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An Environmental Baseline Study of the Los Medaños Waste Isolation Pilot Plant (WIPP) Project Area of New Mexico: A Progress Report

Helen G. Wolfe, et al - Editors

Prepared by Sandia Laboratories, Albuquerque, New Mexico 87115
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WASTE ISOLATION PILOT PLANT (WIPP) PROJECT AREA OF
NEW MEXICO: A PROGRESS REPORT

Prepared for Sandia Laboratories by the
New Mexico Environmental Institute, June 1976

Helen G. Wolfe, et al, Editors

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AN ENVIRONMENTAL BASELINE STUDY OF THE LOS MEDAÑOS
WASTE ISOLATION PILOT PLANT (WIPP) PROJECT AREA OF
NEW MEXICO: A PROGRESS REPORT

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INTRODUCTION

Sandia Laboratories, Albuquerque, New Mexico, has been conducting exploratory drilling operations for a Waste Isolation Pilot Program (WIPP) in southeastern New Mexico for a year. (See Fig. 1-1 and 1-2.)

Prior to the establishment of such a program, Sandia Laboratories initiated an environmental study to serve as a baseline for evaluation of the impact of their future activities in the Los Medaños area. Much of this area has been influenced by human activities over a long period; consequently, the baseline data does not reflect pristine conditions but rather the present, relatively disturbed condition of the environment. This study thus presents a description of the present level of human impact.

Sandia contracted for this study with the New Mexico Environmental Institute (NMEI). This progress report presents the preliminary results of the study conducted from August 1975 to April 1976 by NMEI.

Description of the Area

The Los Medaños study area is located in southeastern New Mexico, approximately 27 miles east of Carlsbad. The 72 sq mi extensive study site is in Eddy and Lea counties. The intensive study site is a 3-sq mi area, most of which is within the extensive study site (Fig. 1-2).

A relatively wet season lasts from May through October, and approximately 75 percent of the total precipitation falls within this period. Winter is the driest season with February being the driest month. July is normally the warmest month and December the coldest. The average monthly temperatures vary far less from year to year than the average monthly precipitation. The length of the frost-free season averages approximately 220 days.

The extensive study site, centered at approximately 32°20'N, 103°45'W,

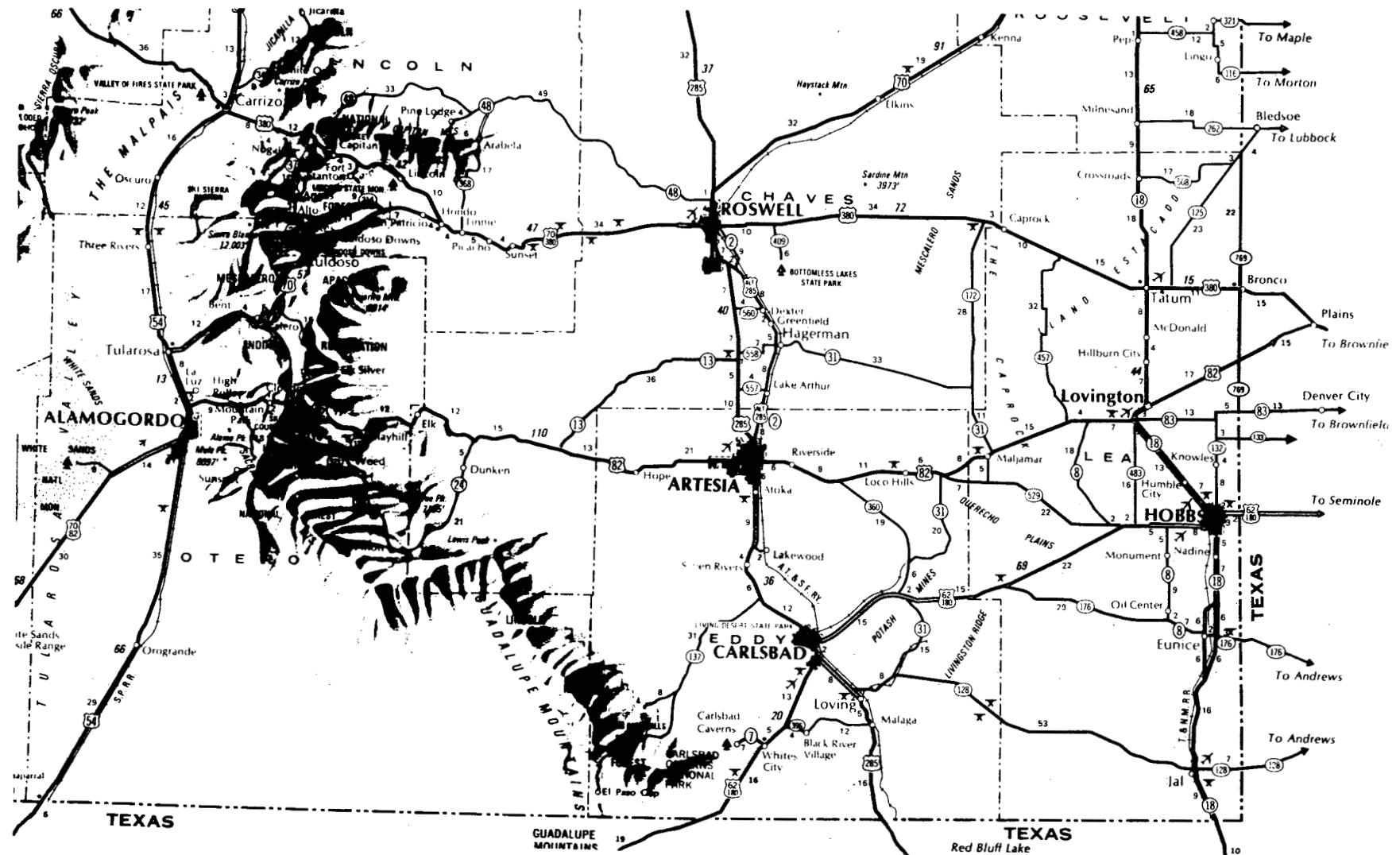
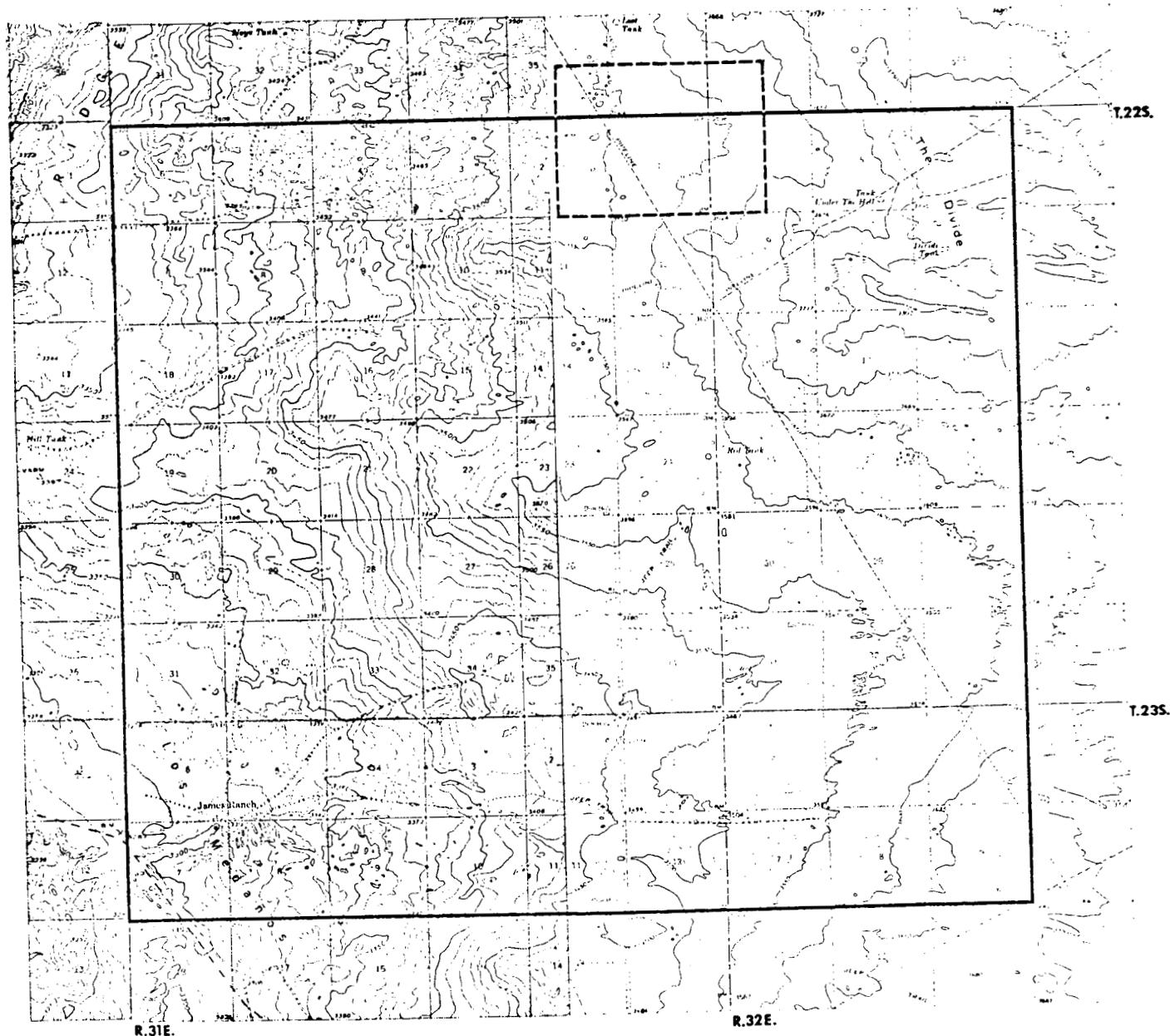


Figure 1-1. Geographic Location of the Site



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Figure 1-2. Location of the extensive study area (solid area) and intensive study area (dashed line).

ranges in elevation from 3,281 ft in the southwestern corner to 3,806 ft in the northeastern corner. The Spanish word "Medaños" means sand hills and the term aptly describes the area. Most of the topography is undulating to gently rolling sand hills. In a few areas large sand dunes are present.

The vegetation of the area is typically of Southern Desertic sandy soils. Potentially the area supports tall and mid-grasses of the Andropogon, Bouteloua and Sporobolus genera with varying amounts of Artemisia and Quercus present. Through past management, the general vegetative situation has shifted from the potential. Artemisia, Quercus and Prosopis have increased with short-statured perennial grasses and large amounts of annual grasses and forbs also present.

AIR RESOURCES

Climate

The Los Medaños study site has a semi-arid continental climate characterized by light precipitation, abundant sunshine, low relative humidity, and temperatures with a wide annual and diurnal range. It is in the "Southeastern Plains" climatological subdivision of New Mexico (Tuan *et al.* 1969); this subdivision covers the southeastern part of New Mexico.

The frequently clear skies and the normally low humidity are conducive to rapid ground radiation after sundown. Consequently, summer nights are usually comfortably cool.

The clear weather is especially noticeable in winter when 70-75 percent of the possible sunshine is normally recorded. It is not uncommon for greater than 90 percent of the possible monthly sunshine to be experienced during the fall and winter months (U. S. Dept of Commerce, Weather Bureau 1959).

