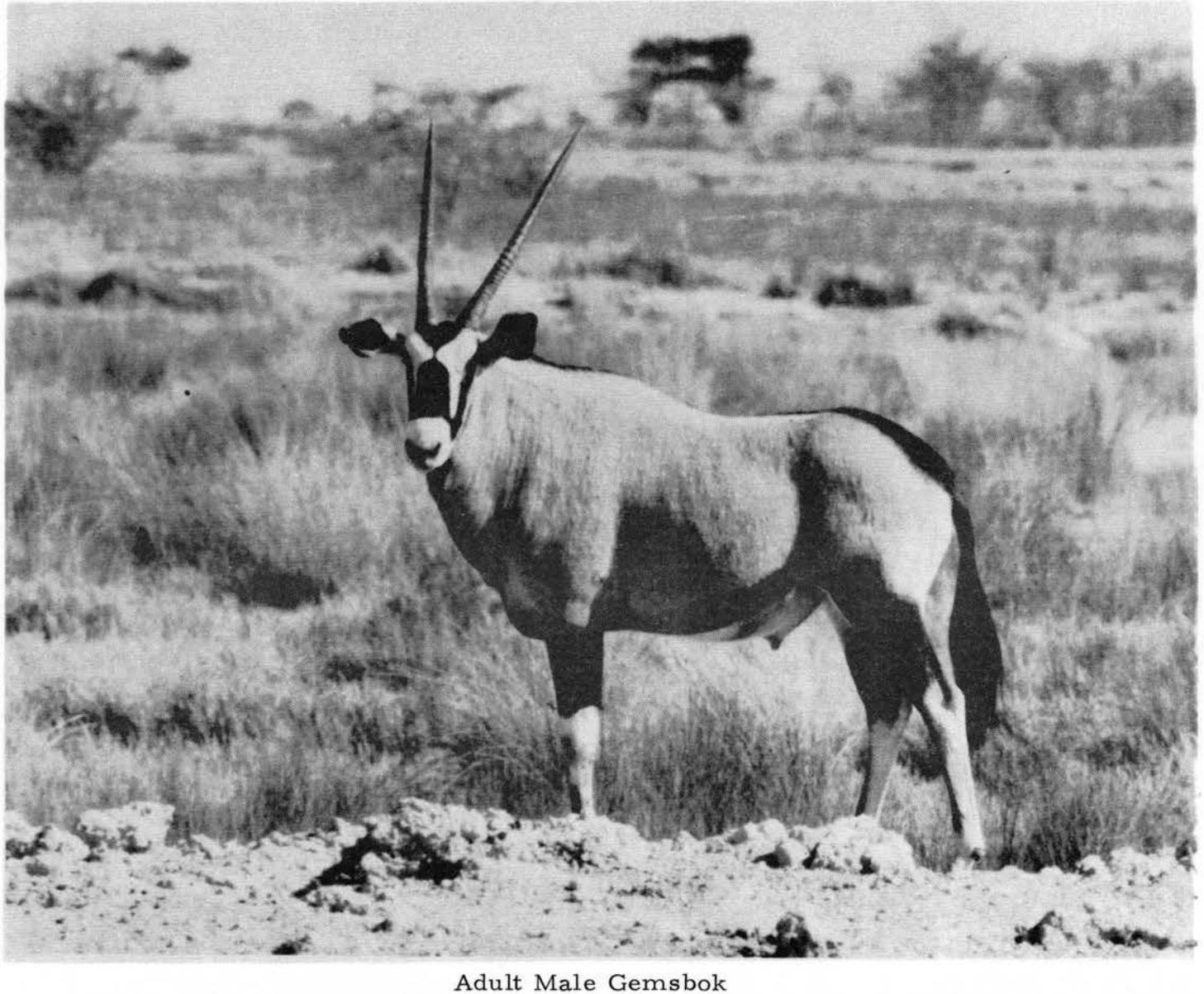

Adult Male Gemsbok

THESIS

ECOLOGY AND BEHAVIOR OF THE GEMSBOK AT WHITE SANDS MISSILE RANGE, NEW MEXICO

Submitted by

Richard B. Saiz

In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Winter, 1975

COLORADO STATE UNIVERSITY

Winter, 1975

WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY RICHARD B. SAIZ ENTITLED ECOLOGY AND BEHAVIOR OF THE GEMSBOK AT WHITE SANDS MISSILE RANGE, NEW MEXICO BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT OF THESIS

ECOLOGY AND BEHAVIOR OF THE GEMSBOK

AT WHITE SANDS MISSILE RANGE NEW MEXICO

The gemsbok (Oryx gazella) is a large desert dwelling antelope native to the Kalahari region of southern Africa. Fifty-one have been released at White Sands Missile Range, New Mexico, as part of the exotic mammal introduction program of the New Mexico Department of Game and Fish. The program's goal is to establish huntable populations of foreign big game in areas where conditions are unsuitable for native big game.

Gemsbok numbers increased to an estimated population of 100 animals by the end of the field study. They occupied semi-desert shrub and grassland habitats. Foods consumed included mesquite bean pods, desert grasses, tumbleweeds, and yucca leaves. They displayed an amazing ability to survive with little or no drinking water.

Gemsbok were not found to compete significantly with the native big game of White Sands Missile Range due to differences in habitat preferences. They are reproducing at a satisfactory rate, and show potential of becoming successfully established in New Mexico.

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ACKNOWLEDGMENTS

The assistance and cooperation of many organizations and individuals made this investigation of the gemsbok possible. Colorado State University, the New Mexico Department of Game and Fish, and personnel of the White Sands Missile Range were essential to the success. They provided technical assistance, financial aid, transportation, equipment, and cooperation.

Professor Eugene Decker of the Department of Fishery and Wildlife Biology at Colorado State University was responsible for the study's conception, planning, and execution. Professor Decker provided invaluable advice and criticism as my major professor. My sincerest appreciation goes to him for serving as advisor, for extreme patience, and for assistance that went far beyond his obligation. Dr. Philip N. Lehner, Department of Zoology, shared his extensive knowledge of animal behavior. Mr. Robert Welch of the New Mexico Department of Game and Fish provided technical assistance in the field and aid in editing of the final draft.

Major General H. G. Davisson, former Commanding General of White Sands Missile Range, granted permission for the initial release of gemsbok on the military installation. Later, Major General Arthur H. Sweeny allowed for the subsequent research projects to be conducted

on the Missile Range. This study would not have been possible without the consenting approval of these two gentlemen.

Jack Ferdig, Chief, Facilities Resources and Requirements Division of White Sands Missile Range, served as coordinator between the New Mexico Department of Game and Fish and the management personnel of White Sands Missile Range. His efforts were instrumental in the successful initiation of the study. Mr. Ferdig's efforts were later continued after his retirement by Mr. Henry M. Cedillo.

White Sands Missile Range security patrol officers ("Range Riders") Tom Dayberry, Bill Bates, John Lacky, John Snow and WSMR Range-Wildlife Technician Tom Emanuel provided invaluable information and assistance in the field plus welcomed companionship on many a lonely desert day.

WSMR employees stationed at Rhodes Canyon Range Center also provided information on gemsbok sightings. Because of their concern for the gemsbok s welfare they maintained a watering tub at the installation and assisted in gathering data on gemsbok watering habits. Other Department of Defense employees at WSMR Headquarters aided in securing weather data, maps, security clearances, aerial photos, helicopter rides, and other helpful services.

New Mexico State University Fishery Science Laboratory performed chemical analysis on water samples and Dr. Splenberg of the NMSU Biology Department assisted in plant identifications. The CSU

Composition Analysis Laboratory displayed much interest in their performance of the Food Habits Analysis.

Professor J. Du P. Bothma of the University of Pretoria, South Africa provided weather information on the gemsbok's native habitat.

Mr. Al Alkair and Mrs. Doris Rust were most cooperative in assistance with the art work and graphics.

And lastly, I would like to thank Wimpy, Shrimpy, WOG, ROB, Whiteface, and all the other gemsbok which I grew so fond of and knew so well. My observance of your antics was the source of endless pleasure, and without you this study would certainly never have been possible.

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CHAPTER I

INTRODUCTION

Exotic Mammal Program

"There is much argument, pro and con, on the advisability of introducing foreign species to the fauna or flora of any country. In terms of the primitive condition, it probably would be for the most part inadvisable. But primitive conditions do not hold for long after the invasion of Caucasian man, and by the time he has thoroughly overhauled the pattern of plant life it stands to reason that he may have prepared habitat niches which no native animal can fill adequately and for which there is something made to order on the other side of the world" (Allen, 1962).

In the early 1960's the New Mexico Game and Fish Commission formally adopted a policy to further pursue the possibilities of introducing non-native game animals into arid areas of the State where terrain and habitat were not suitable for native game species (Anonymous, 1961). This policy resulted from the success of the introduction of Barbary Sheep (Ammotragus lervia) in 1950, which already were providing benefits without evidence of endangering native animals or ranching operations. At first this policy was among the most controversial of Game Department programs. Many people were familiar

with unfortunate situations which have developed from the introduction of non-native wildlife into this country, such as the English sparrow, the starling, and the carp. Bill Huey, then Chief of Game Management, stated: "We are convinced from our experience with the Barbary Sheep that if a population of big game mammals become undesirable their numbers could be adequately controlled and, if necessary, even eliminated. For this reason we do not hesitate to continue our experiments with species that might become established and add to our hunter recreational potential without detracting in any way from the native wildlife management program" (Huey, 1968).

The gemsbok (Oryx gazella) was among the first to be considered, along with the kudu (Tragelaphus capensis), Siberian ibex (Capra siberica), and Persian ibex (C. aegagrus). The gemsbok was chosen because of its ability to occupy an extreme desert niche where native game species no longer exist. Also, it was chosen due to its attractiveness as a trophy species and the improbability of its interbreeding with native wildlife.

Federal restrictions prohibit the direct release of any wild ungulate imported from a foreign country (Parker, 1968). Such animals, after being quarantined in both country of origin and port of destination and certified disease-free, then must remain in captivity with only the progeny considered for release in the wild (Parker, 1968).

The State Game and Fish Commission and the Department were aware that introductions of exotic wildlife is an inflammatory subject, and caution was taken to comply with all federal laws and regulations. The program was supported with a detailed research program (Wood, White, and Durham, 1970).

Two male and six female gemsbok were trapped in South West Africa in early April, 1963. They were quarantined for 60 days at Walvis Bay, South West Africa, certified disease-free, and shipped to New York. They then spent 30 days at the Bureau of Animal Industry Quarantine Station at Clifton, New Jersey, and again were certified free of diseases or parasites that would be harmful to other animals in the United States. On August 3, 1963 they arrived at the Rio Grande Zoo in Albuquerque, New Mexico where they were to spend the rest of their natural lives (Anonymous, 1963).

On June 18, 1964 the first gemsbok calf was born at the zoo (N. M. Wildlife, 1964). A large enclosure was then planned where this and future calves could be released, studied, and allowed to reproduce. A site on State owned lands near Red Rock, 30 miles north of Lordsburg, New Mexico was selected where a 320 acre pasture enclosed by a 9 foot woven wire ($14\frac{1}{2}$ gauge) fence was completed on April 8, 1965. By June of 1966, five gemsbok had been released in the pasture (Lee, 1966) and on March 23, 1967 the first gemsbok calf was born. Studies of the gemsbok in the enclosure preliminary to

their release in the wild were conducted through New Mexico State University (White, 1967).

White Sands Missile Range Release Sites

Federal policy prohibits the introduction of foreign big game on federal lands that are considered primarily grazing lands and that are fully stocked (Anonymous, 1966). Since gemsbok could possibly compete with cattle, a search was made for lands not fully stocked with domestic livestock and at the same time not currently supporting huntable populations of big game animals. A portion of White Sands Missile Range was considered a suitable area since it occupies a huge tract of arid land controlled by the Department of Defense which does not contain native big game or livestock grazing. After negotiation with the parties involved a cooperative agreement was signed on May 26, 1969 between the Department of Game and Fish and the Department of Defense to allow for the release and research of gemsbok on the Missile Range.

At first it was thought that the animals should be released in a large enclosed area within the Missile Range to allow for their administration and facilitate subsequent studies. A nine section enclosure utilizing portions of abandoned cattle fences left from pre-missile range days was built. Due to limited funds, the enclosure was not as elaborate as that at Red Rock, consisting of only five strands of barbed wire. In order to make use of as much existing fence as

possible, the enclosure was made in a hilly, rocky habitat at the head of Sulfur Canyon (Figure 1).

The gemsbok were released into this enclosure in October of 1969 (Table 1). It was immediately obvious that the five strand barbed wire fence was not sufficient to contain an excited gemsbok in unsuitable habitat. The gemsbok not only escaped from the enclosure, but freely crossed through the fence both ways (personal communication May 15, 1974 Tom Emanuel, WSMR Range-Wildlife Technician). The gemsbok moved to the flat lands east of the release site, which apparently was more suitable and is the present area of the established herd.

Subsequent releases of gemsbok were made in the vicinity of Rhodes Canyon Range Center near the center of their present distribution. Fifty-one gemsbok have been released (Table 1) and none are known to have left the boundaries of the White Sands Missile Range by February 1975.

Objectives

This study is aimed at gathering behavioral and ecological information of free ranging gemsbok in New Mexico. With this background information, subsequent studies can be more efficiently planned and accomplished. The objectives were:

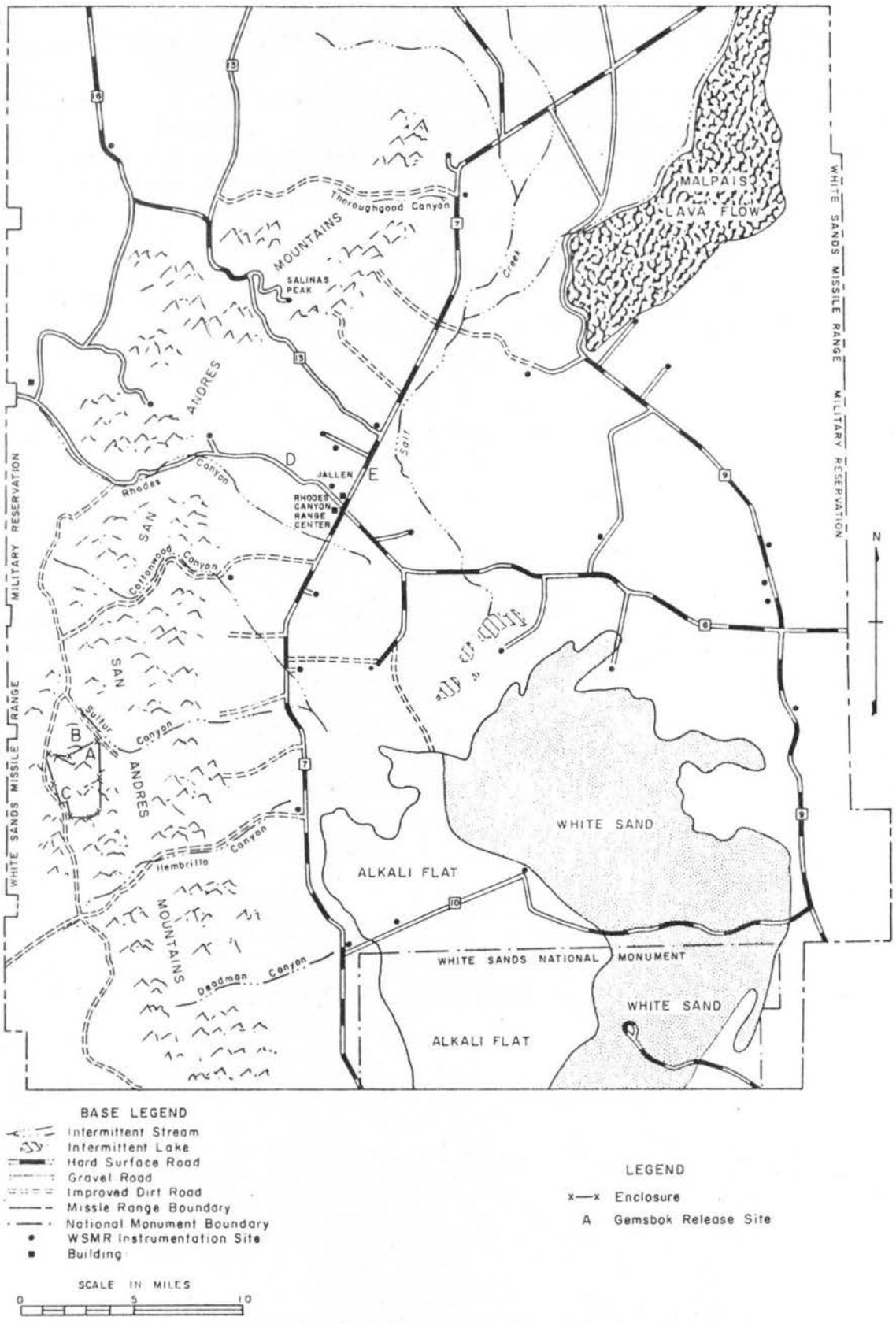

Figure 1. Location of gemsbok release sites on WSMR.

Table 1. Gemsbok releases at White Sands Missile Range, N. M. 1969-1973.

Date	Adult Males	Adult Females	Subadult Males	Subadult Females	Total	Release Site
10-2-69[a]		4	1		5	A
10-2-69[b]				2	2	A
1-28-70[a]	2		1		3	B
6-25-70[b]			3	2	5	C
10-18-71[b]	1		2	2	5	D
10-11-72[b]			2	4	6	D
4-25-73[a]	7	1	4		12	D
6-6-73[b]		1	4		5	D
11-29-73[a]		8			8	E
Totals	10	14	17	10	51	

[a]From Red Rock.

[b]From Rio Grande Zoo, Albuquerque.

1. Determine the seasonal movements and ranges of the gemsbok.
2. Determine the vegetative composition and physical features of preferred habitats.
3. Determine the behavior of the gemsbok with emphasis on herd composition (sex and age ratios), breeding activity, social structure, and calving.
4. Determine food habits by direct observation and through collection of fecal material and samples of utilized vegetation.
5. Prepare cover maps of the study area, showing vegetative communities, seasonal ranges, movement routes and water sources.

Methods and Equipment

The study was designed and planned during the winter of 1972-73 as a cooperative effort between Colorado State University and the New Mexico Department of Game and Fish. Field activities began during May 1973 and continued until June 1974.

Attempts were made to locate the different gemsbok herds several times each week. Locating the animals was greatly facilitated by the use of radio telemetry equipment. Two animals were equipped with telemetry transmitters and released with others from Rock Rock to WSMR on April 25, 1973 (Table 1). With the aid of a tranquilizer

dart shot from a helicopter, four additional gemsbok of the established herd were captured on June 6, 1973 and equipped with transmitters.

The transmitters and receivers used were manufactured by Telonics Inc. of Mesa, Arizona. The lightweight transmitters, utilizing long life lithium-chloride batteries, were set on separate frequencies which enabled the identification of animals by the frequency of the signal received. Most signals were received with the use of a small hand-held directional "H" antenna (Figure 2) while standing on the roof of the vehicle. Later, as they became available during the study, three large 16 foot antennas were permanently mounted on 40 foot masts located at strategic points throughout the study area (Figure 3).

While the hand-held antenna proved satisfactory for most direction finding, the large antennas proved most helpful when the animals had changed their location significantly and moved out of range of the hand-held antenna. Radio reception varied considerably with the conditions of the transmitters and the receiver. The signal strength weakened in some transmitters and was attributed to moisture condensing within the waterproof housing of the collars. Reception of radio signals improved with the acquisition of a new model receiver late in the study. Reception was also greatly improved with any increase in elevation. On many occasions the maximum distance signals were received from less than one to five miles on level ground but up

Figure 2. Hand held "H" antenna.

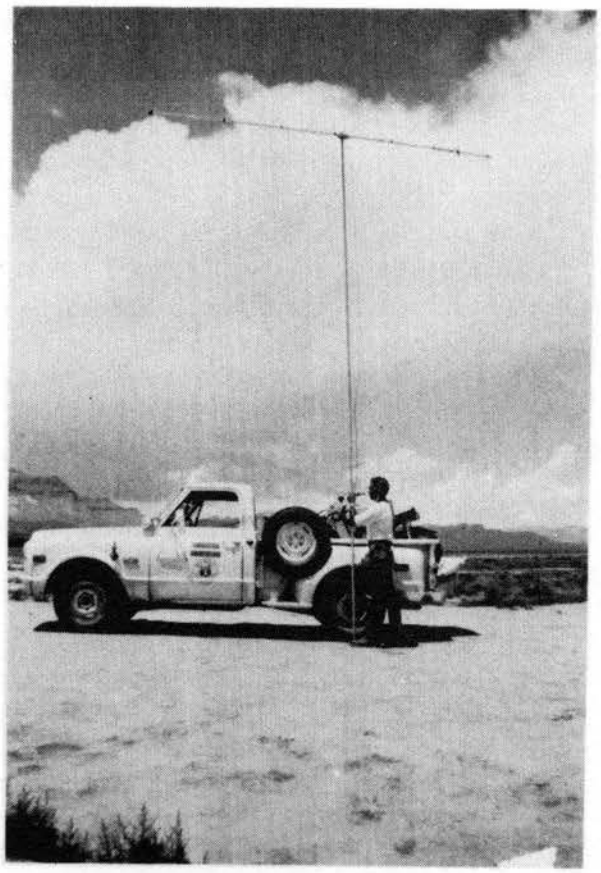

Figure 3. Sixteen foot "H" antenna.

to 25 miles from the top of Salinas Peak which is about 5,000 feet above the gemsbok habitats.

After gemsbok were located, either with the aid of telemetry equipment or by visual searching, direct observations were made with binoculars or a variable power telescope. Gemsbok were more wary of a man on foot stalking them among the sparse vegetation than of a man who remained in a vehicle in full view. For this reason most observations were made from within the cab of a pickup.

The information was recorded in field data sheets (Figure 4) to facilitate transfer to computer punch cards for analysis. Information recorded included date, time, weather, location (subsector and grid coordinates), habitat, classification of animals observed (numbers in each sex and age category), name and code number of identified individuals, behavior during the observation, and reference number. The latter item refers to expansion of specific details of noteworthy behavior which were transcribed from tape recorded notes taken in the field and recorded separately.

Identification of individual animals was facilitated by the use of color coded canvas collars which were attached to all animals released during the field study (25) and by the combination of facial and horn characteristics observed in many non-collared individuals. By these means, 60 individuals were identifiable during the field study.

GEMSBOK INVESTIGATIONS - WHITE SANDS

OBSERVER: ..... SHEET : .....

DATE : ..... SUNRISE: ..... SUNSET: .....

WEATHER : TEMP. : ..... WIND: ..... NEBULOSITY: .....

GENERAL : .....

Obs. No.	Time	Location	Habitat	AM	AF	YR	LB	UN	Ref. No.	Observation

Do Not Write In these Columns

Col. Nos.	Data
9-13	
14-15	
21-22	
23-24	
25	
26-27	
28-29	
30-31	
32-33	
34-35	
36-40	
21-22	
23-24	
25	
26-27	
28-29	
30-31	
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34-35	
36-40	
21-22	
23-24	
25	
26-27	
28-29	
30-31	
32-33	
34-35	
36-40	

Figure 4. Field data recording sheet.

An index to food habits of the gemsbok was determined by direct observation and by microscopic examination of fecal materials collected weekly during the field study. The laboratory analysis of the fecal materials was done by the CSU Composition Analysis Laboratory, Range Science Department under the supervision of Dr. R. M. Hansen, utilizing a technique developed by Baumgartner and Martin (1939). The technique was previously found to be a practical and economical index to foods composition of bighorn sheep (Todd and Hansen, 1972; Todd, 1972).

Fourteen vegetative line transects were conducted in habitats utilized by the gemsbok to determine composition and density using a standard technique developed for big game range analysis in New Mexico (U.S. Forest Service, N.M. Department of Game and Fish, U.S. Bureau of Land Management, undated). A collection of plants occurring in the study area was prepared for identification and future reference.

Reference maps for the study area were secured from White Sands Missile Range or were prepared in the field using existing topographic and planimetric maps.

Weather data for Jallen Site, WSMR, was secured from the Atmospheric Sciences Laboratory, White Sands Missile Range Headquarters.

CHAPTER II

STUDY AREA

Location

The White Sands Missile Range (WSMR) is an area of over two million acres (877,862 ha) administered by the Department of Defense in the heart of the Tularosa Basin of south central New Mexico (Figure 5). The study area is about 160,000 acres (64,777 ha) in size and in the central portion of White Sands Missile Range (Figure 6). It was divided into sectors and subsectors (Figure 7). It is about 23 (37 km) from north to south and 11 miles (18 km) east to west and lies within Sierra and Dona Ana counties, New Mexico. Rhodes Canyon Range Center, near the center of the study area, is about 62 miles (100 km) northeast of Las Cruces, New Mexico, and about 100 miles (161 km) north of El Paso, Texas. The geographic coordinates for Rhodes Canyon Range Center are 33° 12' North and 106° 28' West.

