association (15 plots). If this proved to be too time consuming, one plot in each vegetation series (10 plots), or even each biome (7 plots), could be set. Trapping in each association would take approximately 30 hours a week for five weeks in the summer. Plots should be trapped the same time each year and under the same conditions (i.e. moon phase and weather). Persons conducting the trapping would require minimal training, but would have to be able to identify rodents in hand. Live traps could be obtained from the Cooperative National Park Resources Studies Unit/University of Arizona or the University of Arizona Mammal Museum. Identification of rodents could be accomplished with assistance from the Museum.

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APPENDIX

PLOT DESCRIPTIONS

DIRECTORY

R = range	T = township
sect. = section	E = east
S = south	N = north
W = west	km = kilometer
m = meters elevation	NW = northwest
SW = southwest	SE = southeast
NE = northeast	Mtn. = mountain

All in Arizona, Cochise County, Chiricahua National Monument, all Township 16 South.

1984-5 TRAPPING PLOTS

Sea Captain - R 29 1/2 E, Sect. 24, NE 1/4, SW 1/4, SW 1/4; 0.9 km N and 0.4 km W of Sugarloaf Mtn.; 1790 m.

Mine Road-Bonita Park - R 30 E, Sect. 18, SW, SW, W 1/2; 2.0 km N and 0.5 km W of Sugarloaf Mtn.; 1890 m.

Bonita Campground Impact - R 29 E, Sect. 26, SE, SE, N; 0.7 km S and 0.2 km E of Riggs Mtn.; 1620 m.

Bonita Campground Control - R 29 E, Sect. 26, SE, SW, NE; 0.7 km S and 0.1 km W of Riggs Mtn.; 1620 m.

Entrance North - R 29 E, Sect. 27, SW, SW, W; 10.4 km S and 1.2 km E of Red Mtn.; 1560 m.

Entrance South - R 29 E, Sect. 27, SW, SW, SW; 10.6 km S and 1.3 km E of Red Mtn.; 1565 m.

MAMMOLOGY TRIP PLOTS, 1985

Sugarloaf Mtn.- R 30 E, Sect. 19, SE, SE, S; 0.2 km N and 0.6 km E of Sugarloaf Mtn.; 2060 m.

Natural Bridge Trail Head - R 29 E, Sect. 24, SW, SE, S; 0.7 km N and 0.9 km E of Riggs Mtn.; 1700 m.

China Boy - R 29 1/2 E, Sect. 24, NE, SW, SW; 1.6 km N and 0.4 km W of Sugarloaf Mtn.; 1815 m.

Bonita Park - R 30 E, Sect. 18, SW, SW, S; 2.0 km N and 0.5 km W of Sugarloaf Mtn.; 1865 m.

Entrance - R 29 E, Sect. 27, SW, NW, W; 10.0 km S and 1.3 km E of Red Mtn.; 1565 m.

1986 TRAPPING PLOTS

1. R 29 E, Sect. 22, NW, NW, W; 6.5 km S and 1.1 km E of Red Mtn.; 1575 m.

2. R 29 E, Sect. 22, NW, SW, W; 6.8 km S and 1.2 km E of Red Mtn.; 1560 m.

3. R 29 E, Sect. 35, NW, SW, N; 1.4 km S and 1.1 km W of Riggs Mtn.; 1610 m.

4. R 30 E, Sect. 30, NW, SW, W; 1.8 km S and 0.3 km E of Sugarloaf Mtn.; 1985 m.

5. R 30 E, Sect. 30, NW, NW, S; 0.3 km S and 0.4 km E of Sugarloaf Mtn.; 2030 m.

6. R 29 E, Sect. 25, SW, SW, SW; 1.0 km S and 0.4 km E of Riggs Mtn.; 1660 m.

7. R 29 E, Sect. 36, NW, NW, NW; 1.2 km S and 0.4 km E of Riggs Mtn.; 1635 m.

8. R 29 E, Sect. 26, SW, SW, W; 0.8 km S and 1.1 km E of Riggs Mtn.; 1585 m.

9. R 29 E, Sect. 26, SW, SW, W; 0.8 km S and 1.1 km E of Riggs Mtn.; 1585 m.

10. R 29 E, Sect. 35, NW, NW, N; 1.2 km S and 1.0 km W of Riggs Mtn.; 1630 m.

11. R 29 E, Sect. 27, SW, SW, W; 10.4 km S and 1.2 km W of Riggs Mtn.; 1560 m.

12. R 29 E, Sect. 23, SE; 1.0 km N and 0.1 km E of Riggs Mtn.; 1720 m.

13. R 29 E, Sect. 23, SE, NW; 1.2 km N and 0.3 km W of Riggs Mtn.; 1655 m.

14. R 29 E, Sect. 23, SE, NE, NW; 1.3 km N and 0.1 km E of Riggs Mtn.; 1755 m.

15. R 29 E, Sect. 24, SW, NW, NE; 1.3 km N and 0.7 km E of Riggs Mtn.; 1835 m.

16. R 30 E, Sect. 30, SE, SW, E; 0.7 km S and 0.1 km E of Massai Point; 1970 m.

17. R 30 E, Sect. 31, N; 0.2 km S and 4.5 km E of Garfield Peak; 2060 m.

18. R 30 E, Sect. 31, NE, NE, SW; 0.1 km S and 5.0 km E of Garfield Peak; 2075 m.

19. R 29 E, Sect. 27, SW, NW, NW; 8.8 km N and 1.3 km W of Red Mtn.; 1605 m.

20. R 29 1/2 E, Sect. 24, NW, SW, SW; 0.8 km N and 1.3 km W of Sugarloaf Mtn.; 1725 m.

21. R 30 E, Sect. 30, NE, SW, NE; 0.2 km N and 0.1 km E of Massai Point; 2050 m.