The Los Medaños study site is approximately midway between Hobbs and Carlsbad. The climatological data from these two cities should give long-term general information for the study site. Tables 2-1 and 2-2 are 30-year summaries of climatological data for Carlsbad and Hobbs, respectively.

Precipitation

Approximately 75 percent of the precipitation in the area occurs from May through October. The Gulf of Mexico supplies most of the moisture to the State during this period. July and August are dominated by a strong, influx of moist, unstable air from the Gulf, and precipitation occurs frequently as localized afternoon and evening thundershowers.

Table 2-1. Climatological summary for Carlsbad, New Mexico (1931-1960).

Latitude: 32°25'N
 Longitude: 104°14'W
 Elevation (Ground): 3,120 ft

Month	Temperature (°F)							Mean degree days	Precipitation Totals (Inches)							Mean number of days										
	Means			Extremes					Mean	Greatest daily	Year	Snow, Sleet			Precip. 10 inch or more	Temperatures										
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year					Mean	Maximum monthly	Year	Greatest daily	Year	Max.	Min.								
(a)	30	30	30	30	--	30	--	30	30	30	--	30	30	--	30	30	30	30	(a)							
Jan.	59.1	28.5	41.8	83	1948	-4	1947	600	0.44	0.75	1958	0.8	8.4	1947	8.0	1949	1	0	1	22	•	Jan.				
Feb.	64.6	32.1	48.4	82	1957	-17	1933	460	0.37	0.96	1932	0.3	4.8	1951	3.0	1951	1	0	*	15	*	Feb.				
Mar.	71.4	38.1	54.8	98	1946	9	1932	320	0.46	1.44	1941	0.6	5.0	1947+	5.0	1947+	1	*	*	8	0	Mar.				
Apr.	80.2	46.4	63.3	100	1943+	24	1939	120	0.54	1.65	1931	T	0.1	1939	0.1	1939	1	4	0	1	0	Apr.				
May	87.7	55.0	71.4	108	1934	24	1934	0	1.76	3.41	1959	0	0	--	0	--	3	15	0	0	0	May				
June	95.9	63.9	79.9	111	1933	45	1931	0	1.53	3.70	1946	0	0	--	0	--	2	26	0	0	0	June				
July	96.1	66.7	81.4	110	1933	52	1938	0	1.56	2.25	1950	0	0	--	0	--	3	23	0	0	0	July				
Aug.	95.5	65.0	80.6	113	1944	52	1955	0	1.60	2.15	1942	0	0	--	0	--	3	27	0	0	0	Aug.				
Sept.	89.1	59.3	74.2	106	1948	38	1942	0	1.94	2.35	1932	0	0	--	0	--	3	17	0	0	0	Sept.				
Oct.	79.5	48.7	64.1	101	1934	26	1950	100	1.61	4.30	1945	0	0	--	0	--	3	5	0	*	0	Oct.				
Nov.	67.6	35.3	51.5	92	1934	-1	1957	410	0.35	0.90	1944	0.3	5.0	1957	5.0	1957	1	*	*	12	*	Nov.				
Dec.	60.2	29.3	44.7	86	1933	-4	1953	630	0.47	1.30	1942	1.1	11.5	1960	7.0	1931	1	0	*	21	*	Dec.				
Year	70.6	47.4	63.2	111	June	1939	-17	1933	2700	12.43	4.30	Oct.	1945	3.1	11.5	Dec.	1960	8.0	Jan.	1949	23	122	1	79	*	Year

* Less than one half.

** Base 65°F (estimated).

(a) Average length of record, years.

† Trace, an amount too small to measure.

+ Also on earlier dates, months, or years.

◊ Partial year's record considered.

Table 2-2. Climatological summary for Hobbs, New Mexico (1931-1960).

Latitude: 32°25'N
 Longitude: 104°14'W
 Elevation(Ground): 3,615 ft

Month	Temperature (°F)								Mean degree days **	Precipitation Totals (Inches)						Mean number of days																	
	Means			Extremes			Year	Year		Snow, Sleet			Precip. 10 inch or more 90° and above	Temperatures		Max.	Min.	Mouth	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.			
	Daily maximum	Daily minimum	Monthly	Record highest	Record lowest	Year				Mean	Greatest daily	Year		Max.	Min.																		
(a)	30	30	30	30	--	30	--	30	30	30	--	30	--	30	30	30	30	30	30	(a)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Jan.	56.4	27.0	41.7	63	1953	- 3	1948+	720	0.46	1.01	1944	1.4	7.7	1948	4.5	1944	1	0	1	23	*	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Feb.	61.0	30.8	45.0	87	1940+	- 1	1951	530	0.38	0.87	1921	0.5	3.0	1924+	3.0	1924	1	0	1	17	*	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mar.	67.5	35.8	51.6	93	1946	1	1922	420	0.40	0.95	1941	1.0	10.0	1958	6.5	1941	1	*	*	11	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Apr.	76.5	45.1	60.8	98	19286	17	1939	170	0.89	1.87	1926	0.3	8.0	1942	8.0	1942	2	2	0	2	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
May	84.3	54.1	69.2	107	1951	34	1938	10	1.37	4.10	1947	0	0	--	0	--	3	8	0	0	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
June	92.7	63.2	77.9	110	1950+	37	1939	0	1.67	4.04	1921	0	0	--	0	--	3	22	0	0	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
July	93.0	65.6	79.4	110	1958	47	1939	0	2.09	3.53	1960	0	0	--	0	--	3	24	0	0	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Aug.	52.0	65.7	79.1	107	1952	45	1939	0	1.73	2.80	19326	0	0	--	0	--	3	24	0	0	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Sept.	86.9	58.8	72.0	109	1939	34	1948	0	2.26	4.62	1950	0	0	--	0	--	3	12	0	0	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Oct.	76.6	48.2	62.5	98	1947	23	1925	140	1.93	2.62	1960	T	T	1958	T	1958	3	2	0	*	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Nov.	65.4	35.1	50.3	88	1952	9	1957+	440	0.37	0.78	1940	0.2	4.0	1944	2.0	1944	1	0	*	11	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Dec.	57.9	29.0	43.3	81	1922	1	1926+	670	0.53	1.85	1942	1.4	8.0	1960	5.0	1950+	1	0	1	21	0	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Year	75.9	46.5	61.2	110	1950+	- 3	1948+	3100	14.68	4.62	Sept. 1950	4.8	10.0	1958	8.0	Sept. 1942	25	35	3	65	*	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.

* Less than one half.

** Base 65° F (estimated).

(a) Average length of record, years.

† Trace, an amount too small to measure.

+ Also on earlier dates, months, or years.

‡ Partial year's record considered.

Source: Von Eschen 1961

The average annual precipitation in Carlsbad is 12 inches, and in Hobbs 15 inches. Wide variations in annual precipitation are common in the area. For example, Carlsbad has an annual range of 2.95-33.94 inches in over 60 years of recorded weather data (U. S. Dept. of Commerce, Weather Bureau 1959).

Precipitation data from the Potash Company of America refinery (Table 2-3) and the Carlsbad area (Table 2-4) average 12.6 inches annually. These data include areas surrounding the proposed site and should reflect the annual precipitation for the site itself.

Temperature

Carlsbad's high temperatures exceed 90°F on most days between mid-May and mid-September. The daily temperature range is generally 30 degrees or more, and most nights are cool. Hobbs' climate is somewhat more temperate, but the summer daytime temperatures still exceed 90°F two-thirds of the time. (See Tables 2-1 and 2-2.)

The length of the frost-free season in Carlsbad averages 220 days and has varied from 217 to 241 days (Tuan et al. 1969).

Winds

Wind speeds are normally moderate, although relatively strong winds often accompany frontal activity during the late winter and spring months. During this period, winds may exceed 30 miles per hour for several hours, and peak speeds over 50 miles per hour are not uncommon (U. S. Dept. of Commerce, Weather Bureau 1959).

Wind speed and direction data for Hobbs (the closest city with such data available) are presented in Table 2-5. The wind was from a southerly direction about 54 percent of the time, and the wind speed was between 7 and 16 knots 63 percent of the time.

Table 2-3. Precipitation at the Potash Company of America refinery, 1936-1974.

Year	Total inches	Year	Total inches
1936	11.31	1956	17.55
1937	13.66	1957	7.21
1938	12.18	1958	24.32
1939	9.96	1959	11.45
1940	11.66	1960	23.42
1941	32.37	1961	10.46
1942	16.29	1962	8.98
1943	11.02	1963	11.81
1944	15.84	1964	6.12
1945	6.94	1965	16.58
1946	9.99	1966	12.39
1947	5.99	1967	8.03
1948	11.21	1968	15.68
1949	13.68	1969	19.95
1950	10.36	1970	12.77
1951	8.14	1971	18.18
1952	7.07	1972	14.67
1953	7.27	1973	14.54
1954	8.30	1974	20.50
1955	17.55		

Source: Potash Company of America Refinery Records 1975.

Table 2-4. Annual precipitation data in Carlsbad area, 1953-1971.

Station	Period Analyzed	Annual Average	Annual High	Extreme Low
Carlsbad	1953-71	10.34	21	3.5
Potash Mine (Duval)	1955-71	13.52	29	7.8
Potash Mine (PCA)	1955-71	13.79	24	6.1
Jal	1955-71	11.33	21	4.6

Source: Draft Environmental Analysis Record of Potash Plants, BLM 1974.

Table 2-5. Annual wind frequency distribution for 1949, 1953, 1954* (Summary)
for Hobbs, New Mexico. Speed is in knots.

Direction	1 - 3	4 - 6	7 - 10	11 - 16	17 - 21	Greater Than 21	Avg Spd	Total
N	127	206	303	266	169	56	10.6	1207
NNE	46	83	202	241	173	78	13.1	823
NE	154	232	492	405	204	89	11.0	1576
ENE	50	81	234	217	75	23	10.9	680
E	143	219	413	244	69	7	8.8	1095
ESE	71	192	427	284	71	12	9.6	1057
SE	249	447	1206	687	219	25	9.6	2833
SSE	76	211	786	825	338	71	11.7	2307
S	216	465	1615	1083	383	26	10.4	3788
SSW	95	266	866	579	202	59	10.7	2067
SW	179	366	1254	752	421	220	11.5	3192
WSW	57	104	428	387	216	151	13.1	1343
W	84	122	478	273	101	77	11.0	1135
WNW	45	77	213	172	79	95	12.6	681
NW	125	219	527	260	171	93	10.7	1395
NNW	28	72	165	135	78	40	11.8	518
AVG	2.8	4.9	8.8	13.5	18.0	25.3	10.7	
TOTAL	1745	3362	9689	6810	2969	1122		

TOTAL NUMBER OF OBSERVATIONS 26264

TOTAL NUMBER OF CALMS 567

* Only data which provides stability classifications.

Air Standards

A major problem in southern New Mexico is the high amount of suspended particulates in the air. Most of the particulate matter is in the form of dust from unpaved roads and from dry topsoil with little vegetation exposed to strong, turbulent winds. Tables 2-6 and 2-7 cover the Federal and the New Mexico air quality standards, respectively. Table 2-8 is a summary of the ambient air quality of the area surrounding the study site. The particulate concentration for most areas in southern New Mexico exceeds the New Mexico standards at least once.