History

C. L. Sonnichsen (1972) in his history of the Tularosa Basin described the area as follows: "Tularosa, an appalling succession of volcanic rock, sparce vegetation, and the vast expanse of gypsum known as White Sands, was the last frontier in the continental United States. Its tumultous history has seen great cattle ranchers pitted

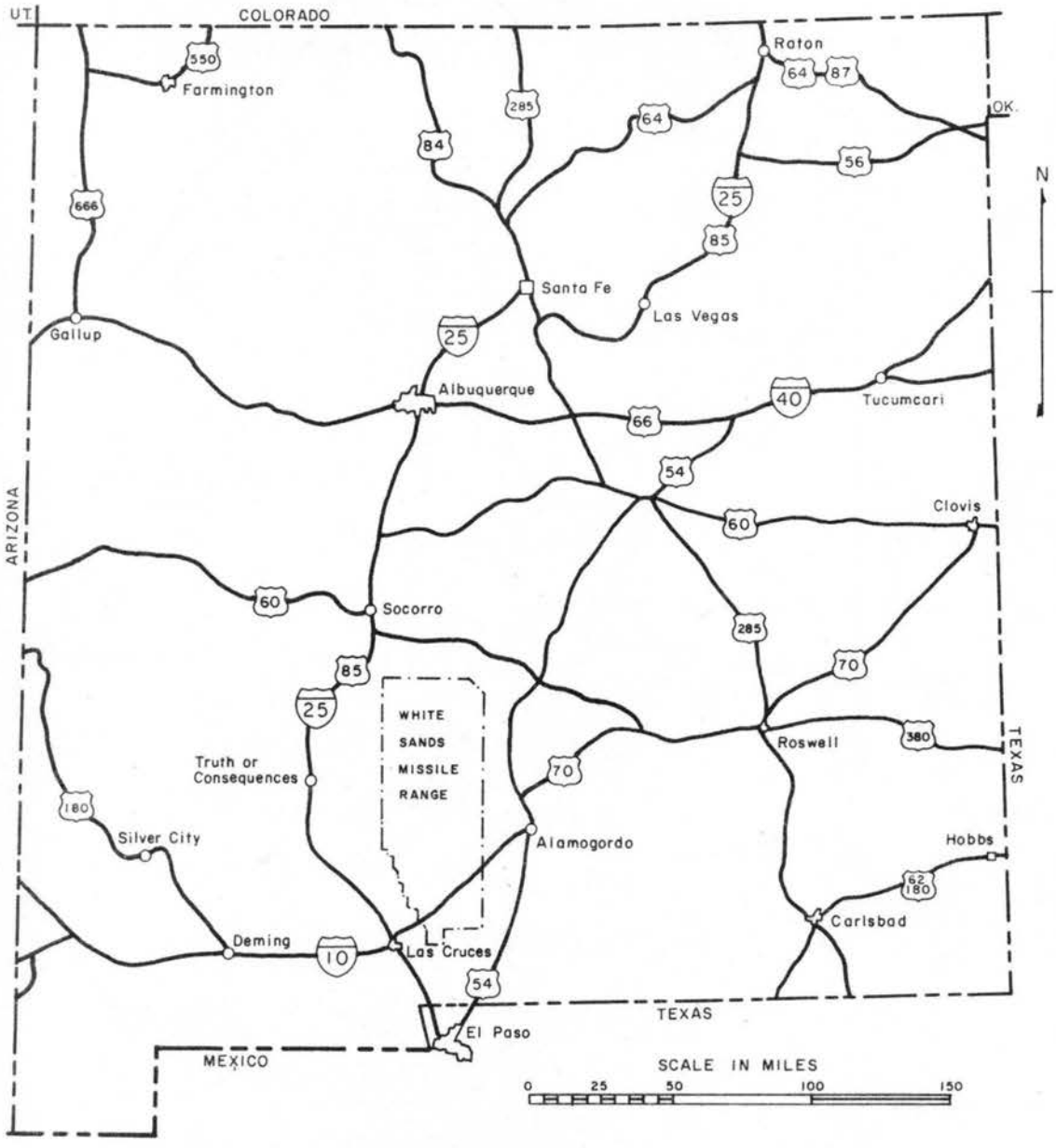

Figure 5. Map of New Mexico with WSMR.

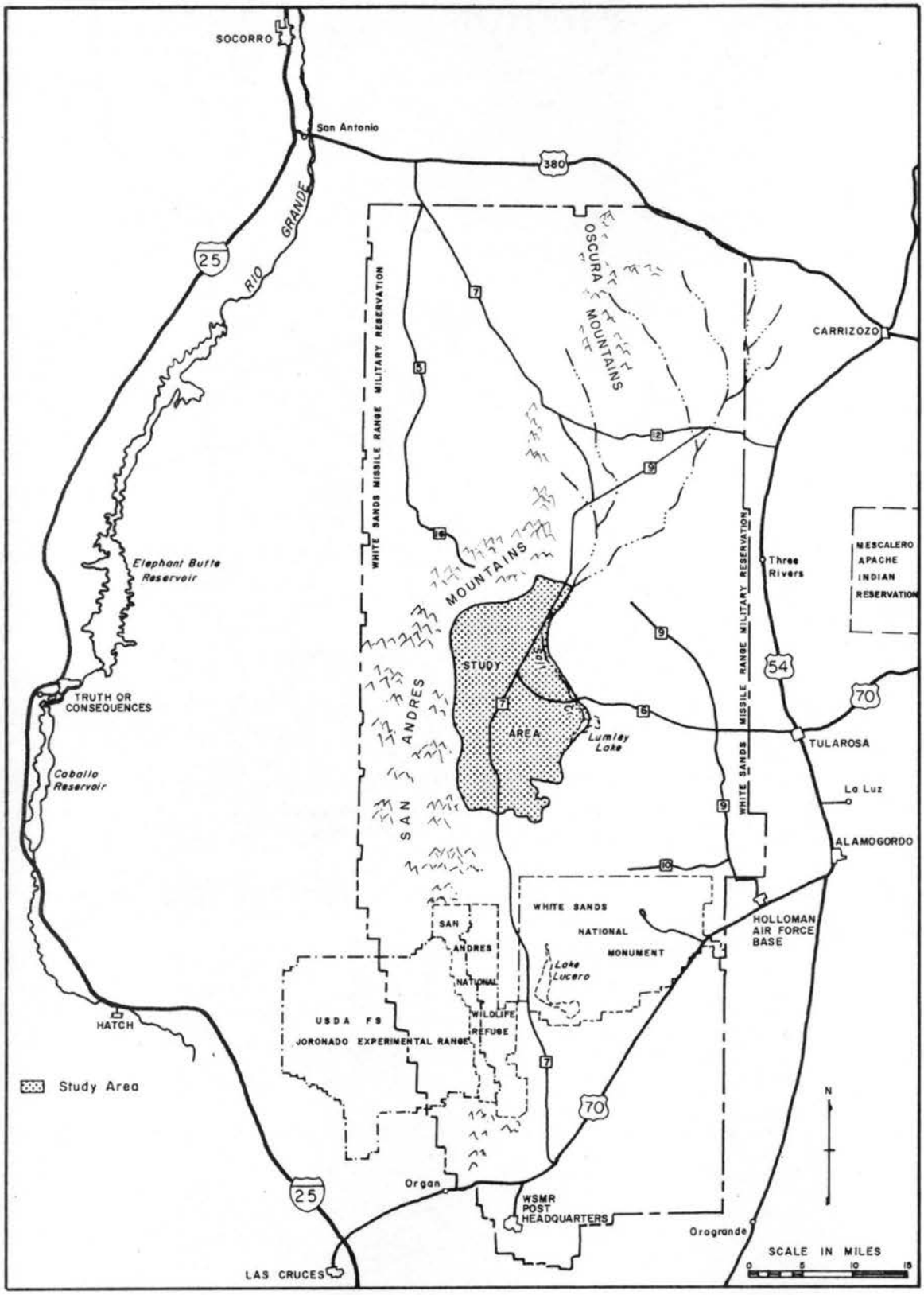

Figure 6. Map of WSMR showing study area.

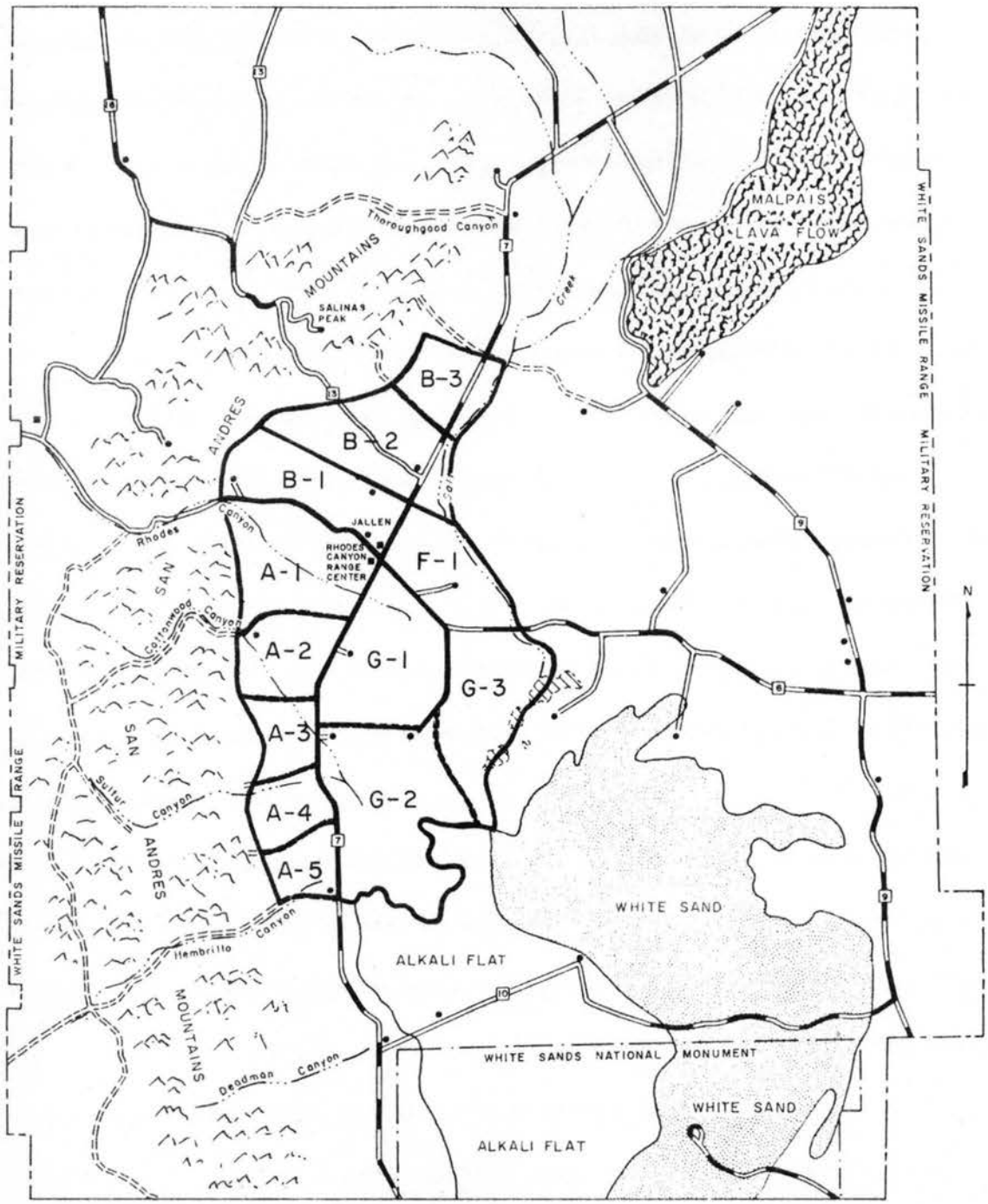

Figure 7. Map of the study area showing subsectors.

against daring rustlers; white men against Apaches; desperadoes against lawmen. In all the sun-scorched and sand-blasted reaches of the Southwest there is no grimmer region than the Tularosa Valley. Everything from cactus to cowman carries a weapon of some sort, and the only creatures who sleep with both eyes closed are dead."

The earliest inhabitants of the White Sands Missile Range area were Indians. Prehistoric Indian ruins and campsites are scattered throughout, particularly along the west slopes of the San Andres Mountains. Present day Mescalero Apache Indians from the adjoining reservation may be descendants of these earliest settlers. Spanish Conquistadores were the first white men to see the area during their search for riches. Legends persist today of a lost Spanish gold mine on the Missile Range.

Although there is controversy as to when the first white settlement occurred in the Tularosa Basin, one report is of a chapel built for the Indians by Franciscan missionaries at the town site of La Luz in 1719 (Pearce, 1965). The town of Tularosa later became the focal point of pioneer activity with its beginnings in the early 1860's (Sonnichsen, 1972). Today Alamogordo, population 31,000, is the major trade center for the immediate region. It is about 35 miles southeast of the study area.

The rugged mountain regions of White Sands Missile Range once served as sanctuaries for many notorious characters; among them

were Billy the Kid, Black Jack Ketchum, and Indian chiefs Geronimo and Victorio. Later, these regions were sites of numerous small mining operations; however, these were abandoned as sources of lead, talc, and other ores were depleted. Estes City (dates unknown) exists now as a small ghost mining town at the southern tip of the Oscuro Mountains.

The first permanent settlements on the Missile Range were made by early homesteading ranch families in the 1880's. Eugene Manlove Rhodes, foremost among western novelists, had his ranch headquarters and is buried at the head of the canyon which now bears his name. Ruins of the ranch headquarters of W. G. Rich, former territorial governor of New Mexico, still stand within the study area. To the south are the ruins of Pat Garret's ranch, the man who shot and killed Billy the Kid.

The original Tularosa Basin vegetation was reputed to have been productive range land supporting some herds of pronghorn antelope. However, the delicate balance required for climax desert vegetation did not exist for long after the invasion of herds of domestic livestock. In 1889, more than 85,000 head of livestock were gathered from the area, and a three-year drought set in the following year, far too heavy a burden for the vegetation (Sonnichsen, 1972). Creosotebush, mesquite, and low forage value grasses invaded areas which once produced grasses dense enough to mow as hay by ranchers. The damage was

not only complete but irreversible. At about the same time came the disappearance of the native Mexican pronghorn antelope throughout most of its range (Baily, 1971).

Although much of the area became marginal for the production of livestock, ranching persisted until 1945. Then it became the White Sands Proving Grounds (later called White Sands Missile Range) when the Army Ordnance Department saw a need for a large tract of land for use as a flight test area for guided missiles. On July 16, 1945, history was made in the area when the world's first atomic explosion took place at what is now called Trinity Site in the north end of the Range.

Construction for missile testing began that same month on 27,000 acres (10,931 ha) of military owned land and 1.7 million acres (688,258 ha) of other land under co-use lease agreements. In 1950, the military rescinded the co-use leases on the range proper and placed the land under their exclusive control. On August 19, 1953, the Secretary of Defense declared that all lands within the range proper were to be under the command, management and operational responsibility of the Department of the Army. At about the same time all federal lands within the range proper, with the exception of the White Sands National Monument, the Joronado Agricultural Experimental Range, and the San Andres Wildlife Refuge, were withdrawn for military use. Land under the exclusive control of White Sands Missile

Range then totaled 2,026,100 acres (820,283 ha) (Post Engineers SWMR 1970).

Ownership

The ownership of the lands contained within White Sands Missile Range and the study area were and remain diversified. Ownership remains mostly with the federal government and the State of New Mexico. Lands within the entire Missile Range include:

Public Domain	1,494,145 acres (604,917 ha)
Portions of White Sands National Monument	142,639 acres (57,749 ha)
Portions of Joronado Experimental Range	42,150 acres (17,065 ha)
San Andres National Wildlife Refuge	41,272 acres (16,709 ha)
Military Land	26,783 acres (10,843 ha)
State Land	348,743 acres (141,191 ha)
Private Land	71,077 acres (28,776 ha)

The White Sands Missile Range has two primary missions: to operate a national missile range and to test and evaluate Army missiles and rockets. No large scale changes in mission or land requirements are anticipated (Post Engineers WSMR, 1970).

Topography and Geology

The gemsbok study area occurs just below the San Andres mountain slopes to the west and above the Tularosa Basin floor to the

southeast (Figure 6). Elevations range from 4,100 to 5,000 feet. The land is gently undulating to rolling with a gradual slope down towards the east.

The Tularosa Basin abounds in interesting geologic features; however, none exist within the study area. The San Andres mountains form the west boundary of the study area. A section of Paleozoic sedimentary rock is exposed here unrivaled in New Mexico in length of continuous outcrop and completeness of time-lithlogic units (Kottlowski et al., 1956).

To the southeast of the study area are extensive white sand dunes of nearly pure gypsum crystals from which the Missile Range and National Monument get their names. The dunes are derived from wind blown sand from a nearby relic lake bed. To the northeast of the study area is a lava flow entering the Range from the northeast. The flow consists of angular blocks of basalt rock deposited up to 65 feet above the adjacent land surface (U.S. Department of Agriculture, 1970).

Soils

A reconnaissance soils and vegetation inventory of White Sands Missile Range was prepared for Post Headquarters by the USDA Soil Conservation Service in 1970. A detailed description of these soils is given in the USDA report (U.S. Department of Agriculture, 1970). Major soils occurring within the study area include the following:

Nickel-Tencee Association, Mimbres-Glendale Association, Marcial-Ubar Association, Mead Association, and Tul-Holloman Association.

These soils originate primarily from alluvial deposits. They are usually high in gypsum content and mostly well drained. Textures vary from fine to coarse and soil depths range from shallow to deep. Rock occurs closer to the soil surface on the west side of the study area near the mountains. Soils vary from slightly saline to strongly saline and from slightly calcareous to strongly calcareous. The pH's range from 7.9 to 9.0.

Weather

Weather information was collected at Jallen Site just west of Rhodes Canyon Range Center and nearly in the center of the study area. Further comparisons between this area and the gemsbok's native habitat are presented in Chapter VI.

Precipitation

The mean annual precipitation at Jallen Site is 8.31 inches (211 mm) per year; over 50 percent occurring from July through September and nearly 75 percent from June through October. The average monthly precipitation is listed in Table 2. Precipitation at Jallen Site is representative of the study area; however, local variations do occur and annual amounts are highly variable. Rainfall often occurs in short intense storms. Snowfall seldom exceeds a few inches in midwinter and is usually melted by the day following the storm.

Table 2. Average monthly precipitation. Jallen Site WSMR, 1967-1973.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
in	0.26	0.34	0.14	0.07	0.37	0.77	1.82	1.50	1.07	0.98	0.44	0.55
mm	.66	0.86	0.36	0.18	0.94	1.96	4.62	3.81	2.72	2.49	1.12	1.40

Precipitation during the period June 1972 through March 1973 was 178 percent the mean for that same period. Vegetation present on the study area during the spring of 1973 reflected this increase in moisture.

Temperature

The temperature pattern is typical of southwest desert climates with wide daily variations, often as much as 50°F (10°C) in 24 hours. Fluctuations as great as 10°F (6°C) in less than 30 minutes were recorded while making gemsbok observations. The most rapid changes occurred near sunrise and sunset.

A frost free season of 250 days normally occurs at WSMR Headquarters with the average last and first frost occurring on March 14 and November 20 respectively. Monthly temperature extremes and means for Jallen Site are shown in Table 3.

Wind

A salient feature of the weather is the dry and often gusty winds. Velocities up to 52 mph (84 kilometers per hour) have been recorded at Jallen Site and as high as 120 mph (193 kilometers per hour) at WSMR Headquarters. Winds may occur as light winds with occasional high gusts, whirlwinds, and sometimes as constant high winds of more than 24 hour duration. The average wind velocity at Jallen Site is 5.1 knots. April is the windiest month. A summary of wind data collected at Jallen Site is presented in Table 4.

Table 3. Monthly mean minimum and maximum temperatures and the highest and lowest daily temperatures by month. Jallen Site, WSMR, 1968-1974.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					Mean Maximum Temperature						
55[a]	60	74	80	86	92	95	91	85	76	64	55
(13)[b]	(16)	(23)	(27)	(30)	(33)	(35)	(33)	(29)	(24)	(18)	(13)
					Mean Minimum Temperature						
25	29	35	44	53	61	68	65	57	46	34	27
(-4)	(-2)	(2)	(7)	(12)	(16)	(20)	(18)	(14)	(8)	(1)	(-3)
					Highest Daily Temperature						
76	81	89	98	98	105	106	106	98	90	79	76
(24)	(27)	(32)	(37)	(37)	(41)	(41)	(41)	(37)	(32)	(26)	(24)
					Lowest Daily Temperature						
-2	5	7	22	30	43	58	50	37	28	16	7
(-19)	(-15)	(-14)	(-6)	(-1)	(6)	(14)	(10)	(3)	(-2)	(-9)	(-14)

[a] Fahrenheit.

[b] Centigrade.

Table 4. Average hourly wind speeds in knots, prevailing directions, and strongest gust, 1963-1967, Jallen Site, WSMR.

Hour (military time)											
02	04	06	08	10	12	14	16	18	20	22	24
Average Hourly Wind Speed (knots)											
3.9	3.6	3.4	3.8	4.9	6.1	7.2	7.4	6.4	5.3	4.6	4.2
Prevailing Directions											
N	N	N	NNE	S	S	S	S	S	WNW	W	N
Strongest Gusts, with Directions											
38	36	42	38	42	45	49	52	47	50	44	49
SW	SSW	SW	SW	SW	SW	SSW	WSW	WSW	SW	SW	WSW

Humidity

The relative humidity is very low with the mean annual open pan evaporation rate in excess of 90 inches (229 cm). Average monthly relative humidity data recorded for White Sands Missile Range Headquarters is shown in Table 5.

Water

Permanent sources of fresh water are scarce throughout White Sands Missile Range and non-existent in the study area. The only permanent water source within the study area is Salt Creek. It flows from an alkali spring and forms most of the study area's eastern boundary. A chemical analysis of Salt Creek water is presented in Table 6. The sample was taken from an area about three miles upstream from the Range Road 6 bridge, a point where gemsbok have been observed to drink.

Other water sources occurring within the study area were temporary accumulations which occur after heavy rains, primarily in roadside ditches and abandoned construction pits. White Sands Missile Range's Facilities Engineers had started repairs on a few old earthen dams in the study area to collect flood water for wildlife use; however, their effectiveness in holding water and use by the gemsbok have not yet been observed. Facilities Engineer personnel stationed at Rhodes Canyon Range Center have also maintained a small watering tub at the

Table 5. Monthly mean relative humidity at WSMR Headquarters, 1950-1969.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% saturation											
46	39	36	26	24	27	43	43	41	34	41	46

Table 6. Chemical analysis of a water sample from Salt Creek, WSMR, N. M.*

1.	Chlorides (as NaCl)	9,550 mg/l
2.	Sulfates	4,700 mg/l
	phth alkalinity	10 mg/l
	total alkalinity	160 mg/l
3.	Hydroxides	0 mg/l
4.	Carbonates = 2 phth	20 mg/l
5.	Bicarbonates = total - 2 phth	140 mg/l
6.	pH	8.4

*Sample collected January 1, 1974 and analyzed by Fishery Science Laboratory, N. M. S. U.

installation which received some light gemsbok use as described in the chapter dealing with watering behavior.

Vegetation

The vegetation within the study area is typical of southwestern semi-desert shrubland and semi-desert grassland. Creosotebush (Larrea tridentata) dominates most sites except the open areas which are dominated by sparse stands of dropseed grasses (Sporobolus spp.). A partial list of plant species found on WSMR (USDA SCS, 1970) is presented in the Appendices.

Twelve vegetation groups were mapped and described by the USDA Soil Conservation Service in the Soils and Vegetation Inventory of the White Sands Missile Range (USDA SCS, 1970). A description of these vegetation groups can be found in detail in their study. Map, Figure 8, shows five major vegetation types found in the study area and the surrounding vicinity. This map is derived from the grouping of some types described in the USDA study (U.S. Department of Agriculture, 1970).

Two areas received high gemsbok use during the field study, one during summer and the other during mid-winter. These were mapped by the author to finer detail and vegetation analysis by transects conducted in both types. A discussion of these areas is presented in Chapter V under Habitats.

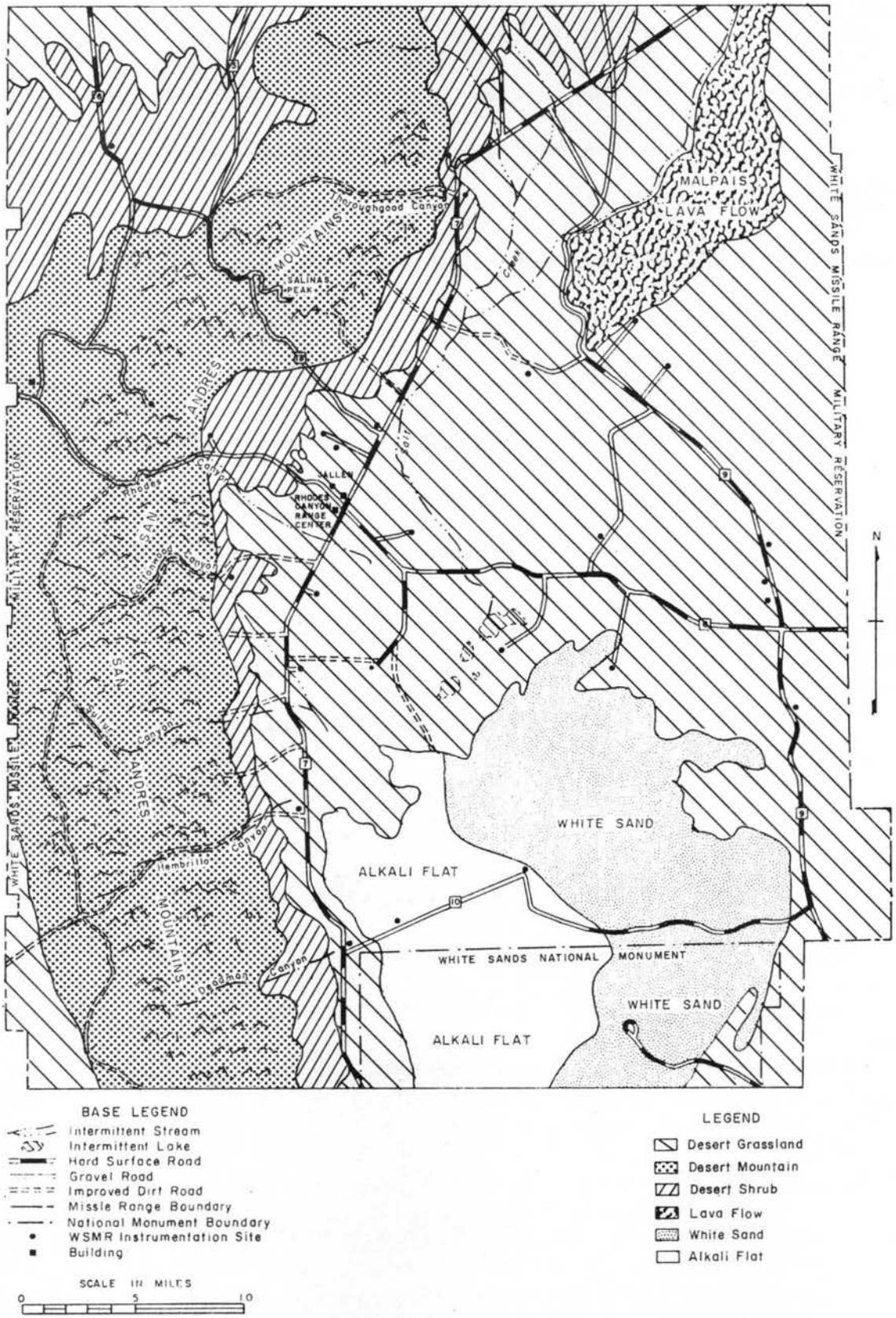

Figure 8. Map of the study area and vicinity showing major vegetation types.