For any area where readings were taken, the SO_2 and NO_2 concentrations did not exceed the New Mexico air quality standards. Data from the study site (Table 2-9) over a three-month period was well below the State limits for SO_2 and NO_2 concentrations.

Radioactive Releases

The two sources of radioactive releases to air or water are (1) human and (2) naturally occurring. The proposed Federal regulations (under the Safe Drinking Water Act, Pub. L. 93-523) for the maximum contaminant levels for radioactivity in water are in Table 2-10. With the exception of radium, the contaminants are grouped by the type of radioactive decay rather than by individual species. But radium is also accounted for in the gross alpha particle activity. The most frequent contaminants, strontium-90 and tritium, are deposited on surface waters.

Although the Federal air standards are not readily available, Table 2-11 is a compilation of maximum permissible air concentrations of many radioactive materials (Benedict and Pigford 1957). Federal air regulations should be similar to the limits in this table.

Table 2-6. Federal primary and secondary air quality standards. All measurements are expressed in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) except for those for carbon monoxide, which are expressed in milligrams per cubic meter (mg/m^3). Equivalent measurements in parts per million (ppm) are given for the gaseous pollutants.

Pollutant	Primary	Secondary
Particulate Matter		
Annual geometric mean	75	60
Maximum 24-hour concentration*	260	150
Sulfur Oxides		
Annual arithmetic mean	80 (.03 ppm)	60 (.02 ppm)
Maximum 24-hour concentration*	365 (.14 ppm)	260 (.1 ppm)
Maximum 3-hour concentration*		1,300 (.5 ppm)
Carbon Monoxide		
Maximum 8-hour concentration*	10 (9 ppm)	
Maximum 1-hour concentration*	40 (35 ppm)	same as primary
Photochemical Oxidants		
Maximum 1-hour concentration*	160 (.08 ppm)	same as primary
Hydrocarbons		
Maximum 3-hour (6-9 am) concentration*	160 (.24 ppm)	same as primary
Nitrogen Oxides		
Annual arithmetic mean	100 (.05 ppm)	same as primary

* Not to be exceeded more than once a year.

Primary: Levels of air quality necessary to protect the public health with an adequate margin of safety.

Secondary: Levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

Table 2-7. New Mexico ambient air quality standards.

201. Ambient Air Quality Standards

A. The maximum allowable concentrations of total suspended particulate in the ambient air are as follows:

		<u>Maximum Concentration</u>
1.	24-hour average	150 ug/m ³
2.	7-day average	110 ug/m ³
3.	30-day average	90 ug/m ³
4.	annual geometric mean	60 ug/m ³

B. When one or more of the following elements are present in the total suspended particulate, the maximum allowable concentrations of the elements involved, based on a thirty-day average, are as follows:

		<u>Maximum Concentration</u>
1.	beryllium	0.01 ug/m ³
2.	asbestos	0.01 ug/m ³
3.	heavy metals (total combined)	10 ug/m ³

C. The maximum allowable concentrations of the following air contaminants in the ambient air are as follows:

		<u>Maximum Concentration</u>
1.	sulfur dioxide	
	(a) 24-hour average	0.10 ppm
	(b) annual arithmetic average	0.02 ppm
2.	hydrogen sulfide	
	(a) for the state, except the Pecos-Permian Basin Intrastate Air Quality Control Region (1-hour average)	0.003 ppm
	(b) for the Pecos-Permian Basin Intrastate Air Quality Control Region (4-hour average)	0.100 ppm
	(c) after January 1, 1976, for within corporate limits of municipali- ties within the Pecos-Permian Basin Intrastate Air Quality Control Region (4-hour average)	0.030 ppm
	(d) after January 1, 1978, for within five miles of the corporate limits of municipalities having a population of greater than twenty thousand and within the Pecos-Permian Basin Intrastate Air Quality Control Region (4-hour average)	0.030 ppm

Table 2-7 (Cont.).

3. total reduced sulfur	
(a) for the state except the Pecos-Permian Basin Intrastate Air Quality Control Region, including hydrogen sulfide (1-hour average)	0.003 ppm
(b) for the Pecos-Permian Basin Intrastate Air Quality Control Region, except for hydrogen sulfide (4-hour average)	0.010 ppm
(c) after January 1, 1976, for within corporate limits of municipalities within the Pecos-Permian Basin Intrastate Air Quality Control Region, except for hydrogen sulfide (4-hour average)	0.003 ppm
(d) after January 1, 1978, for within five miles of the corporate limits of municipalities having a population of greater than twenty thousand and within the Pecos-Permian Basin Intrastate Air Quality Control Region, except hydrogen sulfide (4-hour average)	0.003 ppm
4. Carbon monoxide	
(a) 8-hour average	8.7 ppm
(b) 1-hour average	13.1 ppm
5. Nitrogen dioxide	
(a) 24-hour average	0.10 ppm
(b) annual arithmetic average	0.05 ppm
6. Photochemical oxidants (1-hour average)	0.06 ppm
7. Non-methane hydrocarbons (3-hour average)	0.19 ppm

D. On an annual average, the soiling index shall not exceed 0.4 coh^s/1000 linear feet of air.

*coh^s: coefficient of haze, the quantity of light scattering solids capable of producing an optical density of 0.01 when the amount of light transmitted through the spot of dust collected on the tape of a smoke sampler is measured in a suitable densitometer.

From Section Number 201 of the Ambient Air Quality Standards and Air Quality Control Regulations adopted by the New Mexico Health and Social Services Board on January 23, 1970, as amended.

Table 2-8. Summary of ambient air quality in Pecos-Permian Basin in relation to air quality standards.

Station	Year	Particulate ($\mu\text{g}/\text{m}^3$)		Sulfur Dioxide ($\mu\text{g}/\text{m}^3$)		Nitrogen Dioxide (ppm)	
		Annual Geometric Mean	Maximum 24-Hour Concentration	Annual Arithmetic Average	Maximum 24-Hour Concentration	Annual Arithmetic Average	Maximum 24-Hour Concentration
Artesia	1972	40 (19) ^a	472*				
	1973	b	39	2 (3)	2		
	1974	62* (15)	98	6 (7)	21	0.017 (16)	0.027
Carlsbad	1971	70* (20)	105				
	1972	62* (44)	275*				
	1973	42 (15)	66	2 (23)	5		
	1974	63* (14)	111	3 (12)	5	0.016 (16)	0.037
Clovis	1970	76* (51)	485*				
	1971	102* (21)	188*				
	1972	99* (20)	160*				
	1973	54 (6)	129				
	1974	81* (7)	101				
Eunice	1974	b	98	5 (7)	21		
Hobbs	1970	58 (23)	147				
	1972	44 (5)	283*				
	1973	33 (5)	58				
	1974	53 (15)	184*	7 (5)	13		
Jal	1974	63* (13)	230*	5 (11)	21		
Cooper Ranch	1973	b	282*				
	1974	112* (29)	366*	9 (8)	52	0.016 (19)	0.040
Lovington	1973	34 (6)	95				
	1974	b	85				
Roswell	1971	115* (7)	211*				
	1972	68* (20)	632*				
	1973	b	52				
	1974	54 (11)	87	2 (2)	3		
Smith Ranch	1974	37 (13)	133				

a = nos. in () represent no. of measurements.

b = insufficient measurements to allow calculation of mean

* = exceeds New Mexico standard

Table 2-9. SO_2 and NO_2 concentrations from the Los Medanos study site.*

Date	Concentration ($\mu\text{g}/\text{m}^3$)	
	SO_2	NO_2
1-27-76	0.0	13.07
2-5-76	0.0	24.96
2-12-76	0.0	46.2
2-18-76	4.63	26.4
2-20-76	5.4	38.5
2-24-76	0.0	54.56
3-04-76	0.0	34.72
3-11-76	0.0	20.57
3-18-76	0.0	19.84
3-24-76	0.0	20.05
3-31-76	0.0	4.96
4-06-76	14.58	29.76
4-14-76	0.0	0.0
4-20-76	12.15	43.4
4-21-76	0.0	44.64
4-26-76	0.0	19.68

*Source: Sandia Laboratories Records.

Table 2-10. Maximum contaminant levels for radioactivity.

Contaminant	Level
Combined Radium-226 and Radium-228	5 picocuries per liter
Gross alpha particle activity (including Radium-226)	15 picocuries per liter
Beta Particle and photon radio- activity from man-made radio- nuclides	Annual dose equivalent to the total body or any internal organ not to exceed 4 millirems.

Source: Safe Drinking Water Act, Pub. L. 93-523.

Table 2-11. Properties of radioisotopes.

Isotope	Half-life	Type of decay	Maximum permissible concentration in air, microcuries/ml		Isotope	Half-life	Type of decay	Maximum permissible concentration in air, microcuries/ml	
			Soluble	Insoluble				Soluble	Insoluble
H ³	12.5 yr	Beta	2 x 10 ⁻⁷	4 x 10 ⁻⁵ Sub ^a	Sb ¹²²	2.8 days	Beta	6 x 10 ⁻⁹	5 x 10 ⁻⁹
Be ⁷	52.9 days	EC ^b	2 x 10 ⁻⁷	4 x 10 ⁻⁸	Sb ¹²⁴	60 days	Beta, no EC	5 x 10 ⁻⁹	7 x 10 ⁻¹⁰
C ¹⁴	5,568 yr	Beta	1 x 10 ⁻⁷		Sb ¹²⁵	~2.7 yr	Beta	2 x 10 ⁻⁸	9 x 10 ⁻¹⁰
F ¹⁸	112 min	Beta	2 x 10 ⁻⁷	9 x 10 ⁻⁸	Te ¹²⁷	115 days	IT	6 x 10 ⁻⁸	3 x 10 ⁻⁸
Na ²⁴	15 hr	Beta	4 x 10 ⁻⁸	5 x 10 ⁻⁹	Te ¹²⁹	33.5 days	IT	2 x 10 ⁻⁷	1 x 10 ⁻⁷
P ³²	14.3 days	Beta	2 x 10 ⁻⁹	3 x 10 ⁻⁹	I ¹³¹	8.1 days	Beta	1 x 10 ⁻¹⁰	1 x 10 ⁻⁸
S ³⁵	87.1 days	Beta	9 x 10 ⁻⁹	9 x 10 ⁻⁹	Xe ¹³³	5.3 days	Beta	3 x 10 ⁻⁷ Sub	
Cl ³⁶	4.4 x 10 ⁵ yr	Beta	1 x 10 ⁻⁸	8 x 10 ⁻¹⁰	Cs ¹³⁴	2.3 yr	Beta, no EC	1 x 10 ⁻⁹	4 x 10 ⁻¹⁰
A ⁴¹	109 min	Beta		4 x 10 ⁻⁸ Sub	Xe ¹³⁵	9.1 hr	Beta	1 x 10 ⁻⁷ Sub	
K ⁴²	12.4 hr	Beta	7 x 10 ⁻⁸	4 x 10 ⁻⁹	Cs ¹³⁷	33 yr	Beta	2 x 10 ⁻⁹	5 x 10 ⁻¹⁰
Ca ⁴⁵	152 days	Beta	1 x 10 ⁻⁹	4 x 10 ⁻⁹	Ba ¹⁴⁰	12.8 days	Beta	4 x 10 ⁻⁹	1 x 10 ⁻⁹
Sc ⁴⁶	85 days	Beta	8 x 10 ⁻⁹	8 x 10 ⁻¹⁰	La ¹⁴⁰	40 hr	Beta	5 x 10 ⁻⁹	4 x 10 ⁻⁹
V ⁴⁸	16 days	Beta, EC	6 x 10 ⁻⁹	2 x 10 ⁻⁹	Ce ¹⁴¹	33.1 days	Beta	2 x 10 ⁻⁸	5 x 10 ⁻⁹
Cr ⁵¹	27.8 days	EC, no beta	4 x 10 ⁻⁷	8 x 10 ⁻⁸	Pr ¹⁴³	13.7 days	Beta	1 x 10 ⁻⁸	6 x 10 ⁻⁹
Fe ⁵⁵	2.9 yr	EC, no beta	3 x 10 ⁻⁸	3 x 10 ⁻⁸	Ce ¹⁴⁴	282 days	Beta	3 x 10 ⁻¹⁰	2 x 10 ⁻¹⁰
Mn ⁵⁶	2.6 hr	Beta	3 x 10 ⁻⁸	2 x 10 ⁻⁸	Pm ¹⁴⁷	2.6 yr	Beta	2 x 10 ⁻⁹	3 x 10 ⁻⁹
Fe ⁵⁹	45.1 days	Beta	5 x 10 ⁻⁹	2 x 10 ⁻⁹	Sm ¹⁵¹	73 yr	Beta	2 x 10 ⁻⁹	5 x 10 ⁻⁹
Ni ⁵⁹	8 x 10 ⁴ yr	EC	2 x 10 ⁻⁸	3 x 10 ⁻⁸	Eu ¹⁵⁴	16 yr	Beta	1 x 10 ⁻¹⁰	2 x 10 ⁻¹⁰
Co ⁶⁰	5.3 yr	Beta	1 x 10 ⁻⁸	3 x 10 ⁻¹⁰	Ho ¹⁶⁶	>30 yr	Beta	7 x 10 ⁻⁹	6 x 10 ⁻⁹
Ni ⁶³	85 yr	Beta	2 x 10 ⁻⁹	1 x 10 ⁻⁸	Tm ¹⁷⁰	129 days	Beta, no EC	1 x 10 ⁻⁹	1 x 10 ⁻⁹
Cu ⁶⁴	12.8 hr	EC, beta	7 x 10 ⁻⁸	4 x 10 ⁻⁸	Lu ¹⁷⁷	6.8 days	Beta	2 x 10 ⁻⁸	2 x 10 ⁻⁸
Zn ⁶⁵	250 days	EC, beta	4 x 10 ⁻⁹	2 x 10 ⁻⁹	Re ¹⁸³	155 days	EC	9 x 10 ⁻⁸	5 x 10 ⁻⁹
Ge ⁷¹	11.4 days	EC, no beta	4 x 10 ⁻⁷	2 x 10 ⁻⁷	Ir ¹⁹⁰	12.6 days	EC	4 x 10 ⁻⁸	1 x 10 ⁻⁸
Ga ⁷²	14.3 hr	Beta	8 x 10 ⁻⁹	6 x 10 ⁻⁹	Ir ¹⁹²	74.4 days	EC, beta	4 x 10 ⁻⁹	9 x 10 ⁻¹⁰
As ⁷⁶	26.8 hr	Beta	4 x 10 ⁻⁹	3 x 10 ⁻⁹	Au ¹⁹⁸	2.7 days	Beta, no EC	1 x 10 ⁻⁸	8 x 10 ⁻⁹
Br ⁸²	35.9 hr	Beta, no EC	4 x 10 ⁻⁸	6 x 10 ⁻⁹	Au ¹⁹⁹	3.1 days	Beta	4 x 10 ⁻⁸	3 x 10 ⁻⁸
Kr ⁸⁵	9.4 yr	Beta		3 x 10 ⁻⁷ Sub	Hg ²⁰³	47.9 days	Beta	2 x 10 ⁻⁹	4 x 10 ⁻⁹
Rb ⁸⁶	19.5 days	Beta, no EC	1 x 10 ⁻⁸	2 x 10 ⁻⁹	Tl ²⁰⁴	3.5 yr	Beta, EC	2 x 10 ⁻⁸	9 x 10 ⁻¹⁰
Sr ⁸⁹	53 days	Beta	3 x 10 ⁻¹⁰	1 x 10 ⁻⁹	Po ²¹⁰	138.3 days	Alpha, beta stable	2 x 10 ⁻¹¹	7 x 10 ⁻¹²
Sr ⁹⁰	19.9 yr	Beta	3 x 10 ⁻¹¹	2 x 10 ⁻¹⁰					
Y ⁹⁰	61 hr	Beta	4 x 10 ⁻⁹	3 x 10 ⁻⁹	At ²¹¹	7.5 hr.	Alpha, EC	2 x 10 ⁻¹⁰	1 x 10 ⁻⁹
Y ⁹¹	61 days	Beta	1 x 10 ⁻⁹	1 x 10 ⁻⁹	Ac ²²⁷	22 yr	Alpha, beta	8 x 10 ⁻¹⁴	9 x 10 ⁻¹³
Nb ⁹⁵	35 days	Beta	2 x 10 ⁻⁸	3 x 10 ⁻⁹	Th ²³²	1.39 x 10 ¹⁰ yr	Alpha, beta stable	10 ⁻¹²	10 ⁻¹²
Tc ⁹⁶	4.2 days	EC, no beta	2 x 10 ⁻⁸	8 x 10 ⁻⁹					
Mo ⁹⁹	67 hr	Beta	3 x 10 ⁻⁸	7 x 10 ⁻⁹	Pa ²³³	27.4 days	Beta	2 x 10 ⁻⁸	6 x 10 ⁻⁹
Pd ¹⁰³	17 days	EC	5 x 10 ⁻⁸	3 x 10 ⁻⁸	U ²³³	1.62 x 10 ⁵ yr	Alpha, beta stable	2 x 10 ⁻¹¹	4 x 10 ⁻¹²
Rh ¹⁰³	57 min	IT ^c	3 x 10 ⁻⁶	2 x 10 ⁻⁶					
Rh ¹⁰⁵	36.5 hr	Beta	3 x 10 ⁻⁸	2 x 10 ⁻⁸	Th ²³⁴	24.1 days	Beta	2 x 10 ⁻⁹	10 ⁻⁹
Ag ¹⁰⁵	40 days	EC	2 x 10 ⁻⁸	3 x 10 ⁻⁹	U ²³⁸	4.49 x 10 ⁹ yr	Alpha, beta stable	3 x 10 ⁻¹²	5 x 10 ⁻¹²
Ru ¹⁰⁶	1 yr	Beta	3 x 10 ⁻⁹	2 x 10 ⁻¹⁰					
Cd ¹⁰⁹	470 days	EC, no beta	2 x 10 ⁻⁹	3 x 10 ⁻⁹	Pu ²³⁹	2.44 x 10 ⁴ yr	Alpha, beta stable	6 x 10 ⁻¹⁴	1 x 10 ⁻¹²
Ag ¹¹⁰	270 days	Beta, IT no EC	7 x 10 ⁻⁹	3 x 10 ⁻¹⁰	Am ²⁴¹	470 yr	Alpha, beta stable	2 x 10 ⁻¹³	4 x 10 ⁻¹²
Ag ¹¹¹	7.6 days	Beta	1 x 10 ⁻⁸	8 x 10 ⁻⁹					
Sn ¹¹³	112 days	EC, no beta	1 x 10 ⁻⁸	2 x 10 ⁻⁹	Cm ²⁴²	162.5 days	Alpha, beta stable	4 x 10 ⁻¹²	6 x 10 ⁻¹²
In ¹¹⁴	49 days	IT, no EC	4 x 10 ⁻⁹	7 x 10 ⁻¹⁰					

^aValues given are for submersion in an infinite cloud of gaseous material.

^bOrbital-electron capture.

^cIsomeric transition.

Source: Benedict and Pigford 1957

SOILS BASELINE STUDY FOR THE
LOS MEDAÑOS STUDY AREA

Introduction

The Los Medaños study area covers 72 square miles and includes soils in both Eddy and Lea counties of New Mexico. Soil surveys conducted by the Soil Conservation Service (SCS) are available for both counties. Rather than duplicate these reports, our efforts were directed at verifying the existence and position of soil associations already enumerated by the SCS. Extensive field sampling and soil descriptions were thus conducted throughout the study area. Dominant soil series (identified below) were also sampled at various depths and at various locations within an association for chemical and physical analyses. The analyses were conducted by the New Mexico State Soil and Water Testing Laboratory using standard procedures. A generalized soil map showing the various soil series and indicating the areas of extensive sampling for soil characterization is provided in Fig. 3-1.

Soil Survey - General

The study area is located in the east central part of Eddy County and the west central part of Lea County. In Eddy County, the study area encompasses the Kermit-Berino and the Simona-Pajarito associations. The Kermit-Berino association consists of very sandy soils on undulating plains and low hills. Soils have developed in noncalcareous, reddish, wind-worked sandy deposits. All soils are highly susceptible to wind and water erosion and reflect this susceptibility in billowy and hummocky surfaces and some sculptured dunes.

Kermit soils make up about 60 percent of the association and are deep, loose, noncalcareous fine sands that occur as trains of dunes elongated