Fauna

Forty-seven species of mammals, 212 species of birds, and 30 species of amphibians and reptiles have been reported on either the San Andres National Wildlife Refuge (U.S. Department of the Interior, 1968, 1965) in a mountain habitat or on the White Sands National Monument (U.S. Department of the Interior, 1973) in a basin habitat. A composite list is presented in the Appendices. Both of these areas occur within the boundaries of White Sands Missile Range and represent most faunal species likely to be encountered in or near the study area. The only large mammals besides gemsbok which were observed frequently within the study area were the feral horses (Equus caballus) and coyotes (Canis latrans). An estimate of the number of feral horses present on White Sands Missile Range was 150 to 200 head during the spring of 1974. Most of the horses occurred northeast of the study area.

Large mammals observed rarely in the study area include mule deer (Odocoileus hemionus) and bobcats (Lynx rufus). Although a marginal population of pronghorn antelope (Antilocapra americana) exist on the Missile Range, none have been observed or reported on the study area in recent years. The present major ranges of the pronghorn on the Missile Range are to the east and west of the Oscuro Mountains on the northern part of the Range, and to the west of the San Andres Mountains on the western part of the Range (personal

communication May 15, 1974, Tom Emanuel, Range-Wildlife Technician, WSMR). George Morrison, White Sands National Monument Park Naturalist, also reported a small herd of five to six head near the south boundary of White Sands National Monument in 1974. Several attempts were made up to 1963 by the New Mexico Department of Game and Fish to transplant pronghorn antelope to the study area. The pronghorn failed to become established on the study area and appeared to have moved to more favorable habitats.

CHAPTER III

GEMSBOK TAXONOMY AND DESCRIPTION

Taxonomy

The gemsbok (Oryx gazella) is an African antelope in the order Artiodactyla, family Bovidae, and the genus Oryx. Walker (1964) lists four species in this genus and their distribution as follows:

> "O. leucoryx, the oryx of Arabia and Iraq; O. tao, the scimitar-horned oryx of the Libyan and Sahara deserts; O. beisa, the beisa oryx of eastern Africa; and the type species of the genus O. gazella, the gemsbok of southern Africa. Most species now exist only locally and are rare as they have been hunted intensively; although the biesa is still fairly abundant in parts of Kenya, and the gemsbok is still common in the Kalahari."

There appears to be little controversy as to the taxonomy of the gemsbok, Oryx gazella, the largest and most vividly marked member of the oryx group which was released in New Mexico. However, there is some dispute concerning the classification of the other three members of the genus. Lydekker (1966), Walker (1964), and Shortridge (1934) all recognized each type as a separate species, while Roberts (1951) divided the genus into two species, Oryx gazella and O. biesa (with subspecies). Grzimek (1972) combined all oryx types into only one species classification, Oryx gazella, with each type being classified as subspecies of this; the gemsbok being O. gazella gazella.

Height and Weight

Shoulder heights of 12 tranquilized gemsbok were taken at Red Rock while capturing for a release on WSMR (Table 7). These measurements are comparable with gemsbok from Africa (Shortridge, 1934; Roberts, 1951; Lydekker, 1966) for the same sex and age class.

The average weight of eight adult female gemsbok released to WSMR was 479 pounds (216 kg). At least six of these cows were pregnant. The average weights of five adult gemsbok bulls taken during the first hunt on WSMR in December 1974 was 447 pounds (201 kg) live weight, and 318 pounds (143 kg) dressed weight.

Pelage and Horn Length

Gemsbok are generally sandy-grey in color. Sometimes they appear more sandy or grey under different intensities of light. The face, legs, undersides, and rump are vividly marked with black and white. The head is generally white with a black nasal patch, black between the bases of the horns, and a black eye stripe. In some individuals the black nasal patch is continuous with the black between the base of the horns; in others it is interrupted and the white is continuous between the eyes (Figure 9). The black eye stripe varies in length among individuals. In some cases it does not reach the eye while at the other extreme it may continue past the eye and up to the base of the horn (Figure 10). Combinations of these patterns along with horn peculiarities proved valuable in identifying individual

Table 7. Average shoulder heights of 12 gemsbok released at WSMR, April 25, 1973.

	Number	Mean Shoulder Height	Range
Males	10*	47.4[a] (120.4)[b]	41 - 54 (104)-(137)
Females	2	45.0 (114.3)	45 (114.3)
Combined	12*	47.0 (119.3)	41 - 54 (104)-(137)

*Included four young males bordering on adult age class.

[a]Inches.

[b]Centimeters.

Figure 9. Facial characteristics, nasal patch. Black nasal patch connecting to the black between the base of the horns (A), and black nasal patch not connecting to the black between the base of the horns (B).

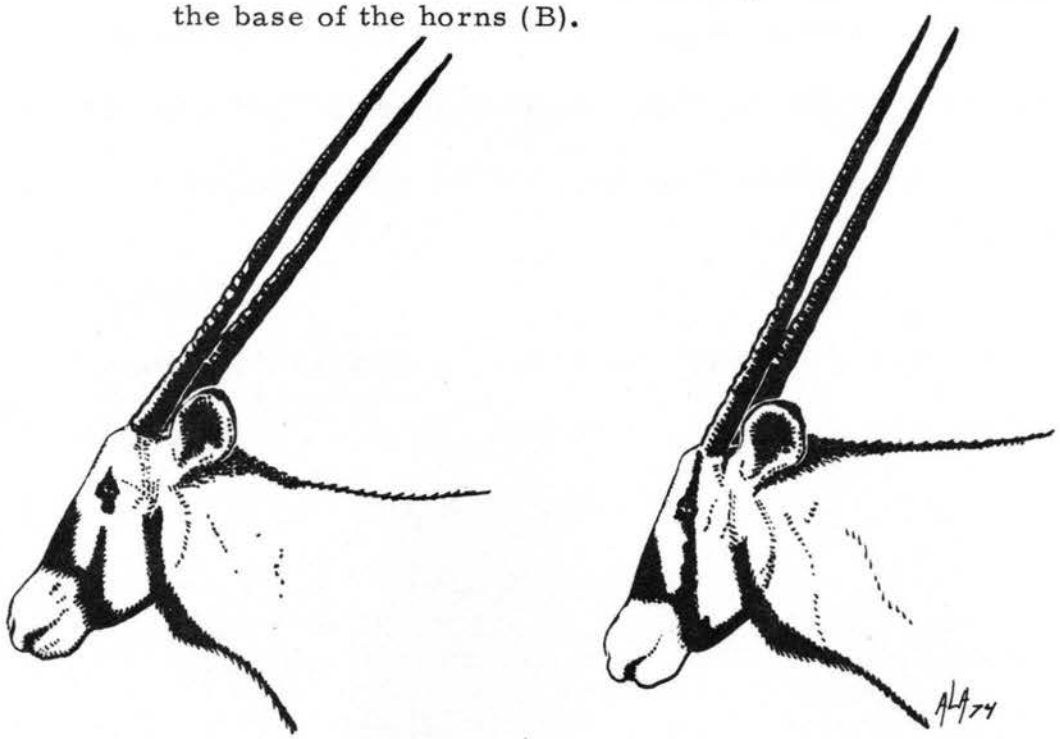

Figure 10. Facial characteristics, eye stripe. Black eye stripe extending only part ways up the side of the face (C), and black eye stripe extending to the base of the horn (D).

animals. While these vivid markings appear to lack camouflage properties, the opposite was found to be true. They served to break the outline of the face and body when the animals were standing in the shade of brush.

Horn length is usually longer among females than males. The reason is not certain, but Shortridge (1934) suggests horn wear by males. At WSMR bulls were observed to spar more frequently than cows and to vigorously rub their horns against available suitable vegetation. A summary of horn lengths of gemsbok released at WSMR is presented in Table 8. These and the horn lengths of African gemsbok compare closely (Shortridge, 1934). Ward (1973) reported the longest gemsbok horn recorded to be 48 inches (122 cm). Horn growth measured on three bulls taken during the first hunt (December 28, 1974) since their release to WSMR (April 25, 1973) ranged from 4 inches (10 cm) to 11 inches (28 cm) during 1 year and 8 months.

Sex Determination

There is little dimorphism between sexes in gemsbok. The only sex determinant of gemsbok in the field was the penis sheath of the bulls (frontis piece). While horn lengths of bulls are generally shorter than those of the cows (and at the same time being heavier at the base), it was not found to be a satisfactory method of sex determination.

The size of the penis sheath varied among males. On young bulls it was a small button covered with white hair. On mature

Table 8. Average length of longest horn on 21 gemsbok released to WSMR, N.M., 1973-1974.

	Sample Size	Mean Length of Longest Horn	Range
Males	11*	33.0[a] (83.8)[b]	26.0 - 38.5 (66.0)-(97.8)
Females	10	37.6 (95.5)	34.0 - 40.0 (86.4)-(101.6)
Combined	21	34.7 (88.1)	26.0 - 40.0 (66.0)-(101.6)

*Includes four young males bordering on adult age class.

[a]Inches.

[b]Centimeters.

breeding males it was observed to be two to three inches long and the skin black, contrasting with the white hairs of the belly. The white hairs became increasingly sparse and longer nearer the tip of the penis sheath.

Sex determination was difficult when the animal was not standing broadside in the open to the observer. However, sex determination was made in most cases by the observer waiting patiently for the animal to assume the proper position. A spotting scope was necessary for accuracy.

Age Determination

Gemsbok calves mature rapidly and resemble adults at an early age. It was difficult to recognize distinct age classes. Three age classes were used: calf, subadult, and adult.

Calves were designated as those from birth until they had obtained the sandy-grey color of the adult at about 15 weeks of age. They were fawn colored with dark brown in place of the black markings of the adult (Figure 11). Horns appeared to grow about one inch per week and were blunt on the tips during this period. At approximately 10 to 12 weeks of age calves began changing to the sandy-grey color of the adults (Figure 12). This process was completed at about the fifteenth week of age. The calf then entered into the "Subadult" age class.

Figure 11. Six-week old gemsbok calf.

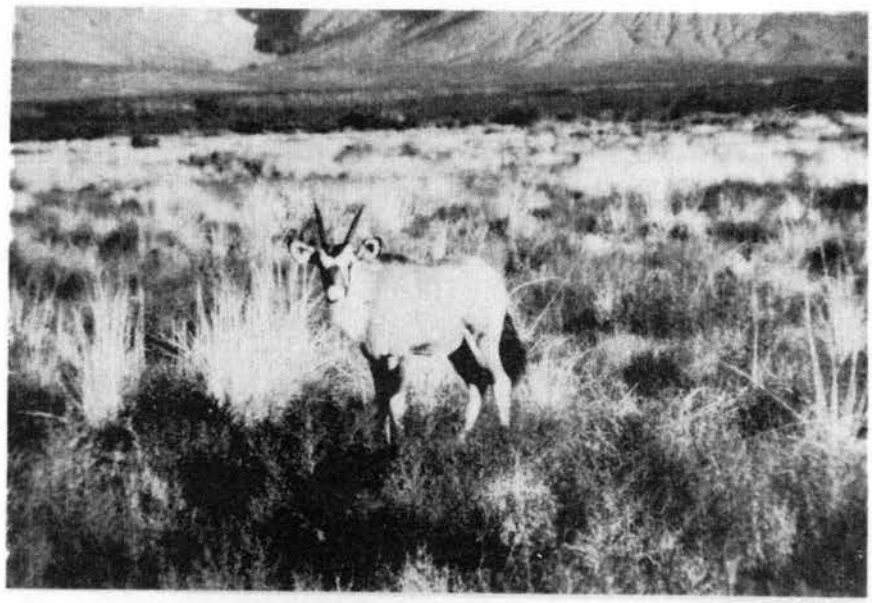

Figure 12. Ten to twelve-week old gemsbok calves (entering into subadult age class).

Subadults (Figure 13) fully resembled the adult in color; however, their sizes were smaller and their horns shorter. Due to this it was sometimes difficult to distinguish between subadults and adults unless one from both age classes was present and near each other. In such cases an examination of the rings near the horn bases was helpful (Figure 13). In subadults the rings were not developed well and were fewer in number, usually less than five.

With time subadults became increasingly difficult to distinguish from adults. The age when subadults became indistinguishable from adults appeared to vary among individuals. In some it occurred as early as eight months while in others as late as 15 months or more. At 18 months of age it appeared that all animals were distinguishable only as adults. No sexual activity was observed among subadult gemsbok.

Adults (Figure 14) were designated as animals which had achieved most of the body and horn growth and were characterized by well developed rings near the bases of the horns. They were then sexually mature and capable of reproduction.

Figure 13. Subadult age class gemsbok (this one estimated at eight months of age).

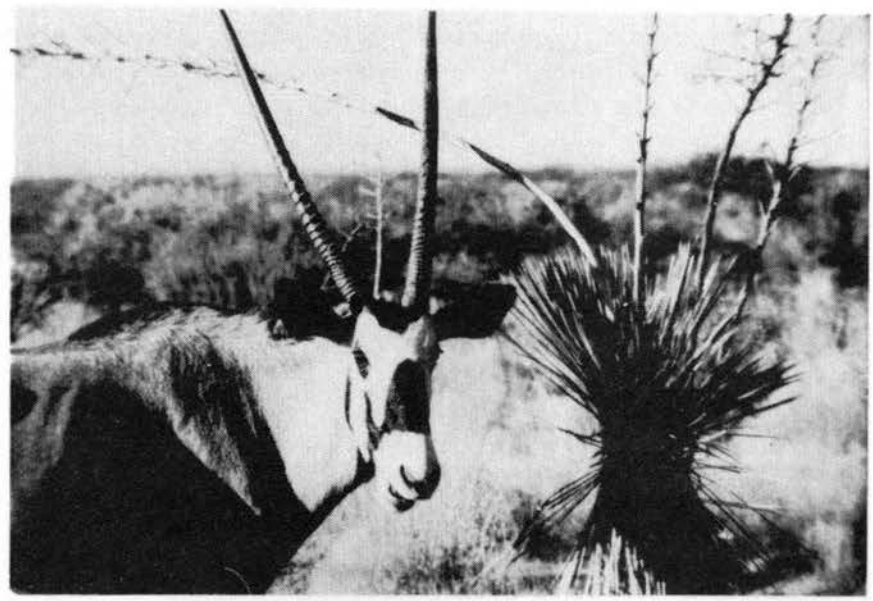

Figure 14. Adult age class gemsbok.

CHAPTER IV

BEHAVIOR

A review of gemsbok literature revealed little about their behavior and life history. Most of the available data consisted of observations by early hunters in Africa who, right or wrong, were quoted by later workers. No detailed studies of the gemsbok life history have been made.

Individual Behavior

Comfort

Gemsbok were often observed scratching portions of their body with their horns (either the tip or the edge of the shaft), their teeth, or sometimes their hooves. They were never observed to scratch or rub their bodies against bushes or other inanimate objects. Nor were they observed to engage in social grooming. When flies were present, they would wag their ears, shake their heads, or swat their backs with their tails or with their heads in a licking motion. After laying down for long periods, they were often observed stretching when standing up.

Inactivity Periods

During periods of inactivity gemsbok were observed to select a spot, often in the shade of a large bush, in which to lay down or stand

motionless. Occasionally, they would paw the ground before laying on that spot, but this was not the usual practice.

Gemsbok would lay down by first bending its front knees, dropping the front part of its body, then folding its hind legs up and underneath its body. Often a vigorous shaking of the tail occurred during the descent. Typically, the gemsbok would orientate its body with its back towards the sun. During periods of inactivity, animals were frequently observed chewing their cud.

Locomotion

The walk was the predominant method of locomotion. It was used while grazing and traversing terrain as the gemsbok appeared to be reluctant to run. They were observed to run only when alarmed by humans or when playfully chasing each other. Playful chasing seldom exceeded 100 yards of running. The gemsbok were not observed to run for the pure joy of running as is reputed among pronghorn antelope. While no footfall formulas or speeds have yet been measured for the gemsbok, it was estimated that their gates and speeds were similar to those of the domestic horse.

When feeding or leisurely walking in a group, gemsbok appeared to arrange themselves randomly. However, when running in flight, they traveled most often in single file, often with an adult cow as leader. A large, dominant bull was often the last individual in the fleeing herd.

Horn Rubbing

Adult gemsbok were frequently observed rubbing their horns against the branches of bushes. The species of bushes most often selected were mesquite (Prosopis juliflora), fourwinged saltbush (Atriplex canescens), yucca (Yucca elata), and less often creosotebush (Larrea tridentata). The rubbing consisted of the animal approaching a large protruding branch, placing its head with the branch between the horns, and vigorously raising and lowering its head while twisting its head from side to side. This caused the branch to rub against the portion of the skull between the bases of the horns and the inner edges of the horns.

The reason for such behavior was not clearly understood. Since the horns of gemsbok are true horn, they did not have to contend with the removal of velvet as do members of the Cervidae with their antlers. Possibly, the gemsbok were attempting to sharpen the tips of their horns, or maybe they were merely play-fighting with an imaginary foe. The reason why bulls often had slightly shorter horns than cows may possibly be due to their more aggressive and more frequent assaults on the bushes.

Vocalizations

The vocal sound made by the gemsbok heard most often was a wheezing noise which resembled a combination of a cough and a sneeze. It was often heard when they were casually feeding and was

made by both sexes. The sound did not appear to serve as an alarm. No reaction was ever observed among the other members of the herd when the noise was made.

During mating activity bulls often made low grunting noises while following close behind the cow.

George Hightower (personal communication, 1974), ranch foreman of Red Rock Wildlife Experimental Area, stated that cows at Red Rock were often heard calling to their calves and the calves responding with a "grunting" call. These vocalizations were most often heard in the late evenings and during the summer months. Such calling was not heard at WSMR.

No mating calls, alarm snorts, bugles, or other vocalizations were heard.

Defecation-Urination

Defecation among males, and both defecation and urination among females was preceded by lifting of the tail and spreading of the hind legs followed by a squatting of the hind quarters. Various degrees of squatting were observed. At times little or no squatting was seen, but occasionally the animals were observed to assume a deep squatting posture with their anal region nearly touching the ground. Grzimek (1972) also mentions this posture among defecating male gemsbok and Thomsons gazelle (Gazella thomsoni) in Africa. Urinating males were not observed to assume a squatting position.

Social Behavior

Daily Activity

Gemsbok typically were more active near sunrise and sunset and less active near midday. Seventy percent of 150 observations of gemsbok actively feeding occurred within 1.5 hours of either sunrise or sunset. Activity became more frequent near midday during the cool months. In the hot months gemsbok were more inclined to become inactive during midday and remain in the shade. During 101 observations where gemsbok were inactive, only one occurred within the 1.5 hours at sunrise or sunset. Gemsbok in Africa are reported to feed at night due to the higher moisture content of the forage (Taylor, 1969). They were not always observed to feed as a social unit. Sometimes only a portion of the herd fed while the others remained inactive, laying or standing motionless.

During periods of no activity, it was common for the herd to separate and select separate resting sites within the general area, but out of view of the other animals. Animals of the same age class usually stayed together. Calves were most often separated from their mothers, and on only two occasions was a calf observed near midday resting near its mother. As evening approached, the different age classes would rejoin and feed as a herd until dark. Calves would run up to their mothers to suckle.

Herd Size and Composition

The average herd size observed throughout the study was 6.28 animals. Herd sizes ranged from 1 to 31 animals. Solitary animals of either sex were common throughout the year (observed 102 times, or 22 percent of all observations). A summary of monthly average herd size is given in Table 9. During the months of September, October, and November slightly larger average herd sizes were observed. They were: 9.86, 10.55, and 9.25 respectively. This may be due to sampling error due to the frequent observance of one large herd during this period. Table 10 is a frequency distribution of the number of herds within each herd size range by month.

Herd size may be a function of population numbers. As the population of gemsbok increases at White Sands Missile Range, the average herd size may increase beyond those observed during this study. Shortridge (1934) mentions observing herds of gemsbok up to 300 to 400 head in South West Africa; however, generally smaller herds were seen.

The larger herds observed throughout the year at WSMR were composed of all sex and age classes; this was also reported in Africa (Shortridge, 1934). No tendency towards complete separation of any sex or age class from the rest of the herd during any season could be detected. Although separation of an age class did often occur, it was mostly temporary as in the case of daily activity. Small herds

Table 9. Average monthly Gemsbok herd size and ranges. WSMR, May 1973 - May 1974.

Month	Average Herd Size	Range	No. Observations
May, 1973	6.67	1 - 17	18
June	4.70	1 - 16	23
July	5.38	1 - 13	24
August	4.33	1 - 15	24
September	9.86	1 - 19	35
October	10.55	1 - 27	31
November	9.25	1 - 31	28
December	6.94	1 - 17	33
January, 1974	5.06	1 - 15	52
February	3.00	1 - 12	27
March	4.80	1 - 15	44
April	5.54	1 - 30	46
May	6.09	1 - 24	70
Yearly	6.28	1 - 31	455

Table 10. Frequency distribution of herds.

Month	Herd Size Range						
	1	2-5	6-10	11-15	16-20	21-25	26+
May, 1973	2[a] (10)[b]	8 (40)	6 (30)	2 (10)	2 (10)	0	0
June	9 (39)	8 (35)	3 (13)	1 (4)	2 (9)	0	0
July	4 (17)	12 (50)	4 (17)	4 (17)	0	0	0
August	10 (34)	12 (41)	6 (21)	1 (3)	0	0	0
September	4 (11)	10 (29)	4 (11)	6 (17)	11 (31)	0	0
October	3 (10)	10 (32)	6 (19)	4 (13)	2 (6)	4 (13)	2 (6)
November	3 (10)	8 (28)	8 (28)	6 (21)	1 (3)	1 (3)	2 (7)
December	7 (21)	10 (29)	8 (24)	7 (21)	2 (6)	0	0
January, 1974	16 (31)	15 (29)	15 (29)	6 (12)	0	0	0
February	10 (37)	13 (48)	3 (11)	1 (4)	0	0	0
March	11 (25)	19 (43)	10 (23)	4 (9)	0	0	0
April	14 (30)	15 (33)	10 (22)	3 (7)	1 (2)	2 (4)	1 (2)
May	13 (19)	23 (33)	22 (31)	9 (13)	2 (3)	1 (1)	0

[a]Number of herds.

[b]Percent of total.

composed entirely of subadult age class animals were sometimes observed alone for a few days, but they were also often observed with adults during the same period.

Response to Human Presence

The reaction of the gemsbok to an approaching human was often unpredictable. Generally, it seemed to correlate with the amount of previous exposure the animal(s) had to humans. Gemsbok that ranged in remote locations within the study area and rarely saw humans would often run upon first observing an approaching human. Those animals that were near areas where human contact was frequent, such as near Rhodes Canyon Range Center or a main road, would often not be frightened when first observing humans. They would stand motionless and watch curiously. If after a time the humans did not appear to pose a threat to the gemsbok, they would watch for a few minutes until it appeared that their curiosity became satisfied. Then they would resume their activity, appearing to ignore the human except for occasional glances in the human's direction, possibly to keep track of its location. Animals which were observed frequently, particularly those with radio transmitters and easy to locate, often became quite tolerant of human presence. This author has approached to within 20 yards on a few occasions, but never was I allowed closer.

Generally, gemsbok appeared less wary of a man in a vehicle in full view than of a man on foot. As long as they knew the human's

exact location and what he was doing, they would tolerate his presence. While attempting to approach the animals closely, this author usually obtained the best results by approaching at an angle while appearing to ignore their presence. They usually became more easily frightened if approached directly.

Reaction to Other Species

The only other large animals (except humans) within the study area exposed to the gemsbok were feral horses and coyotes. Feral horses were numerous on WSMR, but usually concentrated near alkali springs located to the northeast of the gemsbok concentration. When summer rains made water available, several small bands of horses would wander south and come in contact with the gemsbok. When gemsbok and horses were observed together, both species always appeared tolerant of the other's presence and would ignore each other except for occasional glances.

On one occasion a herd of horses walked within a few yards of a gemsbok bedded in the grass. The gemsbok remained resting, chewing its cud. On another occasion a small herd of gemsbok were traveling across a field to a water puddle and passed near a herd of grazing horses. As the gemsbok passed, one stopped and started to approach the horses. He took a few steps at a time, stopping occasionally as if to observe the reaction of the horses to his approach. The horses remained motionless, watching the gemsbok approach.

Slowly the gemsbok approached the nearest horse. He then extended his nose to that of the horse. The horse let out a loud snort causing the gemsbok to bolt back and run to catch up to the rest of his herd.

Coyotes were numerous throughout the study area. Generally, when coyotes came in contact with the gemsbok, both species appeared to tolerate the presence of the other. On several occasions during the summer, traveling coyotes were observed to pass through a herd of grazing gemsbok. At this time no reaction was observed between the two species except for occasional glances in the other's direction. However, during mid-winter, a completely different situation was observed. An attempt of predation by coyotes upon a newborn gemsbok calf was observed. The coyotes were not successful during the time of the observation because the calf was protected by the adult members of the herd. A more detailed account of this incident is discussed in Chapter V.