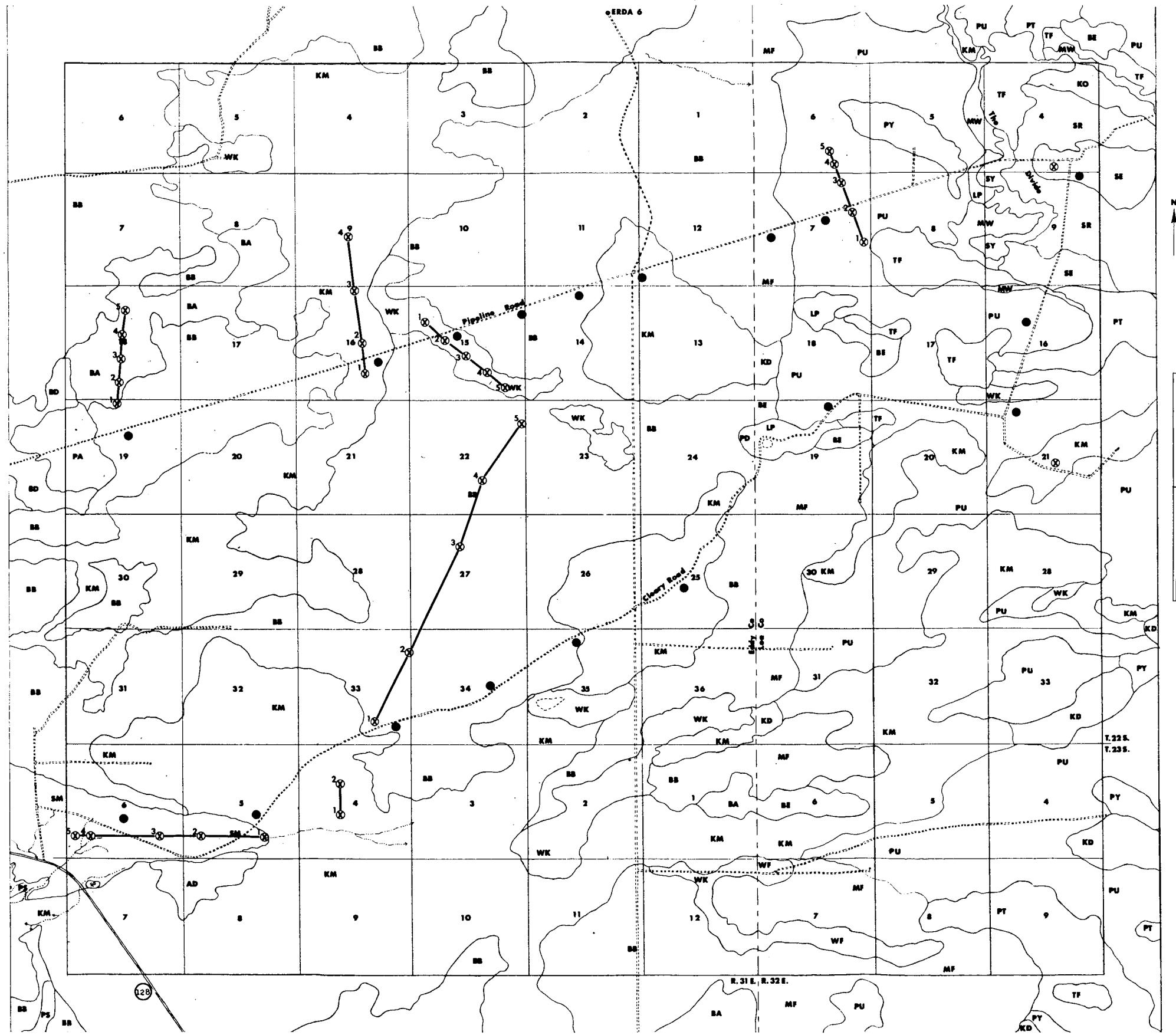
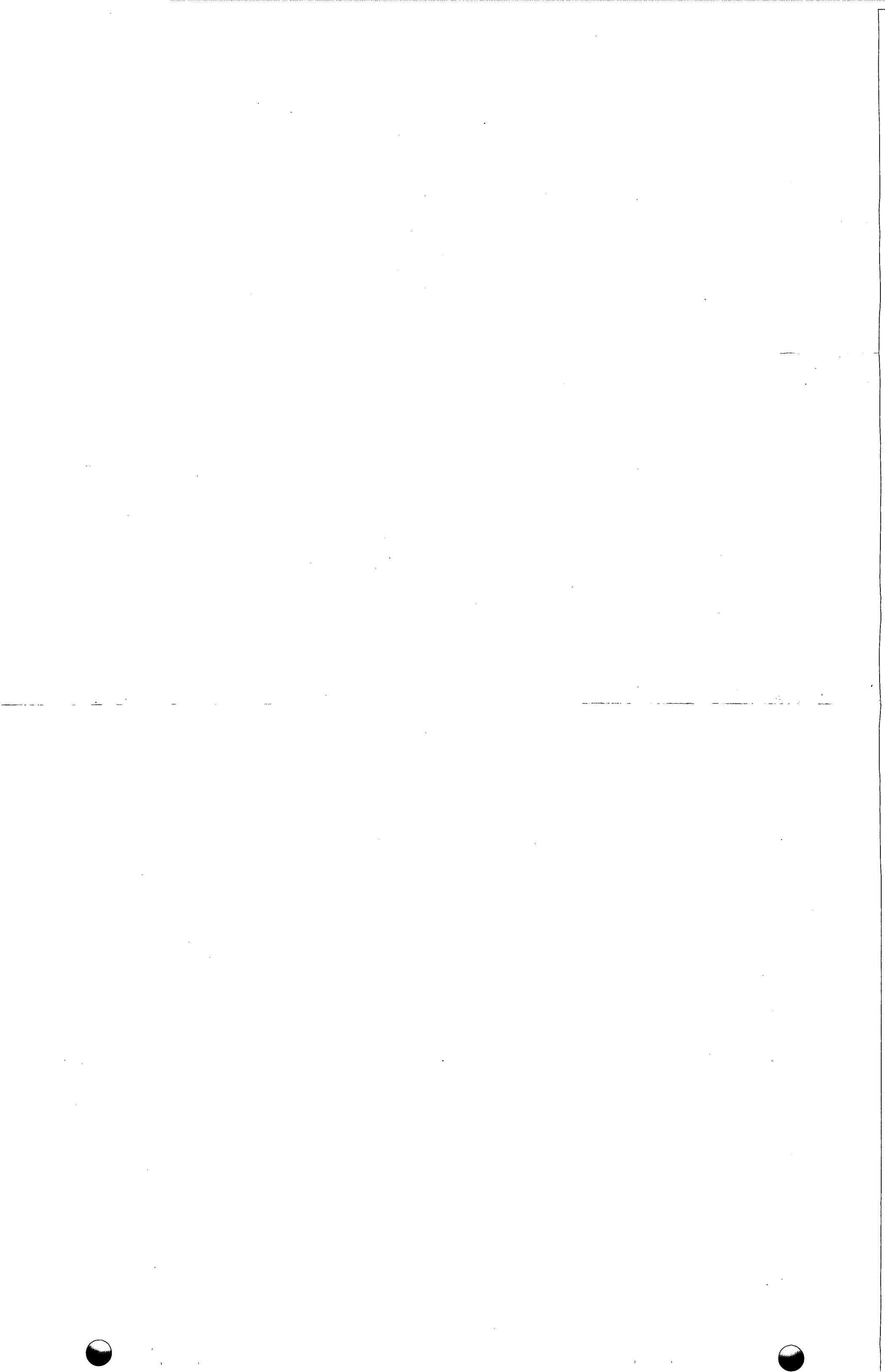


Figure 3-1. Generalized soil map showing extensive sampling areas for soil characterization. The symbol, \otimes , indicates areas from which samples were taken for chemical analysis. Such symbols connected by solid lines indicate transects. The solid circles indicate soil pits dug for verification of profiles of various soil series. For explanation of mapping symbols, see text and Table 4-1.



by wind. They occupy the highest parts of the landscape.

Berino soils make up about 30 percent of the association and are deep, noncalcareous, severely eroded soils with a subsoil of sandy clay loam. Much of the Berino acreage occurs with dune land. In a more recent survey (Lea County), Berino soils occurring on gently undulating and hummocky landscapes between the Berino Dune land complex and the Kermit soil series are called Maljamar fine sands. This distinction is discussed in detail below.

The Simona-Pajarito association also occurs in the study area and is dominated by the Simona soil series that make up about 45 percent of the association. Simona soils are moderately dark colored, sandy upland soils that are shallow over caliche.

In Lea county, the major association encompassed by the study area is the Pyote-Maljamar-Kermit association. Soils are gently undulating and rolling, well-drained to excessively drained and occur on uplands in the southern part of the county. Soils have a fine sand surface layer over layers of sandy clay loam to fine sand. They have formed in sandy sediments and wind-deposited sands.

Pyote soils make up about 30 percent of the association and have a thick, light-brown, fine sand surface layer and a reddish-yellow to light-brown fine sandy loam subsoil. Kermit soils make up about 15 percent of the association and have a pale-brown fine sand surface layer over light yellowish-brown fine sand that extends to a depth of 150 cm or more. Maljamar soils comprise about 20 percent of the association and have a yellowish-red fine sand to loamy sand surface layer and a red sandy clay loam subsoil. The gently undulating Pyote and Maljamar soils are on plains. The rolling Kermit soils are on stabilized dunes.

The Maljamar and Pyote series were established subsequent to the publication of the Eddy County soil survey and represent refined (more detailed) descriptions of the Berino series in Eddy County. In Lea County the Berino soil is broken down into two soil series, Maljamar and Palomas, based on the depth of the surface layer. In Eddy County the Berino surface depth ranges from 20-90 cm. In Lea County the Berino series was divided into Maljamar soils with a 60-95 cm surface layer and the Palomas soils with a 30-50 cm surface layer. The substratum of a light sandy clay loam remains the same below the surface layer in all three soils. Vegetation and range site characteristics are similar for the Maljamar and Berino soils. The Pyote-Maljamar-Kermit association in Lea County thus joins large areas of the Kermit-Berino association mapped in Eddy County. The soil series names in each county are retained here to avoid complications in the interpretation of the respective SCS reports for each county, but no major significance will be associated with the change in soil series names (Berino to Maljamar or Pyote) encountered at the county line in this report.

Major Soil Series

Five major soil series were identified as dominating the study area and were thus characterized in detail. Transects across uniform areas of each soil series (Fig.3-1) were established from which multiple soil samples were taken for analysis. Detailed soil profile descriptions were also made along these transects to characterize each soil series.

Wink Series (WK). The Wink series is a member of the coarse-loamy, mixed, thermic family of the Typic Calciorhids. (A partial explanation of the terminology used herein is offered in Appendix B, *Taxonomy of Soils Sampled for Chemical Analysis*). Typically, the Wink soils have a slightly

calcareous, loamy fine sand A horizon and strongly calcareous, fine sandy loam C horizon. The soils are deep and well-drained.

Typifying Profile (moist colors):

A ₁	0 - 17.5 cm (0-7 inches)	Brown (10YR 4/4) loamy fine sand; weak subangular blocky structure; soft, very friable, nonsticky, nonplastic; slightly calcareous; clear smooth boundary.
AC	17.5 - 75.0 cm (7-30 inches)	Light brown (10YR 6/4) fine sandy loam; massive; soft, very friable, slightly sticky, slightly plastic; strongly calcareous; gradual smooth boundary.
C ₁ ca	75 - 100 cm (30-40 inches)	Pink (10YR 8/2) fine sandy loam; massive; soft very friable, slightly sticky, slightly plastic; strongly calcareous; clear smooth boundary.
IIC2	100 cm (40 inches)	Lacustrine sediments.

Location - occur in swales or depressions in isolated areas.

Topography - nearly level to gently sloping.

Vegetation - mesquite, sagebrush, three awn, some annuals, yucca.

Physical and chemical properties of the Wink soil as determined from samples collected in this study are given in Table 3-1. Soil samples collected from the 0-10 cm depth correspond to the A₁ horizon, whereas samples collected from 25-50 cm correspond to the AC horizon. As predicted from the profile description, the A horizon was slightly calcareous (2.1% CaCO₃) while the AC horizon was strongly calcareous (7.6%). Total salts in both horizons are very low (EC X 10³ = 0.36 and 0.34 for the A and AC horizons, respectively) and the ionic constituents are present in the normal relative abundance for semi-arid calcareous soils. Organic matter, total N, water soluble P and N are very low, reflecting low natural soil fertility. The low cation exchange capacities of both horizons emphasize the sandy nature of the soils. Exchangeable cations reflect the normal

Table 3-1 Physical and Chemical Properties of the Wink (WK) Soil Series.

Property	Soil Sample Depth	
	0-10 cm	25-50 cm
<u>Chemical</u>		
pH	7.99	7.57
Electrical conductivity, mmhos/cm	0.36	0.34
Water soluble ions:		
Ca ⁺⁺ , meq/l	1.84	2.69
Mg ⁺⁺ "	0.74	0.79
Na ⁺ "	0.49	0.11
K ⁺ "	0.30	0.27
Cl ⁻ "	0.18	0.26
SO ₄ ²⁻ "	0.31	0.74
HCO ₃ ⁻ "	4.39	1.50
B, ppm	0.12	0.09
NO ₃ ⁻ "	1.09	1.09
PO ₄ ³⁻ "	0.09	0.01
Exchangeable cations, meq/100 gms		
Ca ⁺⁺	6.90	7.87
Mg ⁺⁺	0.97	1.15
Na ⁺	0.07	0.04
K ⁺	0.28	0.27
Cation exchange capacity, meq/100 gms	8.22	9.33
Gypsum, %	0	0
CaCO ₃ , %	2.10	7.60
Organic Matter, %	0.39	0.49
Total N, %	0.03	0.03
<u>Physical</u>		
Hydraulic conductivity, cm/hr	30.2	6.6
*Available moisture, %	1.9	4.4
Texture	Fine sand	Loamy coarse sand
Sand, %	89.26	83.42
Coarse (2-0.5 mm), %	3.05	50.93
Medium (.5-.25 mm), %	20.79	12.30
Fine (.25-.05 mm), %	65.42	20.19
Silt, %	7.26	9.27
Clay, %	3.48	7.31

*Available moisture determined as the difference in percent moisture at tensions of 1/3 and 15 bars.

distribution expected in calcareous semiarid soils (Ca > Mg > K > Na).

Samples collected for textural analysis from the 0-10 cm depth were classified as fine sand as opposed to the loamy fine sand classification given to the A horizon in the profile description. No particular significance is attributed to this discrepancy since the abundant fine sand can be easily evaluated as silt in field texturing, thus placing the soil in the loamy fine sand category. Textural classifications are most important in their relation to plant growth via the influence on water relations. Both the profile description and the classification given in Table 3-1 would predict high permeabilities and low water holding capacities. These expectations are confirmed in Table 3-1. A lower but still rapid, hydraulic conductivity was observed in the finer AC horizon than in the coarser A horizon. Slightly greater available moisture was also observed for the AC horizon. The Wink soil (including both the A and AC horizons) would be expected to be well-drained and have a low water holding capacity. Plant growth would therefore be expected to be limited by moisture availability.

Berino Series (BA and BB). The Berino series is a member of the fine, mixed, thermic family of the Typic Haplargids. Typically, the Berino soils have yellowish-red, noncalcareous, sandy clay loam Bt horizons. In some areas a light pink, calcareous, clay loam C horizon is present.

Typifying Profile (moist colors):

A₁ 0-47.5 cm (0-19 inches) Yellowish-red (5YR 4/4) fine sand; weak, moderate subangular blocky structure; soft; very friable; nonsticky, nonplastic; abrupt and smooth boundary.

B_{21t} 47.5-70.0 cm (19-28 inches) Yellowish-red (5YR 4/4) sandy loam; weak, coarse, prismatic structure; hard; firm; slightly sticky; nonplastic; abrupt and smooth boundary.

B ₂₂ t	70.0-100 cm (28-40 inches)	Red (2.5YR 4/4) sandy clay loam; moderate, coarse prismatic structure; very hard; firm; sticky; plastic; clear and smooth boundary.
B ₃	100-117.5 cm (40-47 inches)	Red (2.5YR 4/4) light sandy clay loam; weak subangular blocky structure; hard; firm; sticky; plastic; abrupt and smooth boundary.
C _{Ca}	117.5-137.5 cm (47-55 inches)	Pink (5YR 6/4) light clay loam; massive; extremely hard; firm; sticky; plastic; strongly calcareous.

A distinction is made between the Berino soil (BA) and the Berino complex (BB). The Berino soil (BA) is indicative of the typical Berino soil while the Berino complex (BB) includes soils other than the Berino which at the scale of mapping are not identifiable. In the Berino complex (BB), Berino soil occurs in association with Pajarito soils as the smoother areas in swales and depressions between the dunes of Kermit soils. Although the Berino soil (BA) surface is commonly eroded so that the surface horizon is only 20-30 cm thick, the topography is normally level to gently sloping. The Berino complex (BB) surface may be hummocky, particularly under mesquite. There are also slight vegetational differences associated with each phase of the Berino series. In the Berino soil (BA), vegetation consists of mesquite, blue grama, Harvard oak and only a few scattered sagebrush. In the Berino complex (BB), vegetation includes mesquite, three awn, Harvard oak and some scattered sagebrush.

Chemical and physical properties of the Berino soils are given in Table 3-2. Soil samples of the Berino soil (BA) were taken at the 0-10 and 25-50 cm depth and should correspond to the A₁ horizon in the typifying profile. The Berino complex (BB) was sampled at 0-10, 25-50 and 62.5-87.5 cm depths. The first two depths correspond to the A horizon, and the third depth corresponds to the B horizon. Two samples (0-10 and 25-50 cm)

Table 3-2. Physical and Chemical Properties of the Berino (BA and BB) soil series.

Property	BA		BB		
	Soil Sample Depth		Soil Sample Depth		
	0-10cm	25-50cm	0-10cm	25-50cm	62.5-87.5cm
<u>Chemical</u>					
pH	7.40	7.20	7.37	7.25	7.12
Electrical conductivity, mmhos/cm	0.21	0.15	0.26	0.14	0.18
Water soluble ions:					
Ca ⁺⁺ , meq/l	1.09	0.89	2.01	0.83	1.09
Mg ⁺⁺ , "	0.35	0.22	0.46	0.25	0.47
Na ⁺ , "	0.12	0.11	0.08	0.12	0.14
K ⁺ , "	0.33	0.07	0.30	0.12	0.12
Cl ⁻ , "	0.27	0.60	0.12	0.17	0.28
SO ₄ ⁼ , "	0.22	0.18	0.07	0.18	0.37
HCO ₃ ⁻ , "	1.45	0.62	2.81	0.99	1.73
B, ppm	0.07	0.10	0.09	0.12	0.10
NO ₃ ⁻ , "	1.92	4.17	2.04	3.32	1.18
PO ₄ ³⁻ , "	0.03	0.01	0.07	0.01	0.01
Exchangeable cations, meq/100 gm					
Ca ⁺⁺	2.58	3.26	2.42	2.52	7.22
Mg ⁺⁺	0.56	0.59	0.38	0.48	2.03
Na ⁺	0.07	0.11	0.09	0.02	0.05
K ⁺	0.29	0.18	0.23	0.18	0.41
Cation Exchange capacity meq/100 gm	3.50	4.14	3.12	3.20	9.71
Gypsum, %	0	0	0	0	0
CaCO ₃ , %	0	0	0	0	0
Organic Matter, %	0.26	0.16	0.36	0.20	0.20
Total N, %	0.02	0.01	0.02	0.01	0.02
<u>Physical</u>					
Hydraulic conductivity, cm/hr	36.2	24.1	41.9	28.8	12.8
*Available moisture	1.0	0.7	0.7	0.6	2.8
Texture	Fine sand	Fine sand	Fine sand	Fine sand	Fine sandy loam
Sand, %	91.54	91.52	94.15	93.35	79.45
Coarse(.2-.5 mm), %	5.39	1.80	2.12	1.83	2.29
Medium(.5-.25 mm), %	17.85	12.18	24.54	24.65	23.06
Fine(.25-.05 mm), %	68.30	76.54	67.49	66.89	54.10
Silt, %	5.40	4.56	4.72	3.88	6.20
Clay, %	3.06	3.92	1.13	2.78	14.35

*Available moisture determined as the difference in percent moisture at tensions of 1/3 and 15 bars.

of the A horizons of both BA and BB were taken since wind erosion of the soil surface could alter chemical or physical properties of the immediate soil surface (0-10 cm).

There were only minor differences in samples of BA at the two depths. Both samples were noncalcareous, very low in total salts, and low in natural fertility. The 25-50 cm depth of soil BA had a slightly lower pH, lower total salt, lower organic matter, and higher soluble NO_3 . Both depths classified as fine sands and had rapid permeabilities and low water holding capacities.

The two A horizon samples of the Berino complex (BB) were also very similar and were essentially identical to the A horizon samples of the Berino soil (BA). This similarity is expected, of course, since the Berino complex (BB) is dominated by the Berino series. On the basis of chemical and physical properties determined here, the distinction between BA and BB would not appear to be necessary. Samples of the Berino complex (BB) from the 62.5-87.5 cm depth reflected the higher clay content associated with a B horizon, particularly in the hydraulic conductivity and available moisture characteristics. Although the permeability of this horizon is high, more water would be retained and made available to plants than in the extremely sandy A horizons. Natural fertility, however, remains low in the B horizon. Plant growth in the Berino soil (either BA or BB) would be expected to be limited by water availability.

Pyote Series (PU). The Pyote series is a member of the loamy, mixed, thermic family of the Arenic Ustalfic Haplargids. Typically, the Pyote soils have a light reddish-brown, fine sand A horizon and reddish-brown, fine sandy loam B horizons over light reddish-brown, fine sandy loam C horizon to 150 cm.

Typifying Profile (moist colors):

A ₁	0-67.5 cm (0-27 inches)	Light reddish-brown (5YR 5/4) fine sand; single grain; loose, nonsticky, nonplastic; noncalcareous; clear and smooth boundary.
B _{21t}	67.5-95.0 cm (27-38 inches)	Reddish brown (5YR 3/4) fine sandy loam; weak prismatic structure; soft, very friable, nonsticky, slightly plastic; noncalcareous; clear and smooth boundary.
B _{22t}	95.0-120 cm (38-48 inches)	Reddish-brown (5YR 4/4) fine sandy loam; moderate prismatic structure; soft, very friable; slightly sticky, slightly plastic; noncalcareous; clear and smooth boundary.
C	120-150 cm (48-60 inches)	Light reddish-brown (5YR 6/4) fine sandy loam; massive; slightly hard, friable, slightly sticky, slightly plastic; calcareous.

Vegetation - mesquite, Harvard oak, three awn, sagebrush.

Topography - level to gently sloping.

The PU mapping unit is about 45 percent Pyote fine sand, 45 percent Maljamar fine sand and 10 percent inclusions. Some areas are mostly Pyote, some mostly Maljamar, and some areas contain both soils. As discussed previously, the Pyote and Maljamar soils are enumerated only in Lea County and join large areas of Berino (particularly BB) soil in Eddy County.

Chemical and physical properties of the Pyote soil series are given in Table 3-3. Samples were taken at two depths (0-10 cm and 25-50 cm), but both should correspond to the A horizon described in the typifying profile. The two samples are very similar chemically except for the slightly higher salt content of the 25-50 cm sample and a relatively high soluble NO_3 content

Table 3-3 Physical and Chemical Properties of the Pyote (PU) Soil Series.