Agonistic Behavior

One form of agonistic behavior observed was that of "horn slapping." If one gemsbok of either sex approached another too closely, the offended gemsbok would display apparent anger by quickly dropping its head and drawing the chin against its body causing the forward edge of the horns to strike the other in a slapping movement. On many occasions contact failed, but near misses were usually sufficient to chase offenders away.

When one gemsbok of either sex approached another, one or the other was often observed to assume the "threat display." This consisted of the threatening animal standing erect with its head held high. The animal threatened was most often situated laterally (i.e., to the side) of the animal assuming the threat display. The threatening gemsbok would then rotate its head causing the tip of its horn to point towards the individual being threatened and would hold this position for a few seconds. This would often cause the threatened individual to bolt back and away from the potential danger of the threatening individual's horns. The gemsbok assuming the threat display would then return to its normal relaxed posture, apparently satisfied in his success of intimidating the other.

On some occasions, the threatened gemsbok would not bolt away but would continue to walk past the threatening gemsbok, appearing to ignore him. In this situation the gemsbok assuming the threat display would often whirl his body and head in an arc and with his horns lowered follow the other gemsbok as it walked by.

Gemsbok of either sex were observed to spar, but most often only with animals of the same sex. Sparring was observed during all seasons of the year. It consisted of two gemsbok approaching each other head on, dropping their heads, and interlocking their horns at the base followed by much pushing and twisting. On some occasions one or both individuals would drop to their knees in an apparent

attempt to bring the head and horns as low down as possible to gain an advantage. If sparring was prolonged often both would stop and rest for a few seconds and then continue.

The length of the sparring sessions varied from a few seconds to nearly half an hour. Sparring matches ended when the individual losing the advantage bolted away to a safe distance. The victor would then stand in a relaxed position. Sparring matches were repeated several times during periods of activity until the defeated individual no longer accepted challenges. It then would move to another location in the herd. Sometimes the victor would continue to approach, assuming the threat display and attempt to spar again. The defeated gemsbok would often bolt and run. Sometimes the victor would chase the defeated a short distance but was never observed to chase the defeated completely away from the herd area.

While the reasons for sparring are not completely understood, it is believed to play an important part in the determination of relative dominance within the herd's hierarchial system. The male within a herd which was often observed to perform most of the breeding was believed to be the most dominant. The most dominant individual, whether male or female, had the choice of the best resting areas in the shade.

Reproductive Behavior

Mating Behavior

Behavior which resembled a mating ritual was observed during all seasons of the year; however, it may only have been an expression of dominance on some occasions. It consisted of a bull closely following a cow as she walked and fed. The bull often made a deep, low, grunting sound. If a subdominate bull approached the cow, the dominant bull would quickly charge, chasing him to another part of the herd.

Prior to actual mounting, the bull would often lift and drop one of his forelegs near the hind legs of the cow. This "foreleg kick" was also mentioned among gemsbok by Walther (1961) and among several species of gazelles (Gazella spp.) by Grzimek (1972). Giest (1971) describes a similar "front kick" among bighorn sheep in North America. Walther (1961) also mentions the "mating-whirl-round", in which the male and female stand side by side and head to tail, then whirl around each other several times. This was not observed at WSMR. A distinct stiffening of the tail of the bull was seen. The bull would then attempt to mount, only to have the cow, in most cases, walk forward causing the bull to slip off her back. The bull would then patiently remain standing close to the posterior of the cow as she fed, occasionally feeding himself. He would frequently attempt mounting the cow in a similar manner during the activity period. Sometimes the cow would stand and allow for successful copulation.

Throughout the year bulls were frequently observed to assume the "lip curl" (Giest, 1971) upon smelling the urine of a female. This consisted of the bull raising his head, curling his upper lip, and sometimes waving his head from side to side for a few seconds.

Gestation

No accurate measurements of the gestation periods have been recorded at WSMR. Gestation periods of captive gemsbok ranged from eight months (letter dated June 22, 1964 from John P. Roth, Curator, Rio Grande Zoo, Albuquerque, N.M.) to nine months (Labuschagne, 1963).

Calving Season

Newborn calves were observed at WSMR during all seasons of the year, but significantly more (16 of 21) were observed during or near March. At least 21 calves were born during this study, and several subadults were observed which were believed to have been born near March of the year preceding the study. Table 11 shows the estimated number of calves born each month during the study. This data is subject to error because it was often difficult to establish the exact month of birth of a calf. Many calves were not observed for the first time until they were already a few months old. Also, although calves were often observed, it was difficult to get an accurate count of the number of different calves due to their movements and similarity of appearance.

Table 11. Estimated number of calves born during each month. May 1974 - May 1974, WSMR.

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2	0	2	0	0	1	0	0	2	4	9	3	0

Homosexual Behavior

Instances of apparent homosexual behavior were frequently observed between gemsbok bulls during the periods August through November 1973. This behavior too may have been an expression of dominance rather than true homosexual behavior. In all instances it involved the same young bull which was the recipient of attention from other adult bulls in the herd. Behavior observed was similar as that described for heterosexual mating activity, with the most dominant bull chasing away other bulls as he remained close to the posterior of the young bull. The young bull which was the recipient of the other bulls' attention was a subadult nearing the adult age class limit. He was estimated to be between one and two years of age. No other homosexual activity was observed. After November 1973 this bull was not observed engaging in behavior which resembled homosexual activities. In fact, he was observed in February 1974 assuming the dominant position over another bull during a sparring session.

CHAPTER V

ENVIRONMENTAL FACTORS

Habitat Preferences

Gemsbok at WSMR were observed throughout the year using a variety of habitats which ranged from rocky slopes of the foothills to barren alkali flat. They were observed more frequently and in greater numbers at all seasons in areas having the following factors:

a. flat to gently undulating topography

b. non-rocky soils

c. interspersed vegetation consisting of semi-desert shrub and grass species.

The species of shrubs occurring most frequently in the preferred habitats were combinations of the following: creosotebush (Larrea tridentata), mesquite (Prosopis juliflora), soaptree yucca (Yucca elata), fourwinged saltbush (Atriplex canescens), tarbush (Flourencia cernua), Mormon tea (Ephedra trifurca), and broom snakeweed (Gutierrezia sarothrae). Creosotebush is abundant throughout the study area and was the shrub species most often associated with the presence of gemsbok.

An index to habitat preference was determined by computing the minutes of animal use in each habitat. "Minutes of animal use" was

the number of minutes a herd was observed in a habitat multiplied by the number of animals in the herd. During the period November 1973 through January 1974 more observations were made in habitats dominated by mesquite. There were 79 percent of the total minutes of use (48,913) recorded in the mesquite habitats during these months as opposed to only 12 percent of the total minutes of use (160,141) in this habitat during all other months combined.

The greater use may not imply an importance of mesquite dominated habitats during the mid-winter months, since only one large herd was observed frequently during the winter in this type. However, it may reflect a preference of this type by the gemsbok since mesquite bean pods became most available then, and gemsbok appeared to prefer them for food (see food habits section).

Preferred Summer Habitat - 1974

Subsector A-1 received consistently high gemsbok use except during the winter period, November 1974 through March 1975. Five major habitat types and locations of gemsbok sightings (without regard to the number of animals sighted) are shown in Figure 15. Seven vegetative transects were run in these types with locations shown in Figure 16. Results of these transects for each of the five major habitat types are shown by vegetative form class in the Appendices.

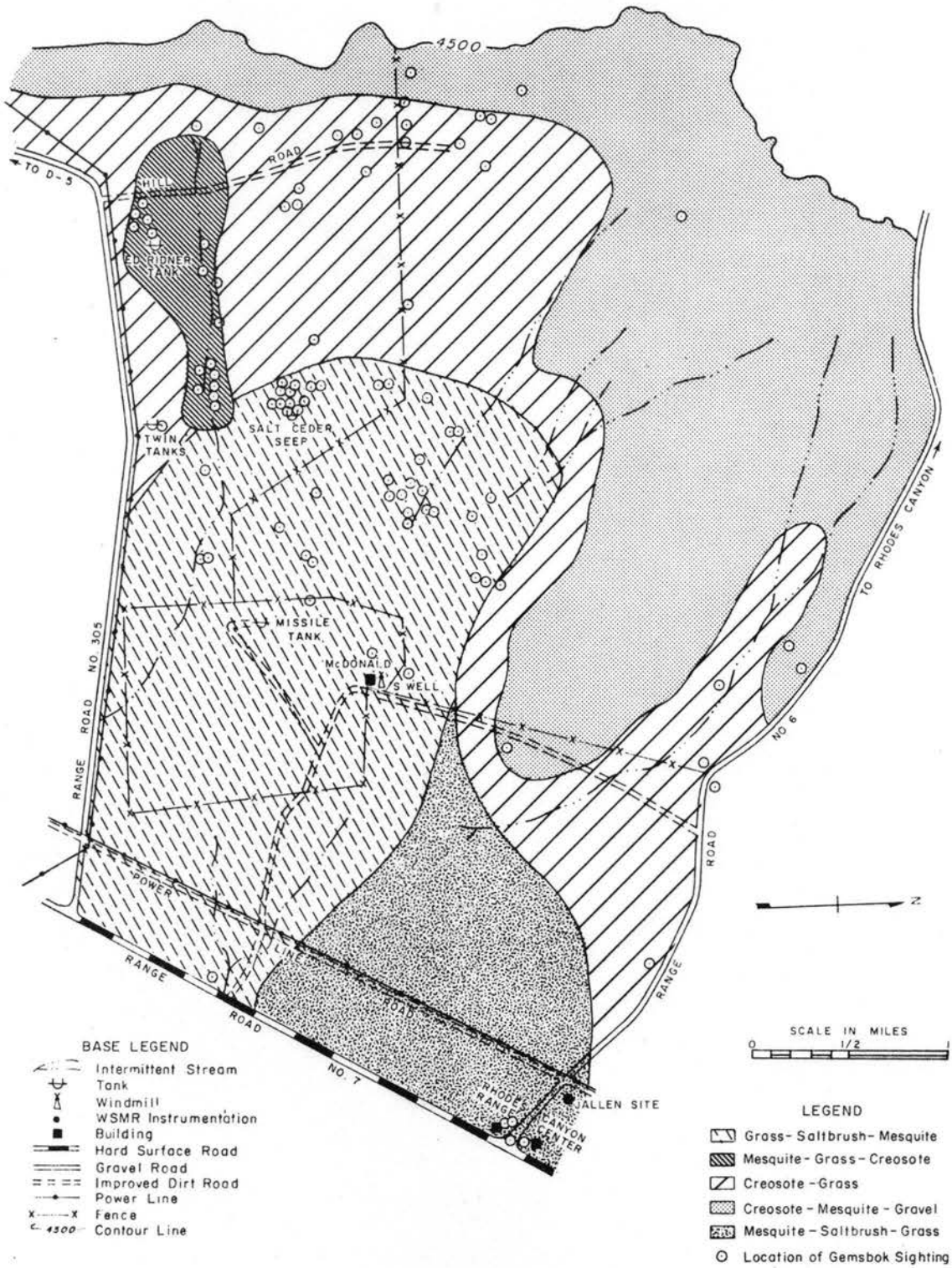

Figure 15. Map of subsector A-1 showing habitat types and locations of gemsbok sightings, May - October 1973 and April - June 1974.

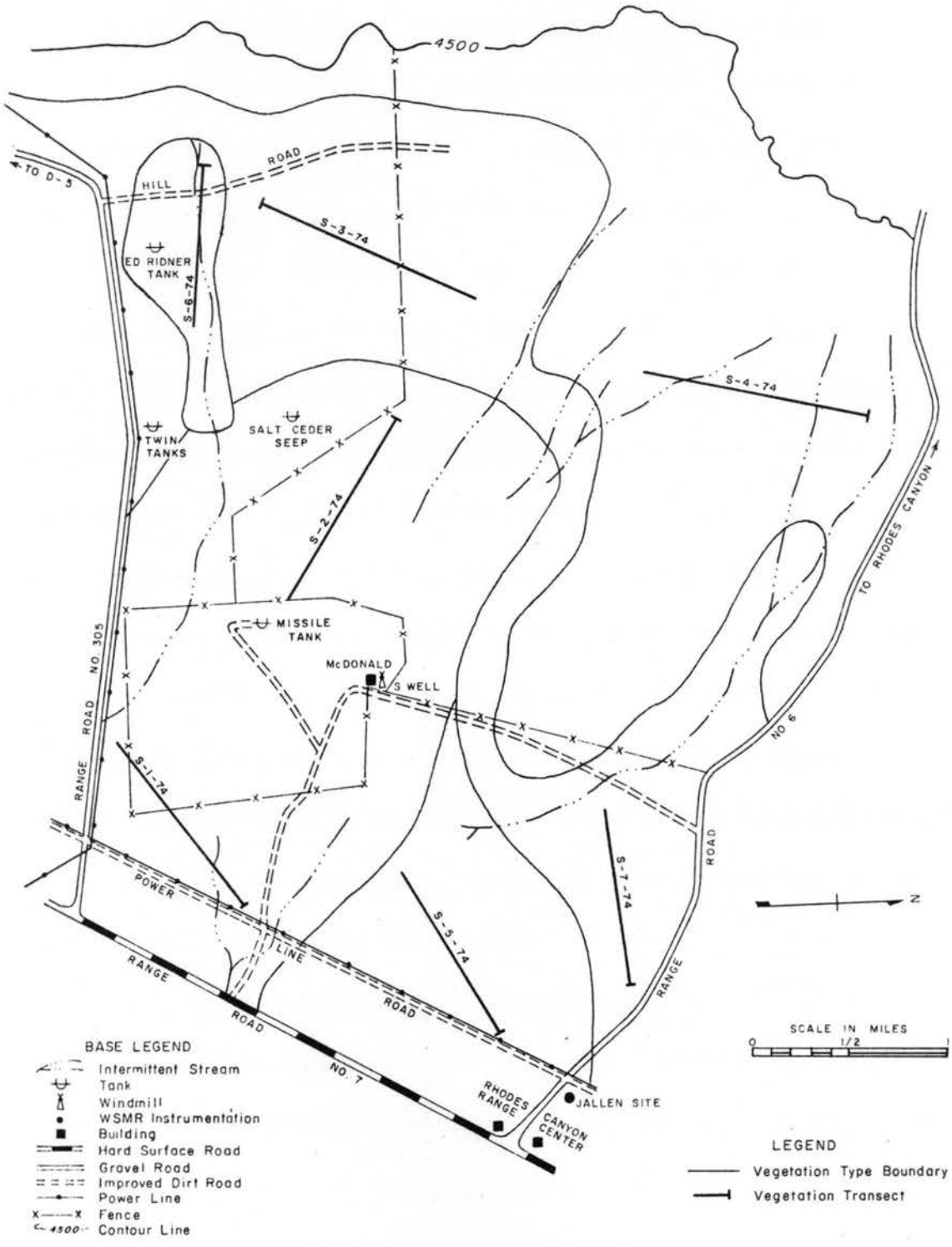

Figure 16. Map of Subsector A-1 showing locations of vegetation transects.

Habitat Type 1, Grass-Saltbush-Mesquite (Figure 17)

The terrain was flat and gently sloping down towards the east. Vegetation was sparse, consisting of scattered clumps of dropseed grasses (Sporobolus spp.), tumbleweeds (Salsola kali), fourwinged saltbush, and mesquite bushes. Large patches of completely barren ground were scattered throughout the type. Saltceder Seep (Figure 16) was a large clump of saltceder bushes (Tamarix pentandra) which received high use by gemsbok for shade. The ecotone created by this type and the creosotebush types received high gemsbok use.

Habitat Type 2, Mesquite-Grass-Creosote (Figure 18)

The topography was mostly flat and gently sloping down towards the east. Vegetation consisted of red three-awn grass (Aristida longisita) and tumbleweeds throughout with dense growths of mesquite, tobosa (Hilaria jamesii), and plains bristlegrass (Setaria macrostachya) occurring along the drainage. Throughout the type gemsbok use was high, particularly along the drainage.

Habitat Type 3, Creosote-Grass (Figure 19)

Terrain was mostly flat and gradually sloping down to the east or southeast. Vegetation was dominated by creosotebush with bare ground underneath and a scattering of dropseed grasses and pepper-weed (Lepidium montanum). A few low areas that collected moisture ("swales") had dense growths of tobosa and Conyza coulteri with scatterings of mesquite and yucca. The type received moderate

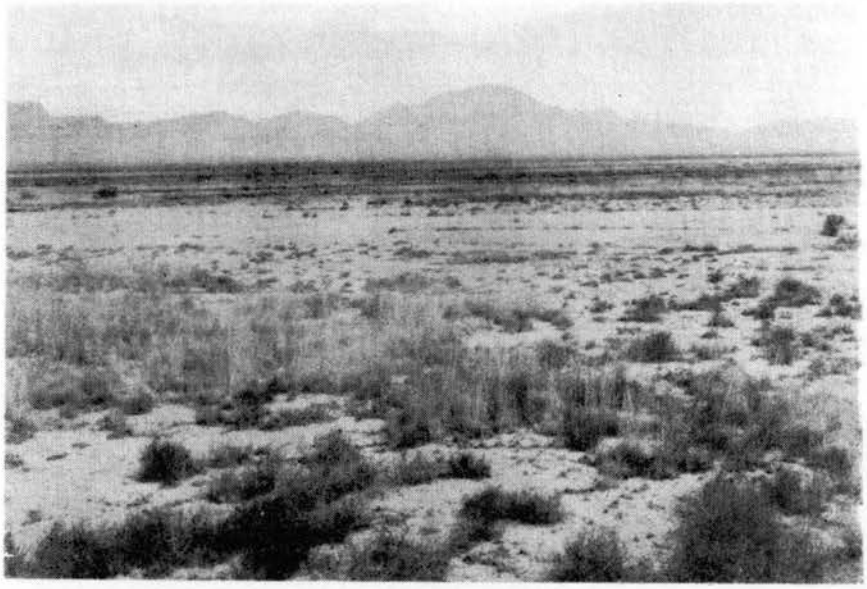

Figure 17. Habitat type 1, Grass-Saltbush-Mesquite.

Figure 18. Habitat type 2, Mesquite-Grass-Creosote. (Foothills in background)

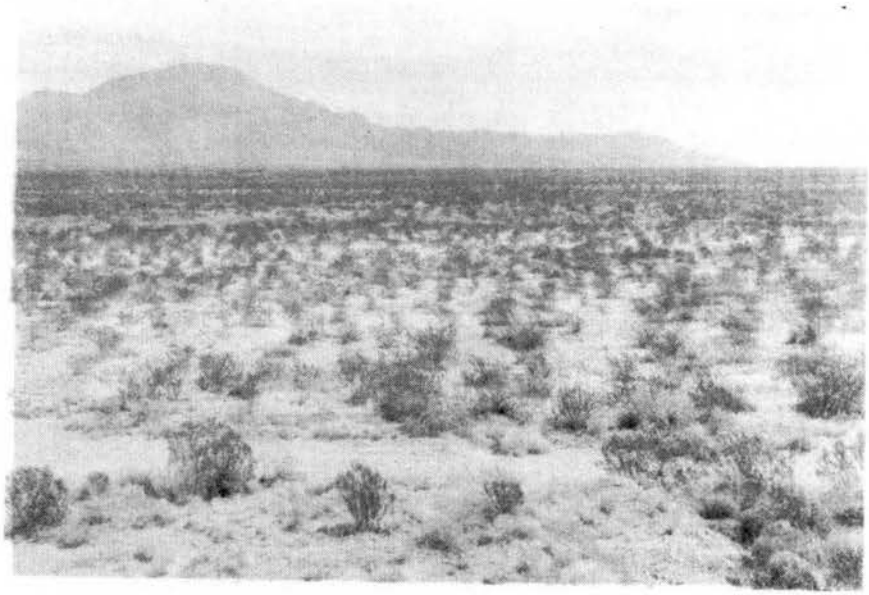

Figure 19. Habitat type 3, Creosote-Grass.

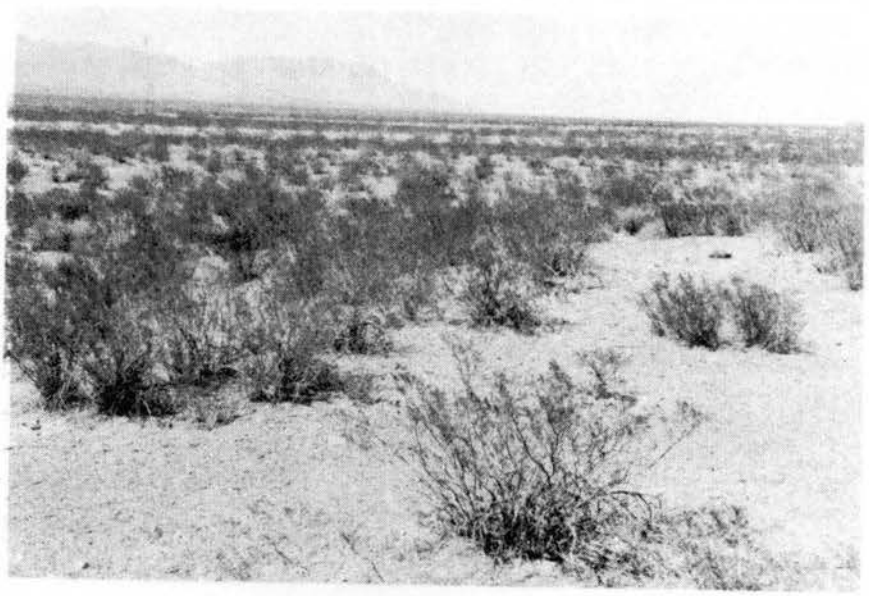

Figure 20. Habitat type 4, Creosote-Mesquite-Gravel.

gemsbok use, particularly in areas with good grass understory, i.e., swales and ecotones with grass types.

Habitat Type 4, Creosote-Mesquite-Gravel (Figure 20)

Topography was rolling, gently sloping down to the southeast and intersected by several gullies of up to 10 to 15 feet in depth. The surface was mostly gravel (erosion pavement) with creosotebush and mesquite comprising most of the vegetation. Snakeweed, grasses, and littleleaf sumac (Rhus microphylla) occurred in the wider gully bottoms and growth became more dense downstream. Very little gemsbok use of the type was observed.

Habitat Type 5, Mesquite-Saltbush-Grass-Dunes

The terrain was flat, gently sloping down towards the southeast. Vegetation was sparse, dominated by mesquite bushes which have wind blown sand around the bases forming small dunes with large patches of nearly barren ground between them. Between the dunes there were a scattering of dropseed grasses, seepweed (Sueda torreyana), four-winged saltbush, tumbleweeds, and pepperweed. This did not appear to be a highly preferred habitat type since limited gemsbok sign was observed here, probably from animals passing through.

Preferred Winter Habitat - 1974-75

Habitat types 6 through 10 occur in subsector F-1 (Figure 21) where high gemsbok use was observed during the period November 1973 through January 1974. Seven vegetation transects (Figure 22)

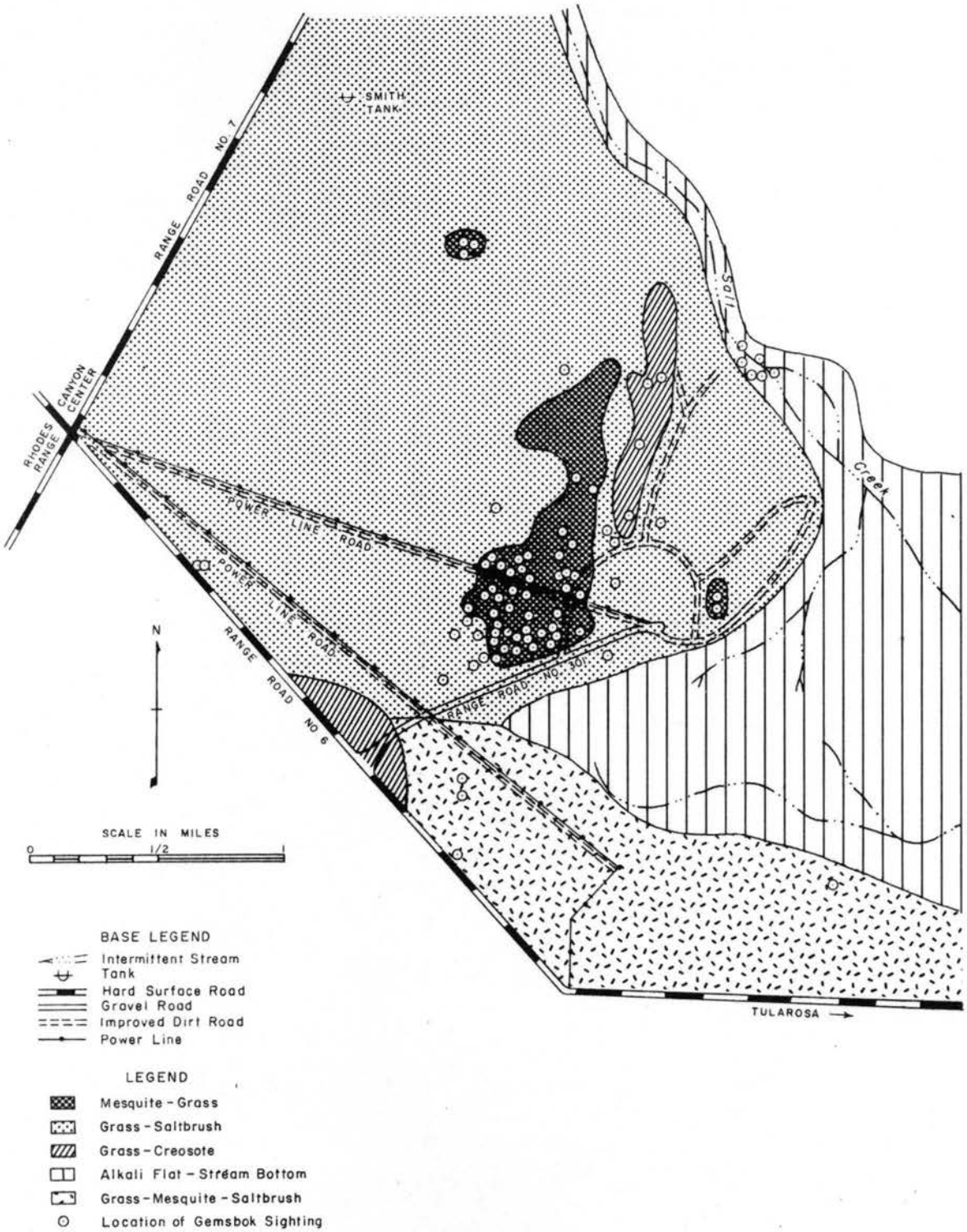

Figure 21. Map of subsector F-1 showing habitat types and locations of gemsbok sightings, November 1973 - January 1974.