<u>Property</u>	<u>Soil Sample Depth</u>	
	<u>0-10 cm</u>	<u>25-50 cm</u>
<u>Chemical</u>		
pH	7.20	7.09
Electrical conductivity, mmhos/cm	0.18	0.30
Water soluble ions:		
Ca^{++} , meq/l	1.20	2.69
Mg^{++} , "	0.25	0.54
Na^+ , "	0.08	0.06
K^+ , "	0.20	0.21
Cl^- , "	0.08	0.01
$\text{SO}_4^{=}$, "	0.11	0.07
HCO_3^- , "	1.48	3.82
B, ppm	0.10	0.16
NO_3^- , "	8.24	0.47
PO_4^{3-} , "	0.05	0.01
Exchangeable cations, meq/100 gms		
Ca^{++}	2.54	2.75
Mg^{++}	0.35	0.44
Na^+	0.11	0.26
K^+	0.23	0.23
Cation Exchange capacity, meq/100 gms	3.23	3.68
Gypsum, %	0	0
CaCO_3 , %	0	0
Organic Matter, %	0.33	0.26
Total N, %	0.02	0.02
<u>Physical</u>		
Hydraulic conductivity, cm/hr	36.3	46.0
*Available moisture	0.9	0.3
Texture	Fine sand	Fine sand
Sand, %	94.28	93.73
Coarse (2-0.5 mm), %	1.08	0.98
Medium (.5-.25 mm), %	13.64	13.09
Fine (.25-.05 mm), %	79.56	79.66
Silt, %	3.86	3.42
Clay, %	1.87	2.85

*Available moisture determined as the difference in percent moisture at tensions of 1/3 and 15 bars.

of the 0-10 cm sample. Subsampling error, however, could easily account for the differences observed. Physically, the samples are essentially identical and further are very similar to the Berino soil samples discussed previously (Table 3-2). The Pyote fine sand is very permeable and retains little moisture for use by plants. The Pyote and Berino soils would be expected to offer very similar environments for plants, restricting plant growth primarily through moisture availability.

Simona Series (SM). The Simona series is a member of the loamy, mixed, thermic, shallow family of Typic Paleorthids. Typically, the Simona soils have a brown, calcareous, gravelly fine sandy loam A horizon and a light brown, strongly calcareous, gravelly fine sandy loam B₂ horizon over a strongly calcareous C horizon to 50 cm.

Typifying profile (moist colors):

A ₁	0-10 cm (0-4 inches)	Brown (10YR 4/4) gravelly fine sandy loam; weak platy structure; soft, very friable, nonsticky, nonplastic; calcareous; abrupt and smooth boundary.
B ₂	10-37.5 cm (4-15 inches)	Light brown (10YR 6/4) gravelly fine sandy loam; weak subangular blocky structure; slightly hard, friable, nonsticky, nonplastic; strongly calcareous; clear and wavy boundary.
C ₁	37.5-45.5 cm (15-19 inches)	Light brown (10YR 6/4) gravelly fine sandy loam; massive; slightly hard, friable, slightly sticky, nonplastic; strongly calcareous, abrupt and wavy boundary.
C ₂	45.5 + cm (19 + inches)	Indurated caliche.

Location - nearly level uplands.

Vegetation - three awn, mesquite, side oats grama, creosote.

Topography - level to gently sloping.

Chemical and physical properties of the Simona soil are given in Table 3-4. Samples taken from the 0-10 cm depth and from the 25-50 cm depth should correspond to the A and B horizons, respectively.

The Simona A horizon (0-10 cm depth) is calcareous (7.2 percent CaCO_3), has low total salt and low natural fertility. Organic matter is higher in the Simona soils than in the other soil series identified herein, but is still less than one percent. The finer texture of the Simona soils is reflected in moderate cation exchange capacities ($\approx 14 \text{ meq}/100 \text{ gm}$).

Neither horizon sample contain sufficient gravel to be classified as gravelly although field texturing resulted in the gravelly classification. Cations and anions, exchangeable or water soluble, are indicative of normal calcareous, semiarid soils. Soil samples from the Simona B horizon (25-50 cm) are strongly calcareous (13.9 percent CaCO_3), but otherwise are very similar to A horizon samples. Both horizons reflect their fine sandy loam texture in lower, but still fast, hydraulic conductivity and greater available moisture compared to the fine sand soils discussed previously. Plant growth would be favored on this soil, but the shallowness of the Simona soils may limit some plants.

Kermit Series (KM). The Kermit soil is a member of the silicious, thermic family of Typic Torripsammets. Typically, the Kermit soils have a yellowish-red, noncalcareous, fine sand to loamy sand A and C horizons. The soils are deep and excessively drained.

Typifying profile (moist colors):

A ₁	0-15 cm (0-6 inches)	Yellowish-red (5YR 4/4) fine sand; single grain; loose when dry or moist; nonsticky; noncalcareous; clear and smooth boundary.
C	15-162.5 cm (6-65 inches)	Yellowish-red (5YR 4/4) fine sand; single grain; loose when dry or moist; nonsticky, nonplastic; noncalcareous.

Table 3-4. Physical and Chemical Properties of the Simona (SM) Soil Series.

<u>Property</u>	<u>Soil Sample Depth</u>	
	<u>0-10 cm</u>	<u>25-50 cm</u>
<u>Chemical</u>		
pH	7.69	7.71
Electrical conductivity, mmhos/cm	0.51	0.44
Water soluble ions:		
Ca ⁺⁺ , meq/l	4.13	3.45
Mg ⁺⁺ , "	0.69	0.69
Na ⁺ , "	0.62	0.19
K ⁺ , "	0.53	0.32
Cl ⁻ , "	0.56	1.08
SO ₄ ⁼ , "	0.62	0.18
HCO ₃ ⁻ , "	5.28	1.16
B, ppm	0.13	0.23
NO ₃ ⁻ , "	3.73	1.26
PO ₄ ³⁻ , "	0.07	0.01
Exchangeable cations, meq/100 gms:		
Ca ⁺⁺	11.84	11.54
Mg ⁺⁺	1.10	1.38
Na ⁺	0.17	0.06
K ⁺	0.91	0.58
Cation exchange capacity, meq/100 gms	14.02	13.56
Gypsum, %	0	0
CaCO ₃ , %	7.2	13.9
Organic Matter, %	0.88	0.88
Total N, %	0.06	0.06
<u>Physical</u>		
Hydraulic conductivity, cm/hr	2.4	3.6
*Available moisture	4.5	5.2
Texture	Fine sandy loam	Fine sandy loam
Sand, %	53.12	67.65
Coarse (2.0-.5 mm), %	3.53	4.71
Medium (.5-.25 mm), %	12.91	10.84
Fine (.25-.05 mm), %	36.68	52.10
Silt, %	41.34	23.49
Clay, %	5.54	8.86

*Available moisture determined as the difference in percent moisture at tensions of 1/3 and 15 bars.

Vegetation - mesquite, sagebrush, oak, yucca.

Topography - level to gently sloping (area consists mostly of stabilized dunes).

Two sampling areas were chosen to characterize the Kermit series. The first, and main, sampling site was in the northwest portion of the study area. The second sampling site was in the southwestern portion of the study area. Chemical and physical properties of samples from both areas are given in Table 3-5. The 0-10 cm samples should correspond to the A horizon of the Kermit series, while the 25-50 cm samples should correspond to the C horizon.

The Kermit soil represent wind blown material, almost entirely sand, very low in clay, soluble salts, organic matter, and natural fertility. The shallow samples, at both locations, differ from deeper samples only slightly except for higher soluble NO_3 contents at shallow depths. All samples have very high hydraulic conductivities and would be expected to contain very little available moisture for plants.

Samples of the 0-10 cm depth at the first sampling site were inexplicably higher in coarse sand than at the second sampling site or than is expected for typical Kermit soil series. Nevertheless, other properties of the samples taken from different sites were essentially identical. Available moisture for all samples was very low, dramatizing the difficulty plants would have existing on these soils. Soil stability would also be expected to be a serious problem.

Table 3-5. Physical and Chemical Properties of the Kermit (KM) Soil Series.

<u>Property</u>	<u>1st Sampling Site</u>		<u>2nd Sampling Site</u>	
	<u>0-10 cm</u>	<u>25-50 cm</u>	<u>0-10 cm</u>	<u>25-50 cm</u>
<u>Chemical</u>				
pH	7.42	7.44	7.39	7.45
Electrical conductivity, mmhos/cm	0.19	0.16	0.12	0.09
Water soluble ions:				
Ca ⁺⁺ , meq/l	1.37	1.10	0.54	0.61
Mg ⁺⁺ , "	0.25	0.25	0.15	0.16
Na ⁺ , "	0.12	0.11	0.12	0.09
K ⁺ , "	0.28	0.18	0.17	0.10
Cl ⁻ , "	0.12	0.03	0.08	<0.01
SO ₄ ⁼ , "	0.18	0.11	0.37	0.37
HCO ₃ ⁻ , "	1.70	1.92	0.49	1.01
B, ppm	0.28	0.12	0.27	0.07
NO ₃ ⁻ , "	16.23	0.77	14.98	2.11
PO ₄ ³⁻ , "	0.37	0.01	0.15	0.01
Exchangeable cations, meq/100 gms				
Ca ⁺⁺	1.81	1.52	1.06	1.54
Mg ⁺⁺	0.29	0.26	0.23	0.27
Na ⁺	0.17	0.03	0.03	0.02
K ⁺	0.16	0.14	0.12	0.12
Cation exchange capacity, meq/100 gms	2.43	1.96	1.44	1.95
Gypsum, %	0	0	0	0
CaCO ₃ , %	0	0	0	0
Organic Matter, %	0.16	0.13	0.13	0.16
Total N, %	0.01	0.01	0.01	0.01
<u>Physical</u>				
Hydraulic conductivity, cm/hr	51.6	37.5	51.2	41.0
*Available moisture	0.3	0.3	0.5	0.3
Texture	Coarse sand	Fine sand	Fine sand	Fine sand
Sand, %	97.47	96.16	97.51	96.26
Coarse (2-.5 mm), %	62.63	1.65	3.02	1.90
Medium (.5-.25 mm), %	26.36	19.51	34.77	28.25
Fine (.25-.05 mm), %	8.48	75.00	59.72	66.11
Silt, %	0.61	2.52	0.15	2.77
Clay, %	1.92	1.32	2.35	0.97

*Available moisture determined as the difference in percent moisture at tensions of 1/3 and 15 bars.

Summary

Five major soil series were identified as dominating the study area and were characterized in detail as to chemical, physical and morphological features. In general, the characterizations agreed with data reported by the Soil Conservation Service in the Soil Surveys for Eddy and Lea Counties. Additional chemical characterization showed the soils to be indicative of nonirrigated semiarid soils with no unique chemical properties. Soluble K^+ and Cl^- contents, for example, were not especially high despite the proximity of the study area to a potash mining area. The soils consist mainly of gently undulating and rolling, deep, sandy soils, highly permeable with little available moisture. The soils should be subject to wind erosion, particularly in the months of March through May when rainfall is minimal and winds are strong. Vegetation establishment will likely be closely associated with water availability.