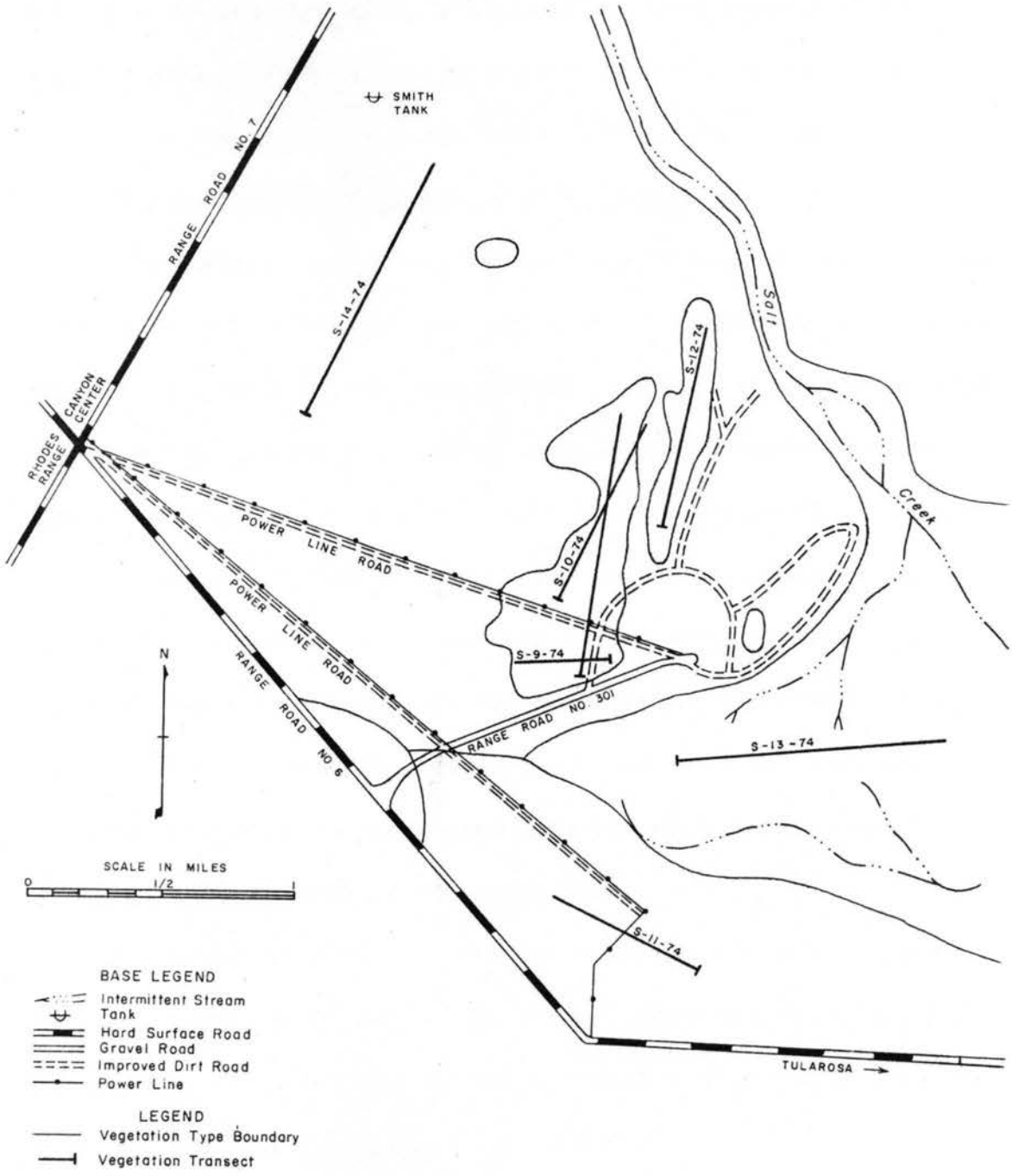

Figure 22. Map of subsector F-1 showing locations of vegetation transects.

were run through the types. Results of these transects for habitat types 6 through 10 are shown by vegetative form class in the Appendices. The following is a description of these habitat types:

Habitat Type 6, Mesquite-Grass (Figure 23)

The topography was very flat and level in habitat type 6, appearing to occupy the site of a relic lake bottom. Vegetation consisted of mesquite bushes averaging between 5 to 10 feet (150-300 cm) in height with scattered clumps of grasses. Dropseed grasses occurred in clumps which were 3 to 4 feet (90-120 cm) in height and tobosa clumps of 2 to 3 feet (60-90 cm) in height. The vegetation appeared to be denser than it actually was when viewed from the horizontal aspect due to the tallness of the grass clumps; however, there were large patches of barren ground between the clumps of grass. In areas of moisture accumulation there were dense stands of vine mesquite (Panicum obtusum) and plains bristlegrass.

This type received very high gemsbok use during November through January of the field study. A few recent gemsbok tracks were observed at the time of the vegetation transects (May 1974); however, this area received its highest use only during the mid-winter months.

Habitat Type 7, Grass-Saltbush (Figure 24)

The terrain in this habitat type was flat and level. Vegetation consisted of clumps and patches of dropseed grasses of about 3 feet (90 cm) in height with a scattering of fourwinged saltbush of the same

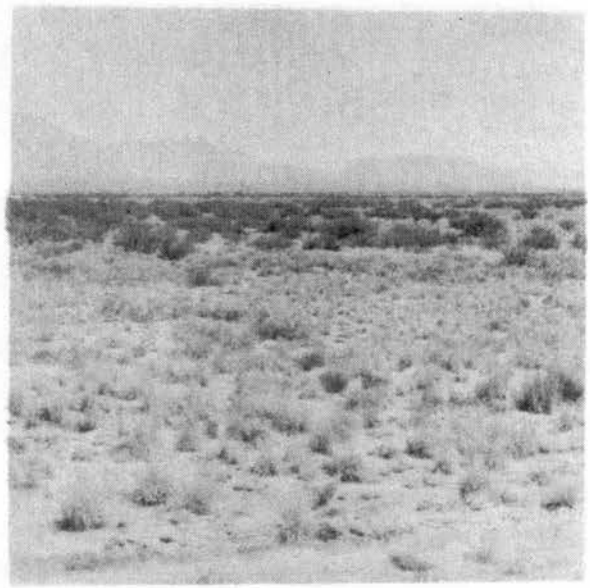

Figure 23. Habitat type 6, Mesquite-Grass.

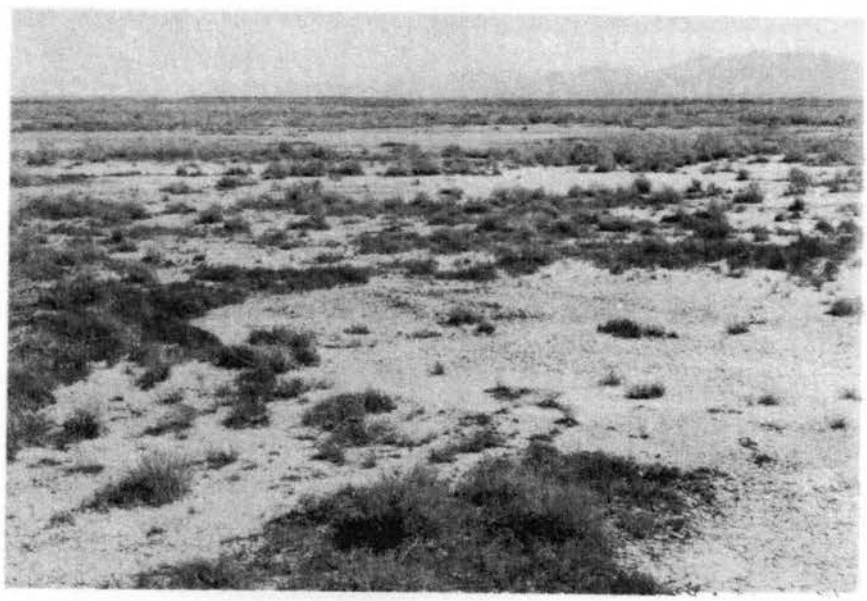

Figure 24. Habitat type 7, Grass-Saltbush.

height. Vegetation appeared denser than it actually was when viewed from the horizontal. Little gemsbok sign was observed during the time of the vegetation transect. It was believed that this type was only moderately preferred by the gemsbok due to its lack of tall bushes for use as cover and shade. Gemsbok sign increased near the ecotone of this type with the highly preferred habitat type 6.

Habitat Type 8, Grass-Creosote (Figure 25)

The topography was gently rolling, occurring along the top and eastern slope of a low ridge. Fourwinged saltbush, Mormon tea, greasewood (Sarcobatus vermiculatus), dropseed grasses, and ring muhly (Muhlenbergia torreyi) occurred throughout the type with creosotebush occurring in patches. No recent gemsbok sign were observed at the time of the vegetation transect (May 1974); however, several old tracks were observed. The sign seen in May were remaining from earlier use of the subsector in November through January. The tracks made were mostly by animals traveling between preferred habitat type 6 (Mesquite-Grass) and Salt Creek.

Habitat Type 9, Alkali Flat-Stream Bottom (Figure 26)

There was no vegetation in most of this type except for small islands of dropseed grasses near the edge of the type and along the streambank where saltceder and seepweed were also found. Terrain was flat and level. Saltcreek, with banks white from alkali deposits, flowed through the type. The soil in the type was often muddy due to

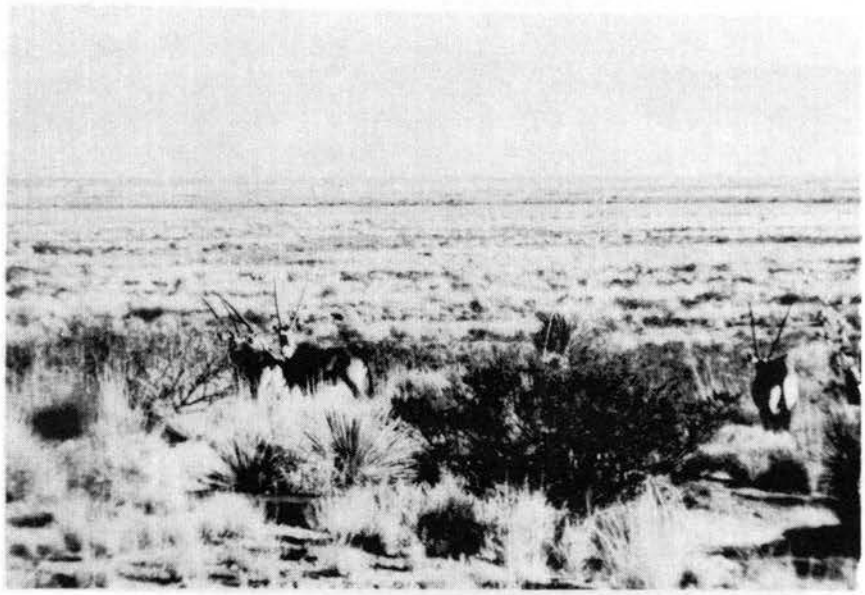

Figure 25. Habitat type 8, Grass-Creosote.

Figure 26. Habitat type 9, Alkali flat-stream bottom.

a high water table. Gemsbok use of the type was mostly for travel to Salt Creek.

Habitat Type 10, Grass-Mesquite-Saltbush

The topography was flat and level. Vegetation consisted of scattered patches of tobosa and clumps of dropseed grasses up to 3 feet (90 cm) in height which appeared denser than they actually were when viewed from the horizontal. Numerous large spaces of barren ground occurred between the clumps of grass. A scattering of mesquite bushes 4 to 6 feet (120-180 cm) fall, fourwinged saltbushes 2 to 4 feet (90-120 cm) tall, and a trace of very tall yuccas occurred here. Little gemsbok sign was observed during the time of the vegetation transect in May 1974. Although grass species appeared favorable for gemsbok, it appeared that the tall shrubs were not dense enough to attract high concentrations of gemsbok for very long.

Subsectors A-1 and F-1, which were mapped and described, received considerable gemsbok use during the field study. They were, however, not the only subsectors to receive gemsbok use. Other subsectors in the study area which received gemsbok use had some habitats that were similar to those described in A-1 and F-1 and received similar gemsbok use in those habitats. Since most observations were made in subsectors A-1 and F-1, the habitats that occur in these two areas were described in detail.

In summary, the characteristics of habitats most often used throughout the study area were: flat to gently undulating topography, non-rocky soils, and an interspersion of shrubs and grasses.

The semi-desert shrub, clay grasslands, and salt flats vegetative types (U.S. Department of Agriculture, 1970) were most frequently used during this study. There were 269,500 acres (109,109 ha) of the semi-desert shrub type, 110,500 acres (44,736 ha) of the clay grassland type, and 141,200 acres (57,166 ha) of salt flat type on the WSMR. These comprise 521,200 acres (211,000 ha) of potential gemsbok habitat on WSMR, assuming similar gemsbok habitat preferences in the future. No comparison of gemsbok with livestock production have been calculated. However, there may be great differences in carrying capacity between a domestic animal and a wild animal on similar habitat depending on factors such as space, shade, forage preferences, water, etc.

Ranges and Movements

Ranges

Fifty-one gemsbok were released on WSMR from October 1969 through November 1973 (Table 1 and Figure 1). Thirty were marked with collars for identification. A map of WSMR showing the known ranges of the gemsbok and any areas they were known to have occupied during the field study are shown in Figure 27. Since the initial release, gemsbok are not known to have left the boundaries of WSMR. The

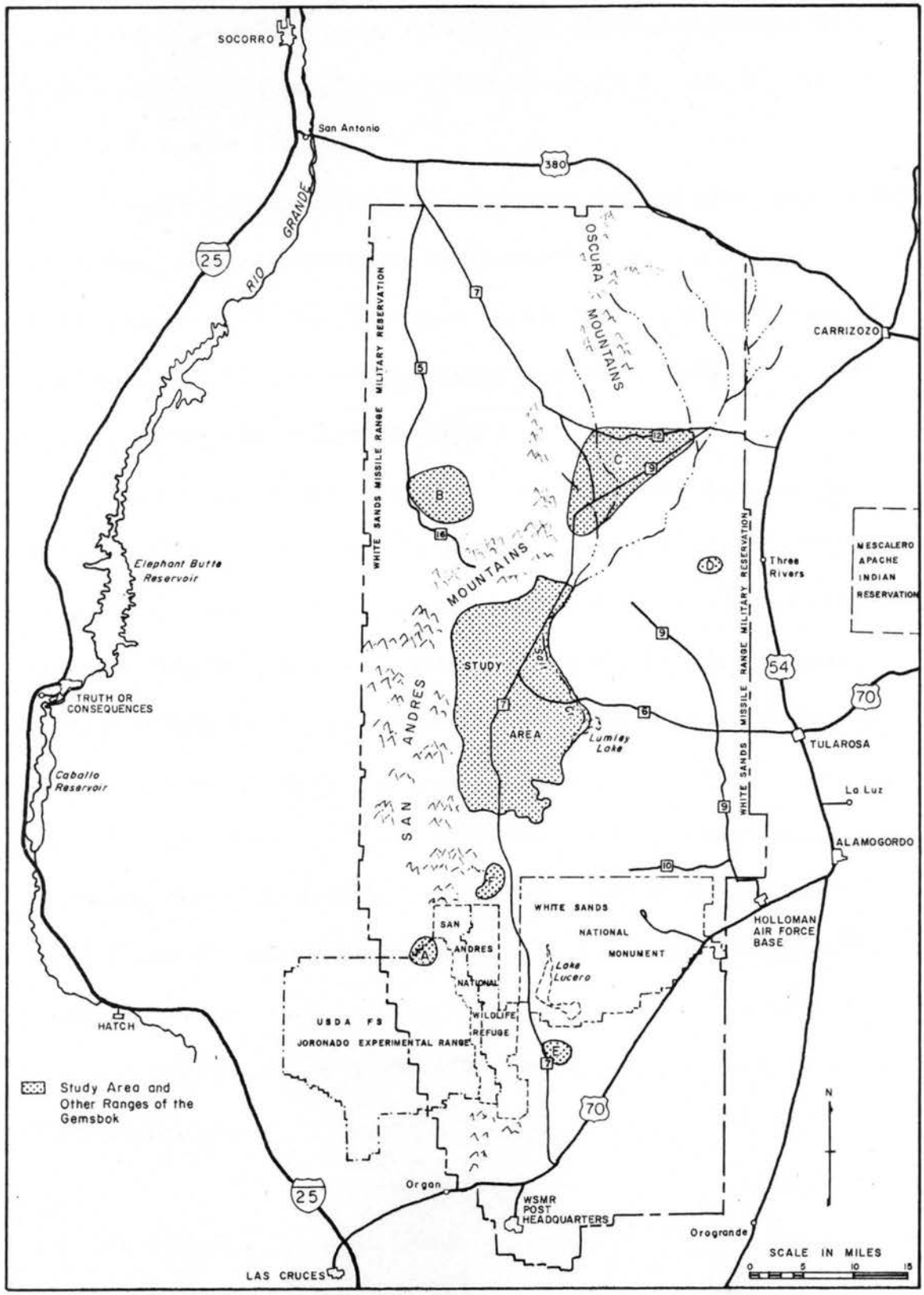

Figure 27. Known ranges of the gemsbok during the field study.

main area of gemsbok occupation has been within that portion designated as the study area (Figure 27); however, a few satellite populations were known.

Reports had been received of two gemsbok observed west of the San Andres Mountains near the north boundary of the Joronado Experimental Range in location A (Figure 27) about 20 miles southwest of the study area. Their presence had been verified by evidence of tracks seen by this author on April 7, 1974.

One adult male gemsbok (#101) had been located northwest of Salinas Peak at the head of Thoroughgood Canyon in location B (Figure 27) from July 30 to September 22, 1973. A report was received in August of another gemsbok with him, but this was never verified. This individual was observed to have returned to the study area on October 2, 1973.

A small group varying in size from one to five head was known to range north of the study area from the mouth of Thoroughgood Canyon towards the Oscuro Range Center in location C (Figure 27) throughout the field study. Individuals in this group were known to return to the main study area, while others were known to have left the study area to join them.

An adult male (#108) was located on June 14, 1973 southeast of the lava flow at location D (Figure 27) 50 days after his release in the Rhodes Canyon Range Center area. He was found immobilized by an

abandoned parachute which was tangled in his horns, over his eyes, and in his front legs. He had apparently engaged in play with the parachute. This individual was tranquilized, the parachute removed, and he was returned to the study area. He was seen again on November 23, 1973 and May 12, 1974 with the previously mentioned satellite herd in location C. The second time observed he had pieces of another parachute tangled in his horns, but not enough to hamper his activities.

Another satellite population of about eight head was reported in location E (Figure 27) on November 4, 1973 by a WSMR employee. A check of this area the following day confirmed the existence of fresh gemsbok sign in this area. Previous reports had been received of gemsbok being sighted from U.S. Highway 70, 5 miles (8 km) to the east. Although these reports were never confirmed, it is possible that they were this same herd. A search of the same area near the end of the field study failed to turn up any gemsbok sign. It is believed that this herd left this location, possibly to return to the study area.

A herd of seven gemsbok including adult male #117 was reported and observed on March 21, 1974 and April 19, 1974 at the mouth of Dead Man Canyon in location F (Figure 27). Later attempts at locating this herd in this area were unsuccessful.

The last mentioned satellite herd was observed at the mouth of Dead Man Canyon in steep, rocky hill slopes. All other satellite herd observations were made in habitats which were similar to those used most often in the study area. Characteristics of these habitats include: flat to gently undulating topography, non-rocky soils, and interspersed vegetation of semi-desert shrub and grass species.

Movements

Gemsbok movements within the study area were complex and any trends were difficult to establish. A total of 1,413 individual gemsbok moves were recorded which averaged less than one mile (1.6 km) per day per move for all animals. Most longer moves were made by individual animals leaving one herd to join another herd or to wander about alone. The longest recorded distance traveled in one day was 8.92 miles (14.3 km) straight line distance from subsector G-1 to subsector A-5 on October 30-31, 1973 by four animals.

A significant herd movement was that of one closely studied herd leaving its preferred area within subsector A-1 in late October. In early November segments of this herd and others were found in subsector F-1 about five miles (8 km) to the east. This new herd remained in subsector F-1 (with exchanges of individuals from other areas) through January 1974 when another exodus occurred. Some members were spotted for a while in subsectors G-1 and G-3 (previously unoccupied areas) and others joined established herds in other

parts of the study area. A large herd concentration was then observed in subsector B-3 while later, another herd established itself again in subsector A-1. Reasons for herds abandoning previously preferred areas and moving into previously unoccupied areas have not been determined.

Tables 12, 13, 14, 15 and Figures 28, 29, 30, 31 show the movements of four gemsbok (numbers 203, 204, 110, 111) for which the most data had been collected. The movements shown are only to different subsectors and do not consider movements within a single subsector.

In summary, gemsbok movements appeared to be complex with no trend established. Hopefully, as the population increases, future studies of the gemsbok at WSMR will be able to better define patterns of gemsbok movements.

Table 12. Movements to different subsectors by Adult Female #203. June 16, 1973 - May 27, 1974.

Location*	Subsector	Dates	# Times Observed in That Subsector
1	A-3	16 Jun	1
2	A-2	7 Jul	1
3	A-3	21 Jul	1
4	A-4	31 Jul - 2 Aug	2
5	A-3	4 Aug	1
6	A-1	12 Sep - 25 Oct	22
7	B-2	19 Nov	1
8	B-3	20 Nov - 4 Dec	2
9	B-2	10 Jan - 28 Jan	4
10	B-3	1 Mar - 19 Mar	11
11	B-2	22 Mar - 24 Mar	3
12	B-3	26 Mar - 10 Apr	9
13	B-2	17 Apr - 6 May	13
14	B-1	10 May - 12 May	3
15	A-1	14 May - 27 May	8

*See Figure 28.

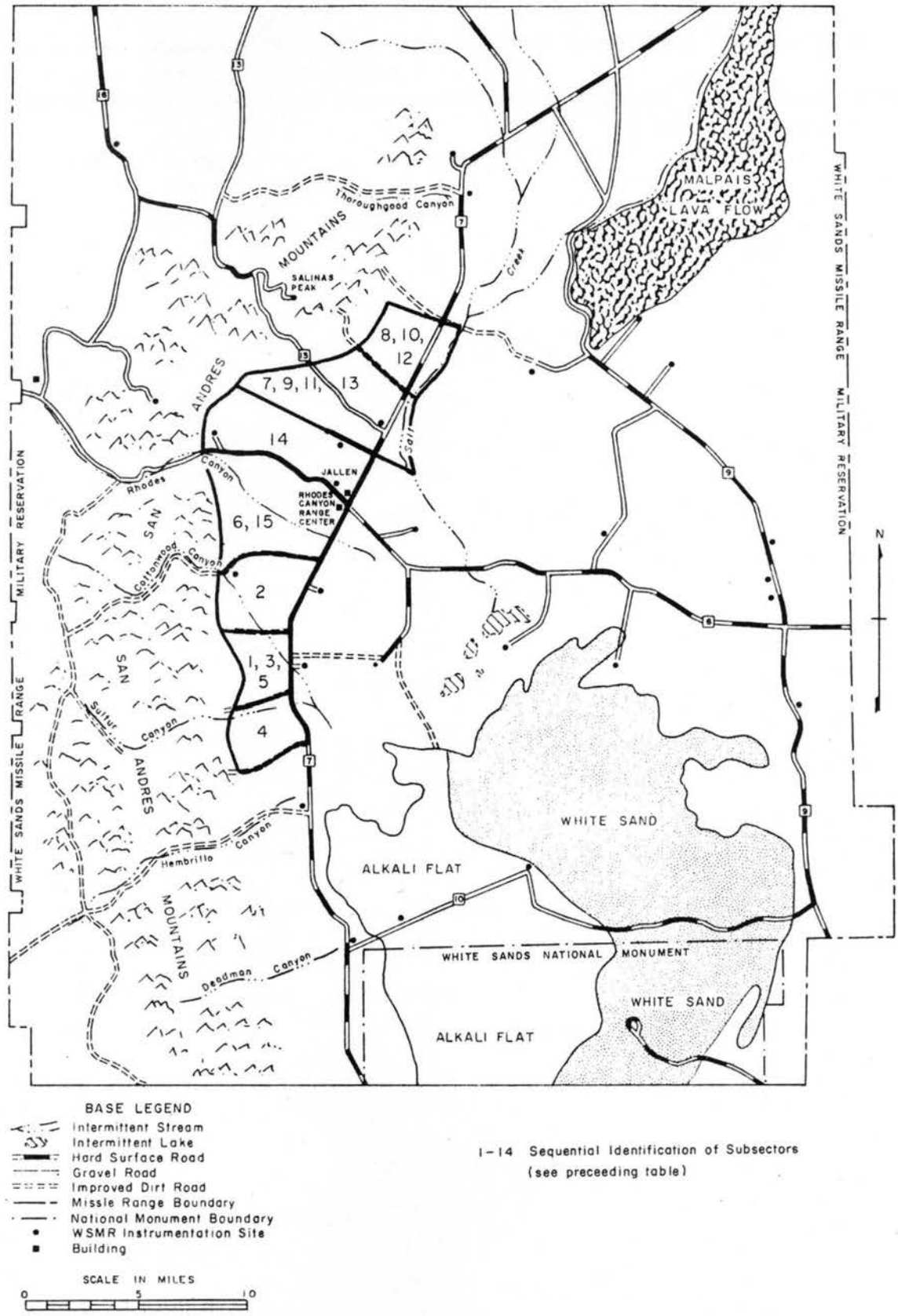

Figure 28. Movements to different subsectors by Adult Female #203.

Table 13. Movements to different subsectors by Adult Female #204 June 16, 1973 - May 29, 1974.

Location*	Subsector	Dates	# Times Observed in That Subsector
1	A-5	16 Jun	1
2	A-1	22 Jun - 27 Sep	30
3	A-3	19 Oct	1
4	A-1	21 Oct - 24 Oct	3
5	G-1	30 Oct	1
6	A-5	31 Oct	1
7	G-1	2 Nov	1
8	F-1	6 Nov - 30 Dec	26
9	G-1	31 Dec	1
10	F-1	1 Jan - 4 Jan	3
11	G-1	5 Jan	1
12	A-1	6 Jan	1
13	A-2	7 Jan	1
14	A-4	11 Jan - 14 Jan	3
15	A-5	16 Jan - 23 Mar	23
16	A-4	25 Jan - 29 Apr	10
17	A-5	1 May	1
18	A-4	5 May - 13 May	3
19	A-3	16 May	1
20	A-5	22 May - 26 May	2
21	A-4	29 May	1

*See Figure 29.

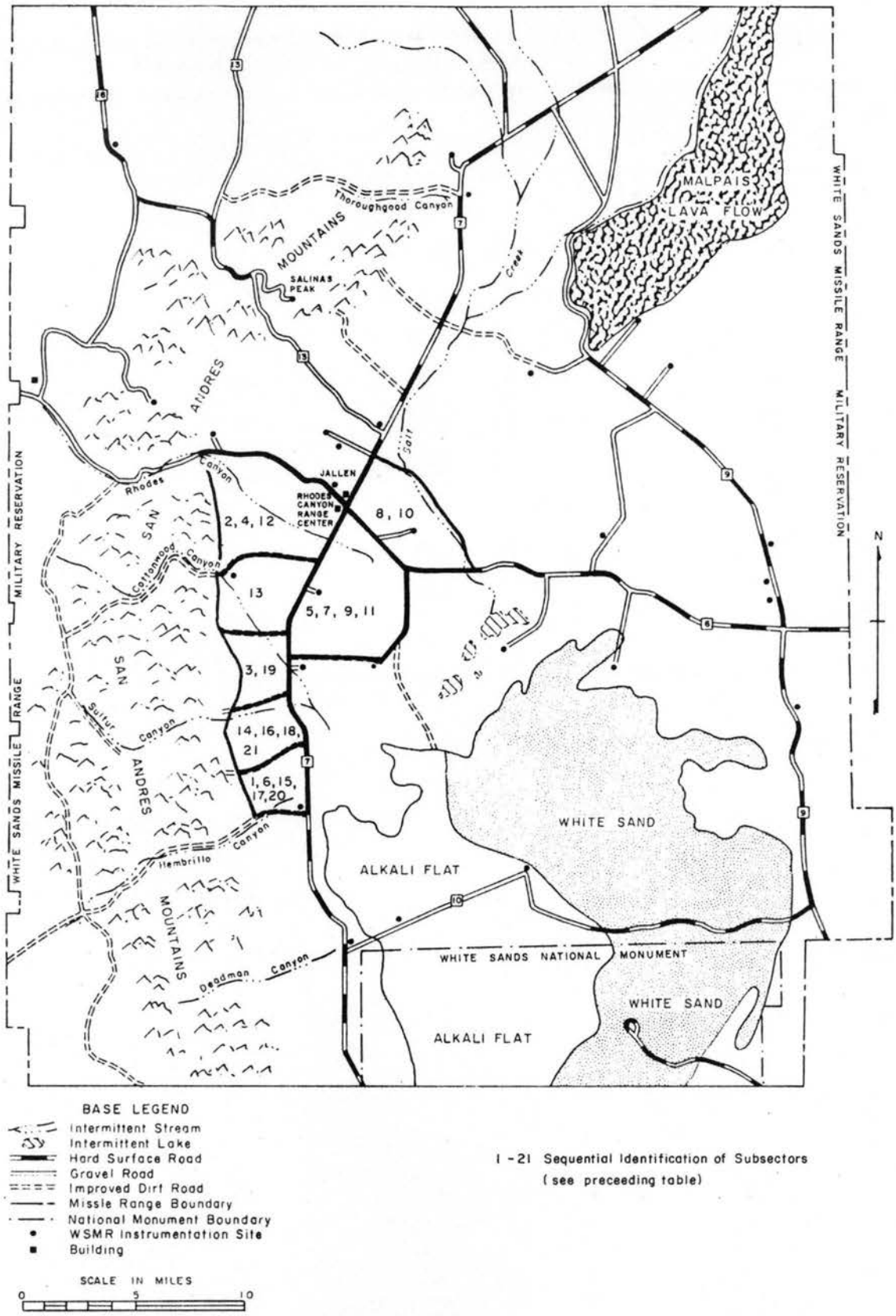

Figure 29. Movements to different subsectors by Adult Female #204.

Table 14. Movements to different subsectors by Adult Male #110 June 22, 1973 - May 26, 1974.

Location*	Subsector	Dates	# Times Observed in That Subsector
1	B-2	22 Jun	1
2	A-1	14 Aug - 27 Sep	21
3	B-2	28 Sep - 2 Oct	3
4	B-1	18 Oct - 21 Oct	2
5	A-1	23 Oct - 29 Oct	4
6	F-1	2 Nov - 22 Jan	30
7	G-1	23 Jan - 25 Jan	2
8	G-3	7 Feb - 8 Feb	2
9	B-3	24 Apr - 15 May	12
10	C (north of mapped area)	26 May	1

*See Figure 30.

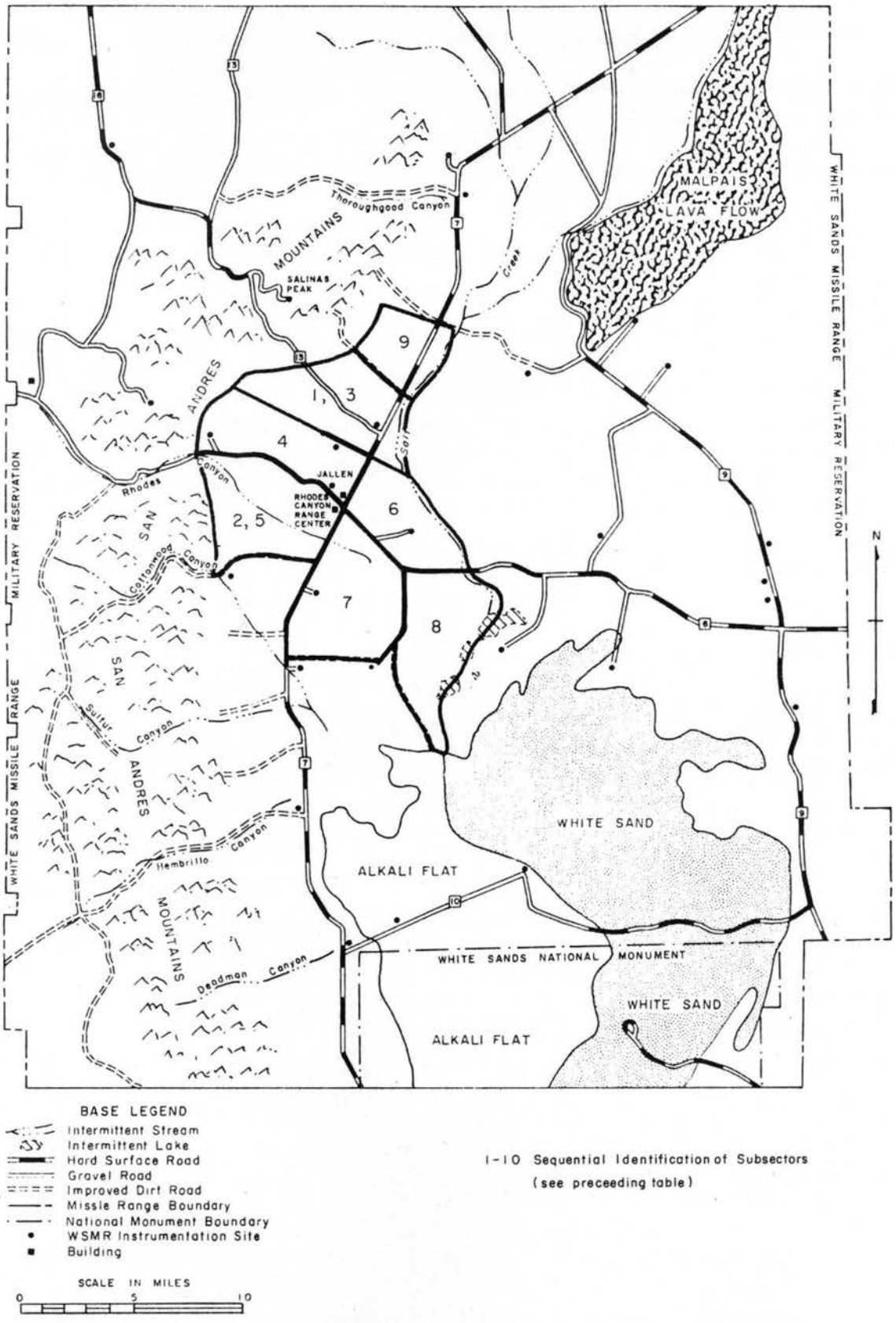

Figure 30. Movements to different subsectors by Adult Male #110.

Table 15. Movements to different subsectors by Adult Male #111 May 18, 1973 - March 28, 1974.

Location*	Subsector	Dates	# Times Observed in That Subsector
1	A-1	18 May - 8 Jun	5
2	B-1	23 Jun	1
3	A-1	15 Aug - 27 Sep	22
4	B-2	1 Oct - 2 Oct	2
5	B-1	18 Oct - 19 Oct	2
6	F-1	20 Oct	1
7	B-1	21 Oct	1
8	A-1	25 Oct	1
9	F-1	6 Nov - 22 Jan	32
10	G-1	23 Jan - 25 Jan	2
11	F-1	7 Feb	1
12	G-3	9 Feb - 17 Feb	4
13	F-1	28 Mar	1

*See Figure 31.

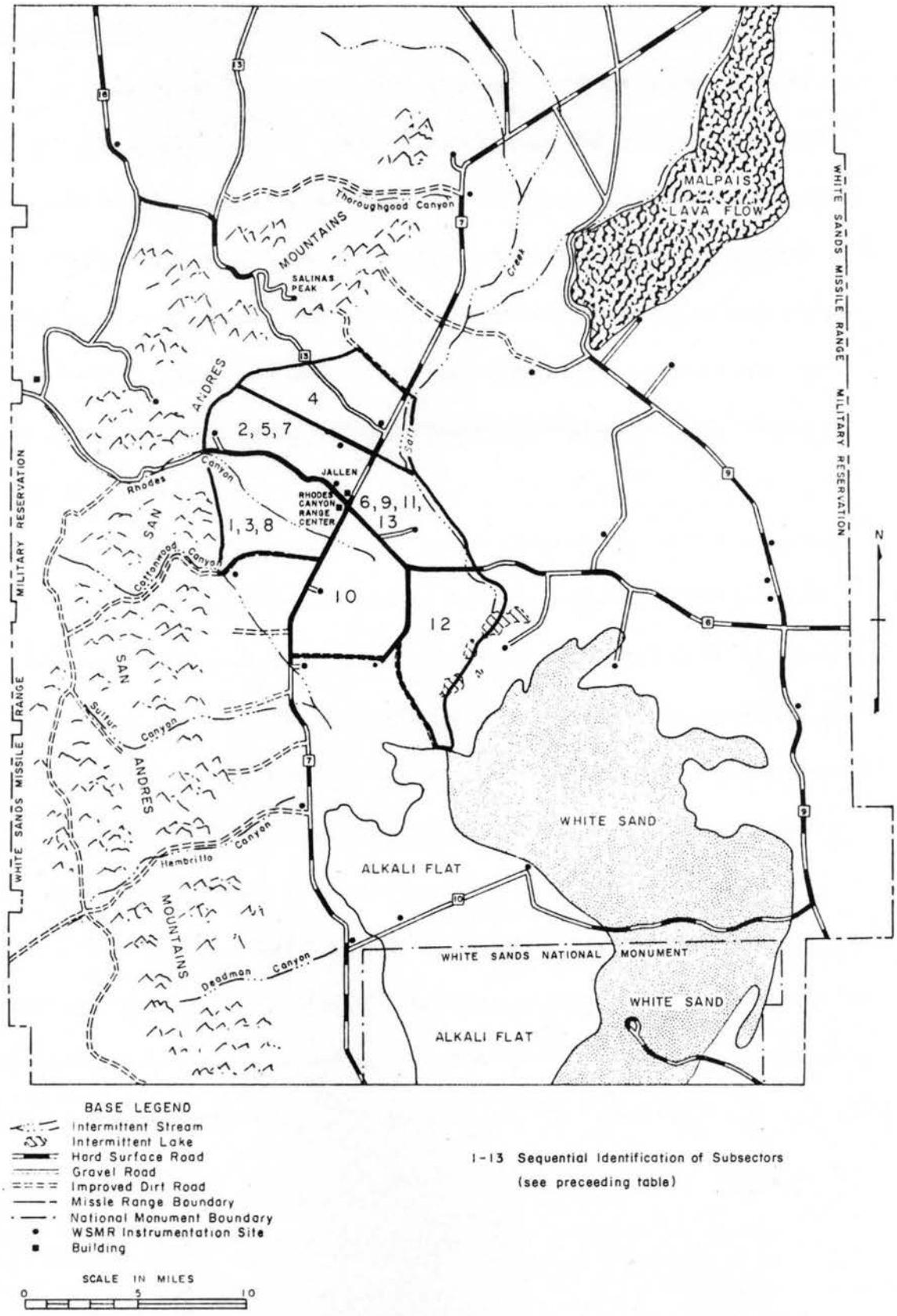

Figure 31. Movements to different subsectors by Adult Male #111.

Food Habits

Rumen analysis of two gemsbok taken in the Kalahari desert of southern Africa indicated that they fed primarily on annual and perennial grasses (Leistner, 1959; Eloff, 1959). In index to gemsbok food habits at WSMR was determined by direct observation of the feeding animals and by the microscopic analysis of fecal material. The technique utilized was previously found to be a "practical and economical" index to foods composition of bighorn sheep (Todd and Hansen, 1972).

Fresh gemsbok pellets were collected in the field from areas previously occupied by the gemsbok. One pellet from each fresh group was collected in an attempt to collect at least 25 to 30 pellets per week. Four weekly samples were pulverized and combined to form each monthly sample. Twelve monthly samples were presented to the Colorado State University Composition Analysis Laboratory, Department of Range Science for processing and analysis.

Plants were classified from cutinized plant epidermal fragments and lignified cell walls remaining after digestion. The technique was developed by Baumgartner and Martin (1939) to determine herbivore diets from microscopic analysis of fecal contents using the principles involved in rumen analysis. Percent relative density expressed as the particle density of a plant species divided by the total number of

particles of all species was calculated for each plant species found within samples.

A list of plant species known to have been eaten by the gemsbok and a ranking of importance in their diet was prepared from visual observation of the feeding animals. A plant collection of these species was used by the Composition Analysis Laboratory to construct a set of reference slides. These slides and the list were employed as comparative aids to laboratory technicians during microanalysis of samples. When a plant specific name was in question, only the generic name was used.

The results of the laboratory analysis are presented in the Appendices. Summaries of the results are presented by season in Table 16, and for the entire year in Figure 32. A graph of the percent relative density of materials found in the feces is plotted by month in Figure 34.

Mesquite was found to comprise about 10 percent relative density in the sample of June 1973. It gradually increased to about 68 percent in November, then dropped down to about 7 percent in March 1974 before beginning an upward trend again in May (Figure 33). This corresponded to observance of increased consumption of mesquite by gemsbok during the fall months when the pods were dry and mature. The pods were the only portion of the plant observed to be eaten.

Table 16. Seasonal density of plants in gemsbok fecal samples June 1973 - May 1974.

	Spring	Summer	Fall	Winter
Grasses	------- percent relative density -------			
Threeawn	0.03	0.23	0.08	0.03
Grama	0.07	4.76	1.71	1.08
Tobosa	1.49	0.46	0.19	0.60
Vine mesquite	0.00	0.00	0.02	0.12
Plains bristlegrass	2.28	18.63	1.33	2.95
Dropseeds	32.90	6.72	5.61	27.85
Other grasses	0.27	2.43	1.34	1.35
All grasses	37.04	33.23	10.28	33.98
Forbs				
Indian rushpea	0.00	0.02	0.06	0.04
Tumbleweed	19.63	38.57	22.83	8.33
Globemallow	2.18	2.88	2.27	2.87
Other forbs	0.17	0.79	0.70	0.29
All forbs	21.98	42.26	25.86	11.53
Shrubs				
Fourwinged saltbush	1.74	0.00	0.01	2.37
Mesquite	11.98	23.76	62.82	35.43
Yucca	27.25	0.13	1.04	18.70
All shrubs	40.97	23.89	63.87	56.50

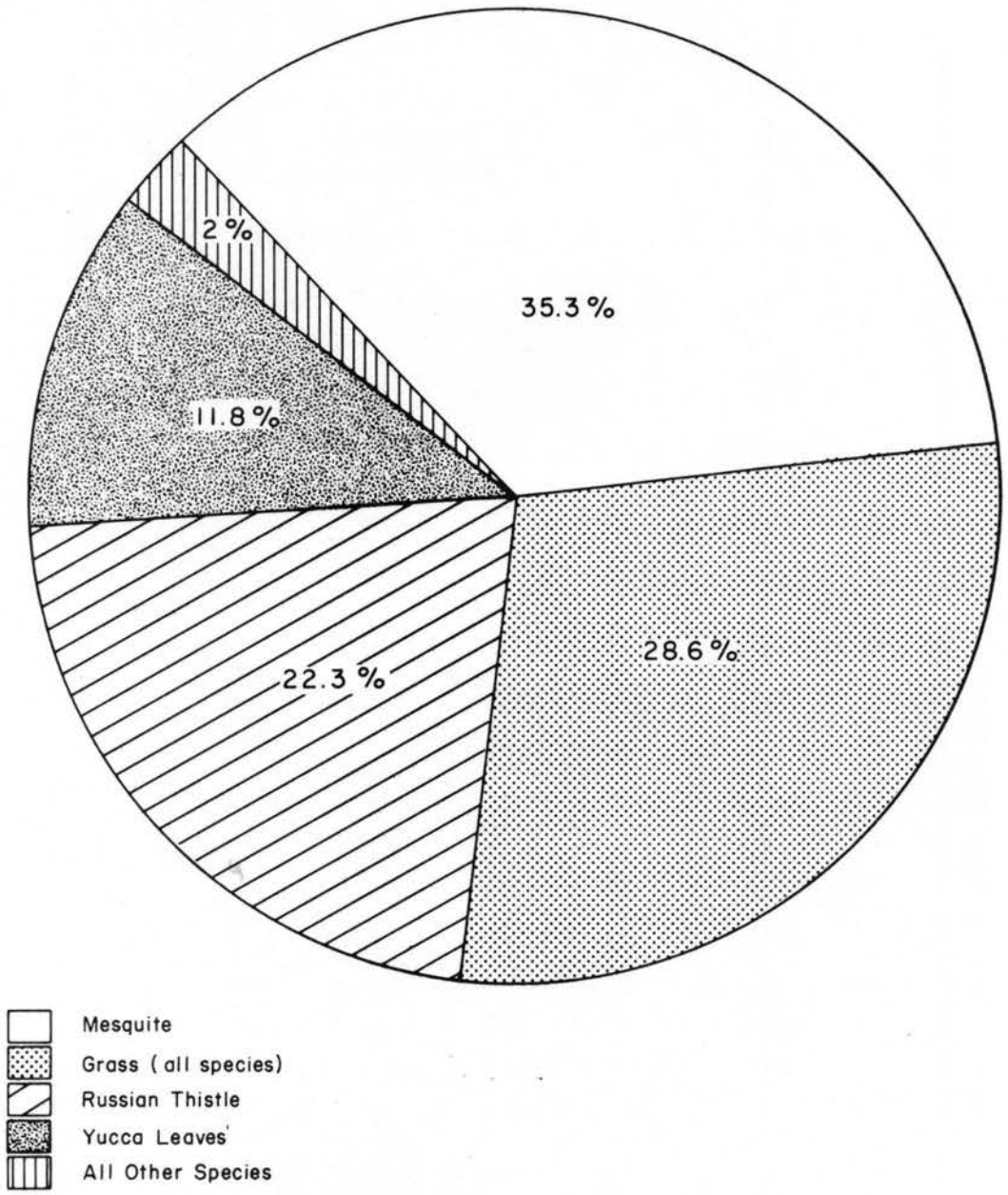

Figure 32. Occurrence of plants in gemsbok fecal samples June 1973 - May 1974.

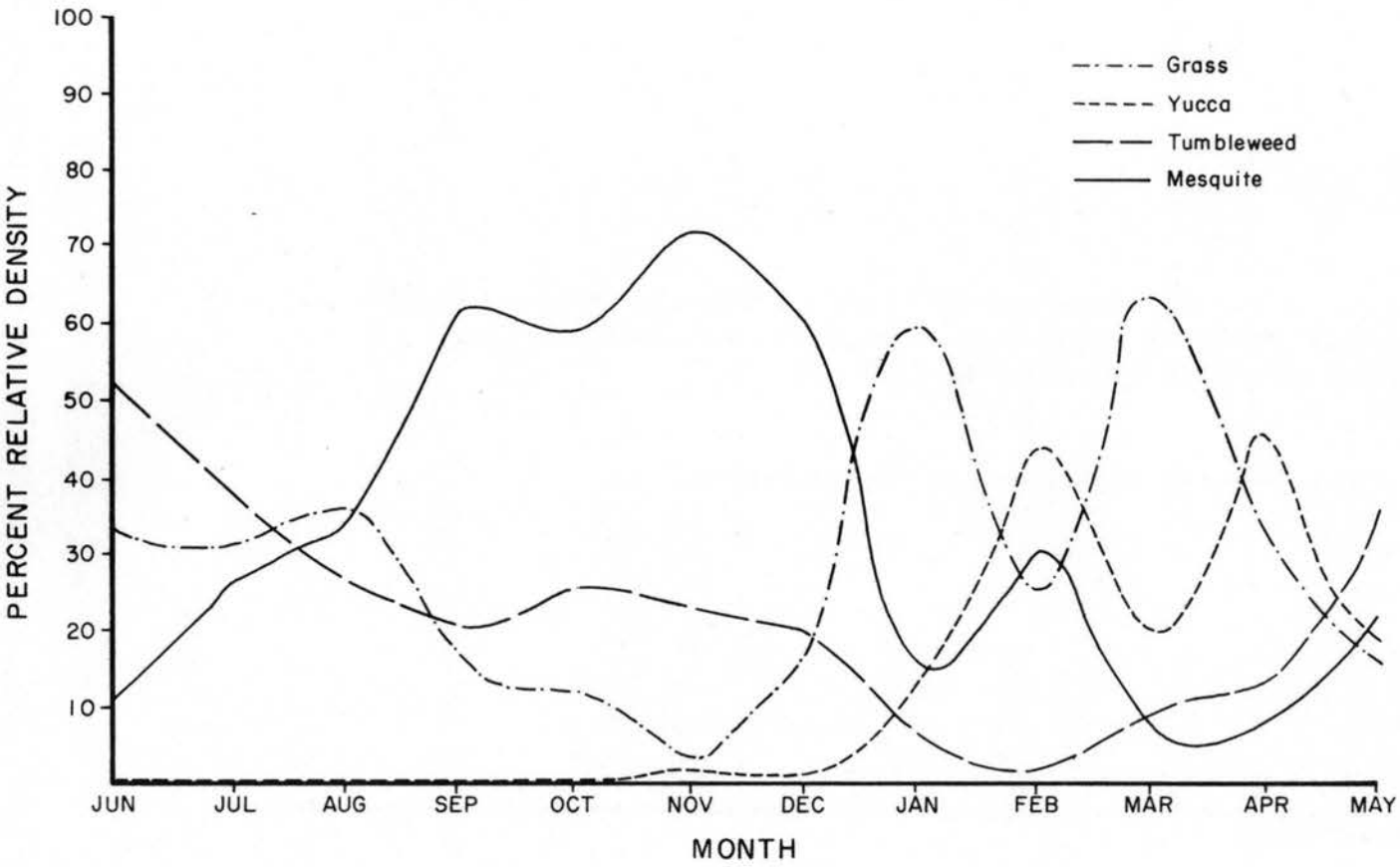

Figure 33. Percent relative densities of major plant materials found in gemsbok feces, June 1973 - May 1974.

The percent relative density of all grass species found in the fecal material was 32 percent in June of 1973. It decreased to 3 percent in November and increased to about 60 percent in January. It then dropped to 25 percent in February, jumped to 60 percent in March, and started a decline to 16 percent at the end of the field study (Figure 33). The reason for the double peaks in January and March with a drop between them in February is not understood, and could not be supported by visual observation. Gemsbok appeared to feed on a consistently high percentage of grass throughout the field study as determined by visual observation.

Tumbleweeds were found to comprise about 50 percent relative density of the fecal material in June 1973. It gradually dropped to nearly zero in February of 1974, and then gradually increased to 37 percent by the end of the field study in May (Figure 33). Gemsbok were observed following a similar trend, eating fewer tumbleweeds in mid-winter when they were the driest and most coarse.

Yucca leaves were found in the feces at insignificant percentages at the start of the field study in June 1973 and so continued until December when an increase began. They then increased to 43 percent in February, dropped to 19 percent in March, and increased to 45 percent in April before tending to drop down again at the end of the field study (Figure 33). Gemsbok were observed to eat yucca at a similar rate; however, the drop in March was not supported by direct

observation and is unexplained. Of interest is that yucca consumption increased during the driest months. Since yucca leaves are relatively high in moisture content, they may help the gemsbok meet their water requirements.

Percent relative densities of all other species of vegetation found in the feces by the laboratory approximate the same rates of consumption as observed in the field. One exception may be that of buffalo gourd (Cucurbita faetidissima) which appeared to be consumed more than indicated by fecal analysis, where it was grouped with "other forbs" at very low percentages (Table 16). Buffalo gourd was recorded to be eaten on at least eight occasions during September and October, 1973 (observed but not recorded on several other occasions).

Error possibilities exist in using the fecal microscopic technique for dietary composition analysis. Soft, fragile plants such as green forbs may digest almost completely and not appear in discernible amounts in the feces (Stewart, 1967; Casebeer and Koss, 1970). In contrast, dried grasses and shrubs may fragment and emerge in fecal residues to the extent of being over-represented in the sample. Research continues on the possibility of applying correction factors to the relative densities in order to obtain more accurate results (Dearden et al., 1974).

Results of fecal analysis presented here should not be considered as the exact percentages of what the gemsbok consumed.

However, the relative ranking of important plants in the gemsbok's diet corresponds well with direct observations and provides a valuable index to foods consumed by the gemsbok.

Feral horse fecal samples were also collected during the field study. An index to food habits of the feral horse was determined by the same fecal microanalysis technique as described for the gemsbok. The results of the analysis are presented in the Appendices. Except for rare observations of mule deer, feral horses were the only other large herbivores besides gemsbok known to range in the study area.

Watering Habits

An outstanding characteristic of the gemsbok at WSMR was their amazing ability to occupy an area completely lacking permanent sources of fresh water. No information is available on the water requirements of the gemsbok for survival, but from observations in this study, it must be very low. A study conducted on Oryx biesa of eastern Africa (Taylor, 1969) concluded that the Oryx have unusual physiological and behavioral adaptations for life in an arid environment. They are seemingly able to withstand a high increase in body temperature without suffering any apparent permanent damage. They also feed upon plants with a high moisture content to meet their water requirements. Numerous eyewitness accounts identify them as animals that do not need drinking water. Although a similar study has not been conducted on gemsbok (Oryx gazella), it appeared that they

too have developed similar physiological and behavioral adaptions to survive in their equally hostile environment of southwestern Africa. African observers (Grzimek, 1972; Shortridge, 1934) reported that the gemsbok dig for tschamma (Colocynthis citrullus) and roots of Elandsboontjie (Elephantorrihza elephantina) as well as other plants with high water content. Gemsbok at WSMR were observed to eat yucca leaves and buffalo gourd, perhaps for their high water content.

While permanent sources of fresh water were not available in the study area at WSMR, gemsbok were observed to drink freely whenever water was readily available. This mainly occurred after a rain when temporary accumulations gathered in roadside ditches and abandoned construction pits. They were also observed during the driest winter months to drink from Salt Creek, an alkali stream which forms most of the eastern boundary of the study area. A chemical analysis of a water sample taken during this period from an area of the stream that gemsbok were observed to drink is presented in Table 6. This water is generally considered unpotable for human or livestock use due to its high salt content. No data on the intervals between waterings at Salt Creek or the amounts consumed have yet been collected.

Department of Defense personnel stationed at Rhodes Canyon Range Center maintained a fresh water tub at the installation which received some gemsbok use. Water for the tub as well as for all other

installation uses was trucked in from Stallion Range Center on the northern boundary of the Missile Range. Use of this water was made primarily by a herd of cows from the most recent release. An attempt was made to determine the frequency of watering by these easily identified animals. They were observed to drink as frequently as every other day on many occasions; however, sometimes a week or more would pass without observation of drinking animals.

On some occasions the tubs would be found partially empty in the morning, possibly due to animals drinking during the night. Since identification of these night drinking animals could not be made, it was impossible to determine intervals between waterings for individuals. Since only those gemsbok from the most recent release (or animals closely following them) were observed to utilize the watering tub, the results may not apply to the wild animals.

The gemsbok at WSMR have been studied only during a period of average or above average rainfall. Precipitation during the period June 1972 through March 1973 was 178 percent the mean for that same period, and vegetation during the early months of the field study reflected this increase in moisture. Additional research during periods of prolonged drought will be needed to reveal the gemsbok's reaction when temporary water accumulations may not be available and the quality of water from Salt Creek can be expected to decrease.

Mineral Requirements

The mineral needs of the gemsbok are not known. In Africa they are reported to utilize the natural "licks" or braks" where natural concentrations of salts occur (Eloff, 1959). Gemsbok at WSMR were observed on only three occasions to lick the soil near Salt Creek where the concentrations of salts were high. No preferred "lick" areas were discovered. Perhaps the salt content of the soil and vegetation throughout the study area is high enough so gemsbok do not need to utilize the same "licks" consistently.

Mortality Factors

Only three cases of gemsbok mortality were confirmed, and two cases of suspected mortality by predation were known, but not confirmed. The three confirmed cases involved adult animals, and in each case the cause of death was not determined. A confirmed mortality occurred prior to this field study involving a recently released individual near the head of Cottonwood Canyon (Figure 1). The carcass of this animal was found near the road by a WSMR employee in the advance stages of decomposition.

The second confirmed case of mortality involved a cow from the June 6, 1973 release. She was discovered 11 days later by a WSMR employee after being observed alive by the author the same day at the same location. Her body was taken to a local veterinarian but no definite cause of death was established (the results of the post-mortem

examination are presented in the Appendices). Unknown to this author and the veterinarian at the time of the examination was that the cow had received two shots of tranquilizing agent (M-99) when she was prepared for transport from the Albuquerque Zoo to WSMR 11 days before. Also, a point from one of the tranquilizer darts broke off in the thigh muscle and was not recovered.

The third confirmed mortality involved a young adult bull which was part of the April 25, 1973 release. This individual was observed as part of the "satellite" herd ranging in area C (Figure 28) on September 22, 1973. He was not seen again until his body was discovered by the author on March 16, 1974 in subsector B-3. The skeletal remains were complete, but the body was badly decomposed, appearing to have been dead for at least a couple of months. No evidence as to the cause of death could be determined.

Predation

Eloff (1964) and other authors reported kills of gemsbok in Africa by lions (Panthera leo). Eloff (1964) also mentions kills made by spotted hyena (Crocuta crocuta). Other possible gemsbok predators in Africa include Cape hunting dog (Lycaon pictus), leopard (P. pardus), cheetah (Acinonyx jubatus), and caracal (Lynx caracal).

Possible gemsbok predators on WSMR included mountain lions (Felis concolor), coyotes (Canis latrans), and bobcat (Lynx rufus). Mountain lions, although present through the San Andres Mountains,

have not been observed or reported on the study area itself. Reports were received from WSMR personnel of one mountain lion sighted twice south of the study area in the flat creosotebush country. This is considered rare, as all other reports of mountain lion were only in the mountainous ranges and out of the gemsbok habitat. No attempts of gemsbok predation by mountain lions were known.

Fox (Urocyon cinereoargenteus), badgers (Taxidea taxus), and especially skunks (Mephitis mephitis) are all believed at this time to be too small to serve as effective predators against even gemsbok calves. While bobcats may possibly be large enough to attempt taking calves, no evidence was found to suggest that they did.

The only confirmed instance of attempted predation on gemsbok by any species was done by coyotes on a newborn calf. On January 5, 1974 from 7:10 a.m. till 12:30 p.m. a group of at least six coyotes were observed attempting to attack a newborn gemsbok calf. The calf was protected by the mother and other adults which would kick at the coyotes with their front legs. The calf was bedded down in open cover about 50 yards from habitat type 6 (Mesquite-Grass) which was a preferred resting area for the gemsbok in subsector F-1. Once the coyotes had retreated out of view, the mother left the calf to return to the mesquite patch and the rest of the herd of 11 animals. About 10 minutes later the cries of the calf were heard as six coyotes attacked it. The mother, joined by three bulls, ran from the mesquite patch

and pawed at the coyotes, running them away from the calf. Soon they were joined by the rest of the herd.

The coyotes walked among the herd, but the gemsbok attacked a coyote only if it would approach within about 5 yards (5 meters). Otherwise the gemsbok would not attempt to charge, possibly because a coyote could easily dodge a charge. Eventually the coyotes retreated out of view and the adult gemsbok returned to the mesquite patch; however, the calf again bedded down alone in the open. This time the mother and two other adults bedded down on the edge of the mesquite patch watching towards the calf.

About 20 minutes later the mother was seen running to the spot where the calf was laying down and again chased two coyotes. The rest of the gemsbok herd stood on alert on the edge of the mesquite patch, some walking towards the mother and calf. After the calf suckled, the mother and the herd returned to the cover of the mesquite patch with the calf following. The calf remained near the safety of the herd for the rest of the observation period.

The following day the same mother was observed standing in the same mesquite patch with her calf bedded down nearby but out of view to this author. A coyote was seen also bedded down not more than 10 yards (10 meters) from the mother. No attempts were made by the mother to chase away the coyote. Instead, the coyote appeared content to lay in wait for his opportunity to get the calf when left unguarded by

the mother. As the calf was not in view to the author at this time, the cow was approached to look for the calf. This caused her to run towards the rest of the herd which was bedded down nearby. At this instant the coyote ran to the calf and began attacking it on the back of the neck. The cries of the calf prompted the mother to return and run the coyote off with her kicking. The calf followed the mother to the rest of the herd, and a coyote was seen circling the herd and looking towards the calf. Eventually, no coyotes were in view and the calf was seen bedded down in proximity to its mother and the rest of the herd for the duration of the observation. This was the last time the calf was seen, although the mother was seen on several subsequent occasions.

On January 15, 1974 another newborn calf was observed in the same area. The next day the mother was first seen drinking alone at Salt Creek. It did not join her lone calf in the mesquite patch until more than two hours later. Although the mother was seen on several later days, this was the last time this calf was observed.

A third cow was observed during this month which appeared pregnant. A calf, if she had one, was never observed although this cow was seen on several subsequent occasions.

No other evidence of predation on newborn calves by coyotes were observed. The attempts reported occurred in January, a mid-winter month when other coyote prey species were scarce. Most

calves during this study were born during or near the month of March, and no coyote problems were then observed. Although some calves may be lost to coyotes, it is not felt at this time that the effect will be enough to cause a severe reduction in gemsbok population growth. Future studies are suggested to better understand the effects of coyote predation upon gemsbok.

CHAPTER VI

GEMSBOK NATIVE RANGE

Distribution

A map, Figure 34, illustrates the approximate known distribution of gemsbok (Oryx gazella) in their native range of Africa. Shortridge (1934) stated that gemsbok had been recorded from every part of South West Africa except the Caprive, east of the Okavango River. According to the same author, they range everywhere towards the coast between the mouths of the Orange and Cunene rivers, but in the middle Namib (Walvis Bay area) they appear uncommon. In Angola gemsbok are restricted to the southwest, and have never been recorded north of the Caprollo River (Shortridge, 1934). Gemsbok also occurred in parts of northern and western Botswana and in extreme western Rhodesia, but were not plentiful there.

Habitat

The characteristics of the native habitats of the gemsbok can be obtained from a vegetative study of the Kalahari Gemsbok National Park conducted by Leistner and Werger (1973) where gemsbok were reported to be well established (Meester, 1964). The following descriptions of the Kalahari are derived from the report of Leistner and Werger (1973).

Figure 34. Distribution of gemsbok (Oryx gazella) in Africa.

Physiography

The Kalahari Gemsbok National Park is largely covered with a layer of wind-blown sand piled into dunes. The monotony of the landscape is broken by several pans (shallow depressions with a flat, level surface), and by two large dry river beds. Calcrete, which is a hard sheet of limestone occurring beneath the sand, is exposed in outcrops occurring along the river courses and around pans.

Soils

Soils can be basically divided into sandy and fine soils. At least 90 percent of the surface of the southern Kalahari is covered by sand, primarily that which is red in color. Some white sand can be found in pans, river beds, and calcrete outcrops. Fine soils (less than 10 percent sand) are deposited by water and are found only in river beds and pans. The soils of the pans are rich in minerals and are very alkaline, with pH of up to 8.8 being recorded. No distinct soil horizons occurred in the Kalahari.

Vegetation

Four main habitat types were recognized: the communities of the sand (covering at least 90 percent of the surface area), the calcrete, the pans, and the dry river beds.

The vegetation of the sandy habitat was generally an extremely open shrub or tree savanna. The dominant woody species were Acacia haematoxylon and A. giraffae. The average ground cover of four

communities of the sands based on 73 vegetation quadrats was 13.9 percent with plots ranging between 5 percent and 45 percent cover.

Four communities were recognized in the pan habitat type. The average ground cover based on 26 quadrats was 25.2 percent with quadrats ranging between 3 percent and 35 percent.

The calcrete habitat had only a single community. Chamaephyte vegetation was prominant. The average ground cover based on 16 vegetation quadrats was 11.6 percent with plots ranging from 6 percent to 30 percent.

Only a single community was reported in the river bed habitat. Average ground cover based on 14 quadrats was 28.6 percent with quadrats ranging between 4 percent and 80 percent.

Climate

Leistner and Werger (1973) described the climate of the Southern Kalahari as follows:

> "The Southern Kalahari is largely a semi-desert region with an average annual precipitation ranging from about 150 mm (5.9 in) in the southwest to 300 mm (11.7 in) in the north. The rainfall is very unreliable, however, and, while one year the precipitation may be less than a third of the average amount, it may be more than double the following year. Within the Gemsbok Park the rainfall shows a marked gradient from about 150 mm (5.9 in) at Twee Rivieren to an estimated 220 mm (8.6 in) at Union's End. About 75 to 85 percent of the rain falls during the summer months. The Southern Kalahari lies in one of the hottest regions of South Africa, yet at the same time it experiences fairly severe frosts during winter. In the Gemsbok Park the mean daily maximum temperature during January, the hottest month, is about

$34^{\circ}C$ ($93^{\circ}F$), while the mean daily minimum during the coldest months, June and July, is about $1^{\circ}C$ ($34^{\circ}F$)."

Weather data collected at two Kalahari locations, the town of Upington and Twee Riviere Camp, is presented in Tables 17 and 18. Twee Riviere Camp is situated in the Kalahari Gemsbok National Park and near the center of the present distribution of the gemsbok. Upington, while situated on the southern limits of the present gemsbok distribution, was formally occupied by gemsbok before the arrival of settlers to that area.

Discussion

Several similarities exist between the native range of the gemsbok in the Kalahari desert of Africa and their new range in the White Sands Missile Range of New Mexico. The main difference between the two areas is that the seasons are reversed. While June and July are the hottest months at WSMR, they are the coldest months at the Kalahari, and while December and January are the coldest months at WSMR, these are the hottest months at the Kalahari. The mean maximum temperature during the hottest months at WSMR is $93.5^{\circ}F$ ($34^{\circ}C$) (Table 3), while in the Kalahari it is $93^{\circ}F$ ($34^{\circ}C$) (Liestner and Werger, 1973). The mean minimum temperature during the coldest months is $26^{\circ}F$ ($-3^{\circ}C$) at WSMR (Table 3), and $34^{\circ}F$ ($1^{\circ}C$) at the Kalahari (Liestner and Werger, 1973). Both areas experience frosts during winter.

Table 17. Average monthly temperatures, precipitation, and evaporation rates. Upington, South Africa, 1965-1973.

Month	Temperature °F	Temperature °C	Precipitation in	Precipitation mm	Evaporation in	Evaporation mm
January	82.0	27.8	0.27	6.8	18.7	478.3
February	79.6	26.4	2.25	57.7	13.8	352.5
March	76.1	24.5	1.94	49.8	11.9	304.7
April	67.3	19.6	1.52	39.0	7.7	198.1
May	59.4	15.2	0.50	12.8	6.1	157.4
June	54.0	12.2	-	0.1	5.3	136.2
July	53.6	12.0	0.01	0.3	6.2	159.9
August	57.9	14.4	-	0.1	8.0	205.1
September	64.4	18.0	0.08	2.1	10.4	267.0
October	70.3	21.3	0.36	9.2	13.5	345.7
November	77.0	25.0	0.27	6.8	16.3	417.3
December	79.9	26.6	0.55	14.0	18.1	464.1

Table 18. Average monthly temperatures, precipitation, and evaporation rates. Twee Rivieren, South Africa, 1965-1973.

Month	Temperature °F	Temperature °C	Precipitation in	Precipitation mm	Evaporation in	Evaporation mm
January	82.4	28.0	1.42	36.5	15.7	402.1
February	61.5	16.4	1.91	48.9	11.4	292.8
March	75.9	24.4	1.20	30.9	10.8	276.9
April	67.6	19.8	1.72	44.2	6.9	176.6
May	58.8	14.9	0.61	15.7	5.8	148.1
June	53.4	11.9	-	0.3	4.7	120.6
July	52.9	11.6	-	0.1	5.9	151.1
August	57.4	14.1	0.00	0.0	7.6	194.9
September	63.9	17.7	0.05	1.3	10.0	257.8
October	70.9	21.6	0.55	14.0	12.6	323.1
November	77.4	25.2	0.47	12.2	14.4	370.5
December	80.6	27.0	0.42	10.9	16.2	415.8

The mean annual precipitation at Jallen Site, WSMR is 8.31 inches (211 mm) per year (Table 2). The mean annual precipitation at Twee Rivieren Camp, South Africa is 8.35 inches (212 mm) per year (Table 18). Nearly 75 percent of the precipitation at Jallen Site, WSMR (Table 2) falls during the summer months (June through October) and about 75 percent to 85 percent of the precipitation at the Kalahari falls during the summer months (Liestner and Werger, 1973). Figure 35 plots the distribution of rainfall at Jallen Site, WSMR and compares it to the average for two Kalahari locations, Twee Rivieren and Upington.

Humidity is very low in both areas. The mean annual open pan evaporation is in excess of 90 inches (229 cm) at both White Sands Missile Range (Post Engineers WSMR, 1972) and the Kalahari (Tables 25 and 26).

At least 15 genera of plants are present in the Kalahari (Liestner and Werger, 1973) which are also found at WSMR (U.S. Department of Agriculture, 1970). Five of these were found to be gemsbok food at WSMR (Table 25). They include Sporobolus spp., Salsola spp., Aristida spp., Setaria spp., and Panicum spp. While mesquite (Prosopis juliflora) and Creosotebush (Larrea tridentata) were not reported in the Kalahari, several species of acacia (Acacia spp.) were found which have a similar growth form to either mesquite or creosotebush. Ranges in percent ground cover are also similar in the two areas.

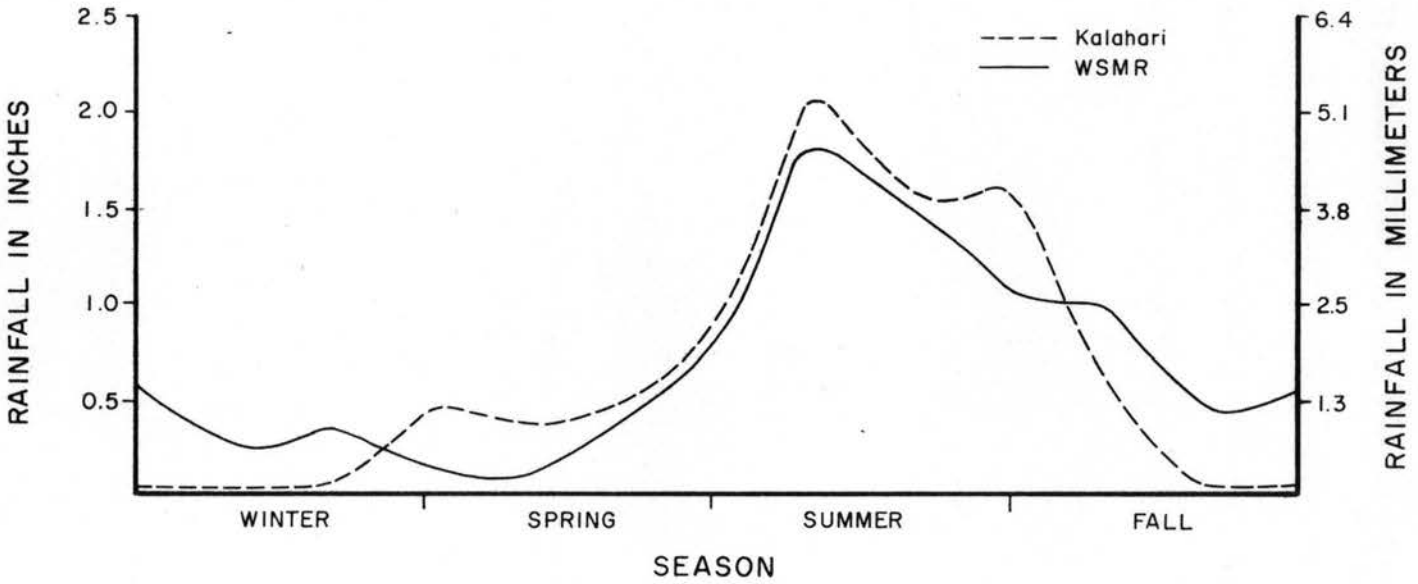

Figure 35. Distribution of rainfall at WSMR, New Mexico and the Kalahari, Africa.

Shallow depressions called pans which are flat, level, and characterized by internal drainage and highly alkaline soils are widespread in the Kalahari (Liestner and Werger, 1973). Shallow depressions called alkali flats which are flat, level, and characterized by internal drainage and highly alkaline soils are widespread at WSMR (U.S. Department of Agriculture SCS, 1970).

CHAPTER VII

SUMMARY AND RECOMMENDATIONS

Summary

The gemsbok (Oryx gazella) is a large desert dwelling antelope native to the Kalahari desert of Africa. It was released at the White Sands Missile Range (WSMR), New Mexico, as part of the exotic mammal program of the New Mexico Department of Game and Fish. The program is aimed at establishing huntable populations of foreign big game in areas of the State which are too dry or otherwise unsuited for establishment of huntable populations of native big game.

This was the first study to be conducted on wild gemsbok out of their native range. The objectives were to gather basic information on the ecology and behavior of the gemsbok in their newly released area of WSMR, New Mexico. From this, future studies could be more efficiently planned and executed.

Movements

Over 1,400 observations on gemsbok movements involving 60 different animals were recorded. Average daily movement for each animal was less than one mile (1.6 km). The longest recorded daily movement was 8.92 miles (14.3 km). Gemsbok movements were complex and no trends were established. No conclusive evidence was

found to prove the existence of well defined seasonal ranges. Known ranges of the gemsbok during the study were defined and mapped. Radio telemetry equipment proved an invaluable tool in tracking and locating animals.

Habitats

Gemsbok were observed throughout the study in a wide variety of habitats, from rocky foothill slopes to barren alkali flat. They were, however, observed more frequently and in greater numbers in particular types of habitat. Characteristics of habitats used most often by the gemsbok at WSMR were:

a. flat to gently undulating topography

b. non-rocky soils

c. vegetation consisting of an interspersion of semi-desert shrubs and grasses.

Behavior

The average size of 455 herds observed was 6.28 animals. Average monthly herd size ranged from 3.00 in February to 10.55 in October. Lone individuals were common, occurring in nearly 25 percent of all observations. The largest herd observed was of 31 animals. Herds were composed of animals of all sex and age categories throughout the year.

Gemsbok performed mating activities year around, with large dominant bulls performing most of the breeding. After an eight to

nine month gestation calves were born. Most cows appeared to give birth on or near the month of March.

Food Habits

An index to gemsbok food habits was determined by microscopic examination of fecal materials from 12 monthly collections. Percent relative density of major foods found in the feces included:

a.	Mesquite	35.3%
b.	Grasses (all species)	28.6%
c.	Tumbleweeds	22.3%
d.	Yucca leaves	11.8%
e.	Other	2.0%

The results correlated well to visual observations of gemsbok feeding in the field.

Cover Mapping

Cover maps showing vegetative communities were prepared. One map showing major communities was derived from a study done by the USDA Soil Conservation Service in 1970. Two subsectors receiving high gemsbok use were mapped to finer detail and vegetation transects run through the types.

Permanent sources of fresh water were not available in the study area. Salt Creek is an alkali spring forming its eastern boundary. This was the only permanent source of water in the study area.

No evidence was found to suggest the existence of continually preferred movement routes.

Climate

Weather data was collected at Jallen Site near the center of the study area. A comparison of climatic and other factors was made between the study area and the native range of the gemsbok. There exists a remarkable degree of similarity between the two areas.

Recommendations

The following recommendations are offered concerning future studies of the gemsbok at White Sands Missile Range:

Movements

Since locating and recording movements of gemsbok was greatly facilitated by the use of radio telemetry equipment, this method should be continued in future years. Spare telemetry collars should be held in reserve. As soon as evidence suggests that batteries are weakening on a transmitter, the animal should be captured while the signal is still alive and the transmitting collar should be replaced. It may be possible to do this in the field without the aid of a helicopter if the batteries are not allowed to drain beyond transmitting level. The replaced collar can then be equipped with fresh batteries and serve as the next reserve. The number of telemetry equipped animals should be increased from the present six to a minimum of ten to allow for an increasing population and simultaneous monitoring of several

gemsbok in a variety of habitats. The number of 16 foot "H" antennas permanently mounted on 40 foot masts should be increased from the present three to six to allow for the expanding ranges of the animals.

Habitats

Future preferred habitats should be defined and compared with habitats used during this study. Vegetation mapping of these habitats should be performed and vegetative transects run in the types. Since rainfall and vegetation were above average during this study, careful attention must be placed to habitat types used during periods of drought.

Behavior

Continued monitoring of gemsbok behavior should take place. Since the study took place during a period of abnormal rainfall, observations should be performed during other periods to detect possible changes in behavior. Since herd size and behavior may be a factor of total population, studies of gemsbok behavior should continue as the population increases.

Due to the year round calving, scattered herds, and other variable factors, the gemsbok reproductive rate and the survival of the young were not adequately determined during this study. Since such information is necessary for sound management, it is suggested that radio telemetry equipment be utilized to assist in obtaining this data. It is suggested that a minimum sample of 10 adult females and 10

young calves be equipped with transmitters and relocated at frequent intervals (minimum of two weeks) during a full year. Such a study should provide information on calving frequency and survival of young.

Food Habits

Although the fecal microanalysis technique used to determine gemsbok food habits did not provide the exact percentages of plants consumed, it did provide a valuable index. Since this method is relatively cheap and easy to perform, it is suggested that such analysis be continued in the future to allow for a collection of comparable data. Food habits studies should be conducted for several years and under varying climatic conditions in order to obtain a more thorough knowledge of the overall feeding habits of the gemsbok.

Physiological Information

Since captive semi-tame animals are available at Red Rock, some of them should be utilized in research to obtain physiological information. Such items as weight gains, growth rates, utilization efficiency of various foods, water turnover, and reproductive behavior should be obtained. Comparisons of this information with that available for livestock, deer, and pronghorn antelope would be helpful in developing management plans.

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APPENDICES

Appendix A
A partial list of plant species found on WSMR

Shrubs and Trees

Scientific Name	Common Name
Acacia constricata	Mescat acacia; Whitethorn
Acacia greggii	Catclaw acacia
Agave parryi	Parry agave; Century plant
Allenrolfea occidentalis	Pickleweed, Iodinebush
Artemisia filifolia	Sand sagebrush
Atriplex canescens	Chamiza; fourwing saltbush
Atriplex Corrugata	Mat saltbush
Baccharis glutinosa	Seepwillow baccharis
Berberis trifoliolata (Mahonia trifoliolata)	Algerita; laredo mahonia
Ceanothus greggi	Desert ceanothus
Cercocarpus montana	True mountain mahogany
Chilopsis linearis	White desert willow
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus pulchellus	Southwest rabbitbrush
Coldenia hispidissina	Rough coldenia
Condalia spatulata	Knifeleaf condalia
Coryphantha macromeris	Nipple beehive cactus
Dalea formosa	Feather dalea
Echinocereus triglochidiatus	Claretcup echinocereus; Flaming torch hedgehog
Ephedra torreyana	Torrey ephedra
Ephedra trifurca	Longleaf ephedra
Eurotia lanata	Common winterfat
Fallugia paradoxa	Apache plume
Fouquieria splendens	Ocotillo
Flourensia cernua	American tarbush
Garrya wrighti	Wright's silktassel
Gutierrezia sarothrae	Broom snakeweed
Holodiscus dumosus	Bushrockspirea
Hymenoclea monogyra	Singlewhorl burrobrush
Juniperus monosperma	One seed juniper
Juniperus deppeana	Alligator juniper

Shrubs and Trees (continued)

Koeberlinia spinosa	Spiny allthorn
Krameria glandulosa	Range krameria; range ratany
Larrea divaricata	Spreading creosotebush
Lycium berlandiera	Berlandier wolfberry
Nolina microcarpa	Sacahuista
Opuntia engelmannii	Engelmann pricklypear
Opuntia imbricata	Walkingstick cholla
Opuntia leptocaulus	Desert Christmas cholla (Tesajo)
Parthenium incanum	Mariola parthenium
Pinus edulis	Pinyon pine
Pinus ponderosa	Ponderosa pine
Poliomintha incana	Hoary rosemarymint
Populus wislizeni	Rio Grande Poplar; Rio Grande cottonwood
Prosopis juliflora	Common mesquite; honey mesquite
Quercus gambeli	Gambel oak
Quercus turbinella	Shrub live oak
Rhus microphylla	Littleleaf sumac
Rhus trilobata	Skunkbush sumac; squawbush
Salix gooddingi	Goodding willow
Tamarix gallica	French tamarisk
Yucca angustifolia	Fineleaf yucca
Yucca baccata	Datil yucca
Yucca elata	Soaptree yucca

Forbs

Scientific Name	Common Name
Abronia angustifolia	Narrowleaf sandverbena
Allionia incarnata	Trailing allionia; trailing four o'clock
Amaranthus retroflexus	Redroot amaranth
Amsonia arenaria	Dogbane
Aplopappus spinulosus	Cutleaf goldenweed
Aplopappus heterophyllus	Jimmyweed

Forbs (continued)

Asclepias arenaria	Sand milkweed
Asclepias galiodes	Poison milkweed
Aster linearis	Savoryleaf aster
Aster parvula	Bog aster
Aster tanacetifolius	Tansyleaf aster
Astragalus allochrous	Halfmoon loco
Cassia lindheimeriana	Lindheimer senna
Centaurea pieris	Russian centaurea
Centaurium texens	Texas centaurium
Cervallia sinuata	Stinging cervallia
Cirsium wheeleri	Wheeler thistle
Clappia suaedifolia	Fleshyleaf clappia
Comandra pallida	Western comandra; bastardtoadflax
Cressa truxillensis	Silky cressa
Cryptantha fulvocanescens	Cryptantha
Cucurbita foetidissima	Buffalogourd
Dicranocarsus parviflorus	Pitchfork dicranocarsus
Dithyraea wislizena	Wislizenus spectaclepod
Erigeron arenarius	Fleabane; wild daisy
Eriogonum rotundifolium	Roundleaf eriogonum
Euphorbia albomarginata	Whitemargin euphorbia
Euphorbia lata	Hoary euphorbia
Euphorbia serrula	Sawtooth euphorbia
Eustoma russellianum	Russell prairiegentian
Frankenia jamesii	James frankenia
Gaura coccinea	Scarlet gaura
Gilia pumila	Low gilia
Greggia camporum	Mesa greggia
Greggia linearifolia	Narrowleaf greggia
Lelianthus annuus	Common sunflower
Hoffmanseggia densifolia	Indian rushpea
Hymenopappus arenosus	Woollywhite; hymenopappus
Kallstroemia hirsutissima	Hairy caltrop
Lepidium montanum	Montana pepperweed
Lepidium alyssoides	Mesa pepperweed
Limonium limbatum	Bordered sea-lavender
Lippia incisa	Tidestrom

Forbs (continued)

Mentzelia integra	Blazingstar mentzelia
Mentzelia multiflora	Desert mentzelia
Mentzelia pumila	Yellow mentzelia
Mirabilus multiflora	Colorado four o'clock
Nama hispidum	Rough nama
Oenothera albicaulis	Pale eveningprimrose
Oenothera runcinata	White eveningprimrose
Oenothera hartwegii	Hartweg eveningprimrose
Oenothera lavandulaefolia	Lavenderleaf eveningprimrose
Pectis angustifolia	Crownseed pectis
Peganum harmala	Harmel peganum
Penstemon barbatus	Beardlip penstemon
Perezia nana	Desertholly
Phacelia corrugata	Wavyleaf phacelia; bluecurls
Psilostrophe tagetinea	Woolly paperflower
Salsola kali var tenuifolia	Tumbling Russianthistle
Sartwellia flaverias	Threadleaf sartwellia
Selinocarpus albicaulis	Whitestem moonpod
Selinocarpus lanceolatus	Gyp moonpod
Senecio longilobus	Threadleaf groundsel
Sida lepidota	Scurfy sida
Sideranthus anstralis (Aplopappus anstralis)	Southern goldenweed
Solanum elaeguifolium	Silverleaf nightshade
Sphaeralcea angustifolia	Narrowleaf globemallow
Sphaeralcea incana	Soft globemallow
Sphaeralcea lobata	Lobed globemallow
Streptanthus arizonicus	Arizona twistflower
Suaeda suffrutescens	Desert seepweed
Suaeda torreyana	Torrey seepweed
Thelesperma megapotamicum	Hopi tea greenthread
Tidestromia lanuginosa	Woolly tidestromia
Verbena bracteata	Bigbract verbena
Verbesina encelioides	Golden crownbeard
Zinnia grandiflora	Rocky Mountain zinnia

Grasses

Scientific Name	Common Name
Agropyron smithi	Bluestem wheatgrass; Western wheatgrass
Andropogon barbinodis	Cane bluestem
Andropogon saccharoides	Silver bluestem
Andropogon scoparius	Little bluestem
Aristida adscensionis	Six weeks threeawn
Aristida divaricata	Poverty threeawn
Aristida fendleriana	Fendler threeawn
Bouteloua barbata	Six weeks grama
Bouteloua breviseta	Gyp grama
Bouteloua curtipendula	Sideoats grama
Bouteloua eriopoda	Black grama
Bouteloua gracilis	Blue grama
Bouteloua hirsuta	Hairy grama
Bromus carinatus	Mountain brome
Chloris virgata	Showy chloris; Feather fingergrass
Distichlis stricta	Inland saltgrass
Eragrostis erosa	Chihua lovegrass
Hilaria jamesi	Galleta
Hilaria mutica	Tobosa
Koeleria cristata	Prairie junegrass
Leptochloa dubia	Green sprangletop
Lycurus phleoides	Wolftail
Muhlenbergia arenacea	Ear muhly
Muhlenbergia asperifolia	Alkali muhly
Muhlenbergia dubia	Pine muhly
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia metcalfei	Metcalfe muhly
Muhlenbergia porteri	Bush muhly
Muhlenbergia richardsonis	Mat muhly
Muhlenbergia torreyi	Ring muhly
Oryzopsis hymenoides	Indian ricegrass
Oryzopsis micrantha	Littleseed ricegrass
Panicum hallii	Halls panicum
Panicum obsusum	Vine mesquite
Poa fendleriana	Mutton bluegrass

Appendix B
Partial list of faunal species found on WSMR

Mammals

California Myotis	Myotis californicas
Small-footed Myotis	Myotis sublatus
Hoary Bat	Lasiurus cinereus
Western Big-eared Bat	Corynorhinus rafinesquii
Mexican Freetail Bat	Tadarida mexicana
Pallid Bat	Antrozous pallidus
Badger	Taxidea taxus
Kit Fox	Vulpes macrotis
Gray Fox	Urocyon cinereoargenteus
Red Fox	Vulpes fulva
Ringtail Cat	Bassariscus astutus
Raccoon	Procyon lotor
Coyote	Canis latrans
Spotted Skunk	Spilogale gracilis
Striped Skunk	Mephitis mephitis
Hognose Skunk	Conepatus mesoleuces
Mountain Lion	Felis concolor
Bobcat	Lynx rufus
Spotted Ground Squirrel	Citellus spilesoma
Blacktail Prairie Dog	Cynomys ludovicianus
Rock Squirrel	Citellus variegatus
Whitetail Antelope Squirrel	Citellus leucurus
Plains Pocket Gopher	Geomys arenarius
Mexican Pocket Gopher	Cratogeomys castanops
Pigmy Pocket Gopher	Thomomys umbrinus
Silky Pocket Mouse	Perognathus flavus
Apache Pocket Mouse	Perognathus apache
Desert Pocket Mouse	Perognathus penicillatus
Bannertail Kangaroo Rat	Dipodomys spectabilis
Merriman Kangaroo Rat	Dipodomys merriami
Ord Kangaroo Rat	Dipodomys ordi
Southern Grasshopper Mouse	Onychomys torridus
Northern Grasshopper Mouse	Onychomys leucogaster
Western Harvest Mouse	Reithrodontomys megalotis
Deer Mouse	Peromyscus maniculatus
Hispid Cotton Rat	Sigmodon hispidus
Southern Plains Woodrat	Neotoma micropus
Whitethroat Woodrat	Neotoma albigula
Desert Woodrat	Neotoma lepida
Mexican Woodrat	Neotoma mexicana

Mammals (continued)

Porcupine	Erethizon dorsatum
Blacktail Jackrabbit	Lepus californicus
Desert Cottontail	Sylvilagus audoboni
Pronghorn Antelope	Antilocapra americana
Mule Deer	Odocoileus hemionus
Bighorn Sheep	Ovis canadensis
Gemsbok	Oryx gazella
Feral Horse	Equus caballus

Birds

Western Grebe	Great Blue Heron
Horned Grebe	Snowy Egret
Eared Grebe	White-faced Glossy Ibis
Pied-billed Grebe	
	Canada Goose
White Pelican	Snow Goose
Black Crowned Night Heron	Mallard
Gadwall	Long-billed Curlew
Pintail	Spotted Sandpiper
Green-winged Teal	Solitary Sandpiper
Blue-winged Teal	Willet
Cinnamon Teal	Greater Yellow-legs
American Widgeon	Least Sandpiper
Shoveller	
Redhead	Long-billed Dowitcher
Ring-necked Duck	Semipalmated Sandpiper
Canvasback	Western Sandpiper
Greater Scaup	Baird's Sandpiper
Lesser Scaup	Lesser Yellow-legs
Ruddy Duck	American Avocet
Bufflehead	Black-necked Stilt
	Wilson's Phalarope
Common Merganser	
Turkey Vulture	Bonapartes' Gull
	Ring-billed Gull
Sharp-shinned Hawk	Franklin's Gull

Birds (continued)

Cooper's Hawk
Ferruginous Hawk
Black Hawk
Western Red Tailed Hawk
Swainson's Hawk
Rough-legged Hawk

Golden Eagle

Marsh Hawk
Prairie Falcon
Peregrine Falcon
Pigeon Hawk
Desert Sparrow Hawk
Sharp-shinned Hawk
Zone-tailed Hawk

Gambel's Quail
Scaled Quail
Harlequin Quail
Chukar
Turkey

Sandhill Crane
Black-bellied Plover

Common Gallinule
American Coot
Virginia Rail

Semipalmated Plover
Snowy Plover

Killdeer
Common Snipe

Ash-throated Flycatcher
Empidonax sp.
Black Phoebe
Western Wood Phoebe

Horned Lark

Black Tern
Forster's Tern

Mourning Dove
Ground Dove
White-winged Dove
Band-tailed Pigeon

Roadrunner

Great Horned Owl
Short-eared Owl
Screech Owl
Burrowing Owl
Spotted Owl

Poor-will
Common Nighthawk
Lesser Nighthawk

White-throated Swift
Black-chinned Hummingbird
Broad-tailed Hummingbird

Belted Kingfisher

Ladder-backed Woodpecker
Red Shafted Flicker
Acorn Woodpecker

Yellow-bellied Sapsucker
Vermillion Flycatcher
Western Flycatcher
Western Kingbird
Cassins's Kingbird

Cedar Waxwing

Northern Shrike
Loggerhead Shrike

Starling

Birds (continued)

Violet-green Swallow
Tree Swallow
Bank Swallow
Rough-winged Swallow
Barn Swallow
Cliff Swallow
Purple Martin

Crow
White-necked Raven
Pinon Jay
Steller's Jay
Scrub Jay
Clark's Nutcracker

Red-breasted Nuthatch
Brown Creeper

Bewick's Wren
Long-billed March Wren
Rock Wren
Cactus Wren
House Wren
Canyon Wren

Mockingbird
Crissal Thrasher
Sage Thrasher
Curve-billed Thrasher

Robin
Hermit Thrush
Swainson's Thrush
Townsend's Solitaire
Phainopepla
Gray Vireo
Warbling Vireo
Solitary Vireo
Mountain Bluebird
Western Bluebird
Blue-grey Gnatcatcher
Ruby-crowned Kniglet
Verdin

Painted Redstart
Orange-crowned Warbler
Yellow Warbler
Audubon's Warbler
MacGillivray's Warbler
Yellow-throat
Wilson's Warbler
Black-and-White Warbler
Palm Warbler
Northern Waterthrush
Virginia's Warbler
Black-throated Gray Warbler
Townsend's Warbler

House Sparrow

Scott's Oriole
Western Meadowlark
Yellow-headed Blackbird
Red-winged Blackbird
Bullock's Oriole
Brewer's Blackbird
Boat-tailed Grackle
Common Grackle
Brown-headed Cowbird

Western Tanager
Summer Tanager
Pyrrhuloxia

Black-headed Grosbeak
Blue Grosbeak
Lazuli Bunting
Evening Grosbeak
Cassin's Finch
House Finch
Lesser Goldfinch
American Goldfinch
Lawrence's Goldfinch
Dickcissel
Green Towhee
Rufous-sided Towhee
Brown Towhee

Birds (continued)

Mountain Chickadee
Plain Titmouse
Common Bushtit

Water Pipit

Vesper Sparrow
Black-throated Sparrow
Sage Sparrow
Oregon Junco
Slate-colored Junco
Grey-headed Junco
Clay-colored Sparrow
Chipping Sparrow

Pine Siskin

Savannah Sparrow
Baird's Sparrow
Lark Bunting

Brewer's Sparrow
Black-chinned Sparrow
White Crowned Sparrow
Lincoln's Sparrow
Song Sparrow
Lark Sparrow
Rufous-crowned Sparrow
Cassin's Sparrow

Reptiles and Amphibians

Snakes

Western Hognose Snake, Heterodon nasicus
Western Coachwhip, Masticophis flagellum
Sonora Gopher Snake, Pituophis melanoleucus
Painted Desert Glossy Snake, Arizona elegans
Texas Long-nosed Snake, Rhinocheilus lecontei
Checkered Garter Snake, Thamnophis marcianus
Plains Black-headed Snake, Tantilla nigriceps
Texas Night Snake, Hysiglena torquata
Ground Snake, Sonora episcopa

Poisonous Snakes

Desert Massasauga, Sistrurus catenatus
Prairie Rattlesnake, Crotalus viridis
Western Diamondback Rattlesnake, Crotalus atrox

Lizards

Lesser Earless Lizard, Holbrookia maculata
Long-nosed Leopard Lizard, Crotaphytus wislizenii
Collared Lizard, Crotaphytus collaris
Southern Prairie Lizard, Sceloporus undulatus consobrinus
Cowles Prairie Lizard, Sceloporus undulatus cowlesi
Sesert Spiny Lizard, Sceloporus magister
Sesert Side-blotched Lizard, Uta stansburiana
Texas Horned Lizard, Phrynosoma cornutum

Lizards (continued)

Round-tailed Horned Lizard, Phrynosoma cornutum
Checkered Whiptail, Cnemidophorus tesselatus
Little Striped Whiptail, Cnemidophorus inornatus
New Mexican Whiptail, Cnemidophorus neomexicanus

Turtles

Yellow Box Turtle, Terrapene ornata

Toads

Great Plains Toad, Bufo cognatus
Red-spotted Toad, Bufo punctatus

Spadefoot Toads

Plains Spadefoot, Scaphiopus bombifrons
Western Spadefoot, Scaphiopus hammondi
Couchs Spadefoot, Scaphiopus couchi

Appendix C
Percent ground cover of grasses occurring in Habitat Types 1 - 10
May 1974

Species	Habitat Type 1	2	3	4	5	6	7	8	9	10
Aristida spp.	1.48	14.30	0.40					0.83		
Bouteloua eriopoda				Trace						
Hilaria jamesii	Trace	8.25	2.35			5.53	1.94			12.75
Muhlenbergia torreyi		0.75						4.96		
Panicum obtusum						2.87				
Setaria macrostachya	1.48	0.75	Trace							
Sporobolus spp.	9.49	1.50	3.85		2.50	9.38	17.48	0.83	2.00	4.55
Tridens pulchellus	Trace									

Appendix D
Percent ground cover of forbs occurring in Habitat Types 1 - 10
May 1974

Species	Habitat Type 1	2	3	4	5	6	7	8	9	10
Baileya multiradiata			Trace							
Circium spp.						Trace		Trace		
Conyza coulteri	0.50		0.40							
Cryptantha angustifolia				Trace						
Eriogonum rotumdifolium			Trace							
Lappula redowski			Trace							
Lepidium montanum	0.50	Trace	0.75		0.80			Trace		Trace
Phacelia popei	Trace									
Salsola kali	2.96	1.50	0.20		Trace					Trace
Sphaeralcea angustifolia	Trace	0.75								
Sueda torreyana					0.80				3.00	
Verbena wrightii				Trace						

Appendix E
Percent ground cover of shrubs occurring in Habitat Types 1 - 10
May 1974

Species	Habitat Type 1	2	3	4	5	6	7	8	9	10
Atriplex canescens	2.65	0.50		0.10	3.90	1.63	2.10	5.80		5.80
Ephedra spp.							0.30	3.00		
Flourencia cernua			0.05		0.10					
Guttierezia sarothrae				1.00		Trace				
Koeberlinia spinosa					1.20					
Larrea tridentata		2.00	21.25	20.00				5.80		
Opuntia leptocaulus			0.05					Trace		
Prosopis juliflora		22.50	0.60	6.60	12.50	19.50	0.50			3.10
Rhus microphylla				1.10						
Sarcobatus vermiculatus			0.50			Trace		2.70		
Tamarix pentandra	Trace								5.00	
Yucca elata				0.35				Trace		

Appendix F
Percent relative density of discerned fragments from gemsbok fecal samples based on 400 fields per sample, June 1973 - May 1974

Tentative Identifications	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Aristida spp.		0.15	0.55		0.09	0.16			0.09		0.09	
Bouteloua spp.	0.92	2.77	10.32	0.49	4.15	0.49	0.81		2.44		0.17	0.04
Hilaria mutica	0.20	0.59	0.60	0.44	0.13		0.69	0.82	0.28	0.31	3.41	0.76
Panicum obtusum				0.05			0.17		0.19			
Setaria macrostachya	28.22	16.77	10.91	2.11	1.71	0.16	1.17	1.97	5.70	0.42	2.48	3.94
Sporobolus spp.	2.10	7.51	10.56	9.95	5.01	1.88	12.78	56.45	14.31	60.89	26.76	11.05
Other grasses	1.02	3.75	2.52	1.79	1.57	0.65	2.40	0.30	1.35		0.35	0.45
Atriplex canescens					0.04		0.06	6.57	0.47	3.32	1.04	0.86
Hoffmanseggia densiflora	0.05			0.05		0.12	0.11					
Prosopis juliflora	11.19	26.80	33.28	62.73	57.89	67.83	60.44	15.00	30.84	6.32	7.10	22.51
Salsola kali	50.30	37.26	28.14	19.91	25.53	23.04	19.86	4.94	0.19	9.69	12.45	36.76
Sphaeralcea spp.	3.40	3.28	1.97	0.84	3.44	2.53	1.23	6.82	0.57	0.21	0.78	5.56
Yucca spp.	0.05	0.34			0.31	2.82	0.17	13.13	42.81	18.84	45.11	17.81
Other forbs	0.55	0.78	1.05	1.64	0.13	0.32	0.11		0.76		0.26	0.26

Appendix G

Percentage of diets for wild horses from the White Sands Missile Range in southern New Mexico, 1973-74

Kinds of plants	Months of Collections											
	June 73	July 73	Aug. 73	Sept. 73	Oct. 73	Nov. 73	Dec. 73	Jan. 74	Feb. 74	Mar. 74	Apr. 74	May 74
Wheatgrass (Agropyron)	18.41	10.87	2.61	0.92		0.18	0.08	0.08				
Threeawn (Aristida)	0.19		0.29	0.08								
Grama (Bouteloua)	6.57	4.18	9.78	2.05	2.25	0.53	0.50	0.15	0.23			2.78
Tobosa (Hilaria mutica)	11.56	0.35	0.29	1.43	0.37	0.71		0.30				
Prairie junegrass (Koeleria cristata)	5.28	7.20	2.41	4.04	1.85	5.92	11.30	11.03	18.02	25.62	25.29	25.47
Green Sprangletop (Leptochloa dubia)	3.91	2.12	1.38	0.59	0.30	1.52	0.25					
Muhly (Muhlenbergia)	0.78	0.09	13.59	3.39	1.53	0.09	0.17					
Vine mesquite (Panicum obtusum)	1.31	0.09		0.08	0.07							
Plains bristlegrass (Setaria macrostachya)	4.44	5.05	4.20	1.01	0.22	0.18						
Dropseed (Sporobolus)	24.44	42.01	23.60	15.29	31.99	20.06	17.87	14.85	8.33	16.87	18.81	15.59
Unknown grass	3.76	6.16	6.09	5.37	2.82	4.70	6.82	2.59	8.43	2.13	7.74	12.35
Saltbush (Atriplex)						3.61	14.74	7.95	8.74	14.74	12.76	3.59
Mesquite (Prosopsis juliflora)	3.99	6.78	23.60	52.83	31.56	29.26	4.64	25.88	6.59	1.97	2.54	4.04
Russian thistle (Salsola)	13.75	14.84	11.57	12.51	26.44	32.88	46.63	37.17	49.66	38.67	32.86	36.10
Globemallow (Sphaeralcea)	0.13	0.09		0.08								

Appendix H

Results of Autopsy Performed on Dead Gemsbok

Alamogordo Animal Hospital
G. L. Wiley, D. V. M.
519 Canal, P. O. Box 602
Alamogordo, New Mexico 88310
Telephone 437-5145

June 24, 1973

To whom it may concern:

I have this day examined an Oryx female for the Department of Game and Fish. Autopsy findings were as follows:

SKIN		
	No visible lesions	
THORAX		
	Trachea	- Normal
	Lungs	- Normal
	Heart	- Possible slight enlargement
	Valves	- Normal
ABDOMEN		
	Rumen	- Full of ingesta which appeared normal
	Small intestine	- Some hemorrhage but possible post mortem change
	Large intestine	- Normal
	Liver	- Some degeneration noticed Cyst attached to one lobe
	Adrenals	- Normal
	Kidneys	- Normal
	Uterus	- Single fetus present Placentation appeared normal

No definite cause of death was ascertained by this veterinarian. The general body condition of the animal was good but based on gross observations, I would suggest the possibility of a poisonous plant of some sort. Tissue specimens will be submitted for histological study and a report forwarded to the Department upon receipt.

Respectively,

G. L. Wiley, D. V. M.