BIOTIC RESOURCES

VEGETATIONAL BASELINE STUDY FOR THE LOS MEDAÑOS STUDY AREA

Introduction

The study area covers 72 sq mi in Eddy and Lea Counties. The Soil Conservation Service (SCS) has conducted soil surveys for both counties, but no detailed vegetational surveys have been done. Range site descriptions and corresponding soil series are listed in the Soil Surveys of Eddy Area and of Lea County (U. S. Department of Agriculture, SCS 1971, 1974) and were used as a basis for developing an extensive vegetative range survey to determine the dominant vegetation present. Vegetation was evaluated by ocular sampling techniques at various locations within each range site. Representative sampling locations were distributed throughout the study area but were limited by the accessibility of the area. Fig. 4-1 shows the extensive sampling areas, and Table 4-1 shows the range site designation for each of the soil series.

Range Survey

The range (or ecological) site is the most basic unit of rangeland identification. It can be defined as a given area of land that has the capability of supporting a distinctive kind of plant community which can be identified and described by kind and proportion of species, or differences in average total annual production. Basically the range site is a product of its environment which is regulated largely by climate, soils, and topography. Since the study area is located within the Southern Desert Land Resource Area, the climatic effects are similar. Hence range site differences express changes in soil and topography. Because many soils have similar characteristics important to plant growth, it is possible to have



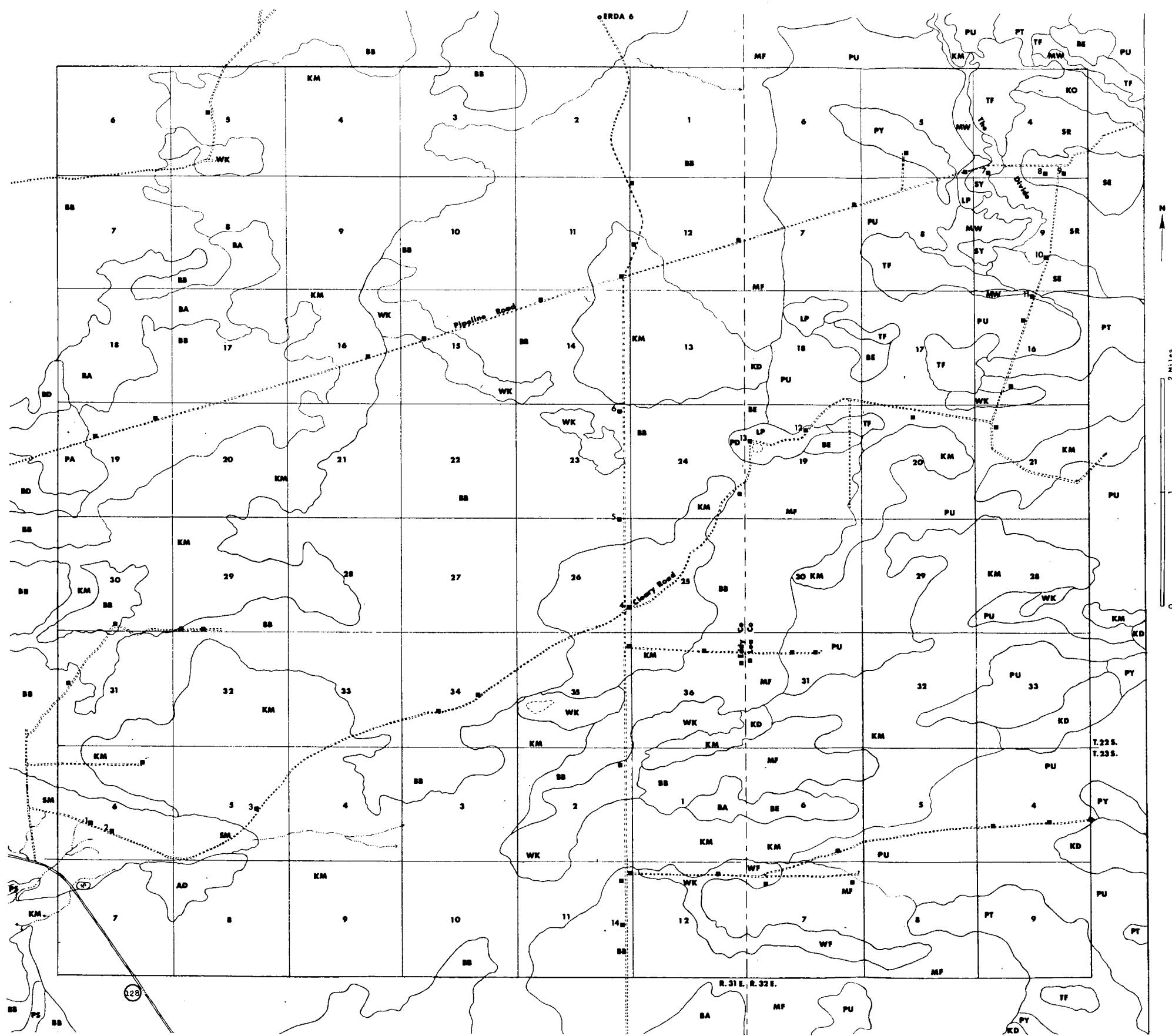


Figure 4-1. Generalized soil map showing the extensive sampling areas for the vegetative baseline study. The numbered squares indicate sampling areas referred to specifically in the text. Mapping symbols are explained in Table 4-1.

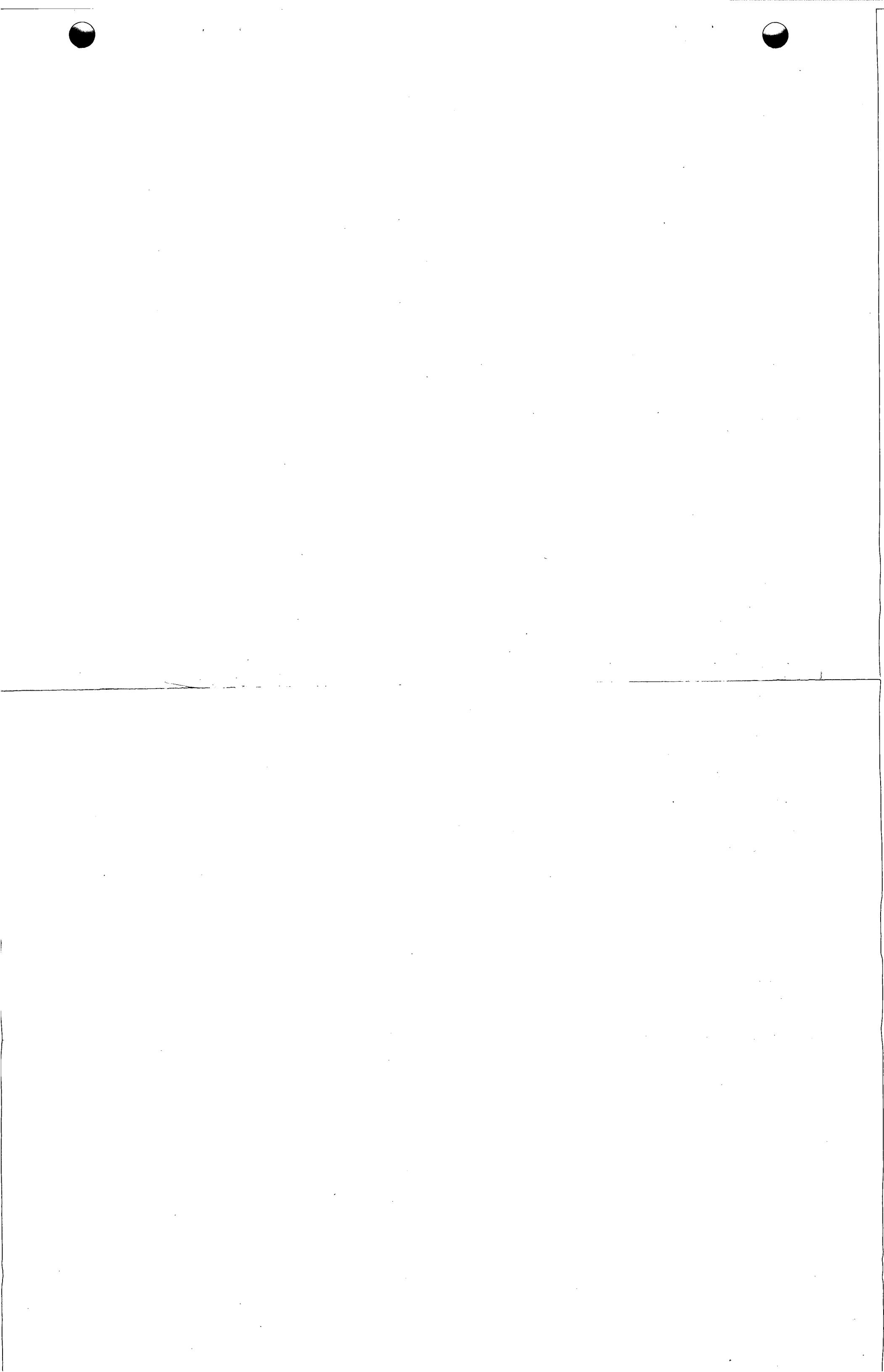


Table 4-1. Range site designations for the soil series present in the extensive study site. Abbreviations for the various soil series are also given.

Mapping Units		Range Sites
Eddy County:		
AD	Active dune land	----
BA	Berino loamy fine sand, 0-3% slopes	Sandy
BB	Berino complex, 0-3% slopes, eroded	Deep Sand
BD	Berino-Dune land complex, 0-3% slopes	Deep Sand
KM	Kermit-Berino fine sands, 0-3% slopes	
	Kermit fine sand	Sand Hills
	Berino fine sand	Deep Sand
PA	Pajarito loamy fine sand, 0-3% slopes, eroded	Deep Sand
PD	Pajarito-Dune land complex, 0-3% slopes	Deep Sand
PS	Potter-Simona complex, 5-25% slopes	
	Potter gravelly loam, 5-25% slopes	Shallow
	Simona gravelly fine sandy loam, 0-3% slopes	Sandy
SM	Simona-Bippus complex, 0-5% slopes	
	Simona gravelly fine sandy loam, 0-3% slopes	Sandy
	Bippus silty clay loam	Bottomland
WK	Wink loamy fine sand, 0-3% slopes, eroded	Deep Sand
Lea County:		
BE	Berino-Cacique loamy fine sands association	Sandy
KD	Kermit-Palomitas fine sands, 0-12% slopes	
	Kermit soil	Sand Hills
	Palomas soil	Deep Sand
KM	Kermit soils and Dune land, 0-12% slopes	
	Kermit soil	Sand Hills
	Dune land	----

Table 4-1. (Cont.)

Mapping Units		Range Sites
KO	Kimbrough gravelly loam, 0-3% slopes	Shallow
LP	Largo-Pajarito complex	
	Largo soil	Loamy
	Pajarito soil	Sandy
MF	Maljamar and Palomas fine sands, 0-3% slopes	Deep Sand
MW	Mobeetie-Potter association, 1-15% slopes	
	Mobeetie soil	Sandy
	Potter soil	Shallow
PT	Pyote loamy fine sand	Deep Sand
PU	Pyote and Maljamar fine sands	Deep Sand
PY	Pyote soils and Dune land	
	Pyote soil	Deep Sand
	Dune land	----
SE	Simona fine sandy loam, 0-3% slopes	Sandy
SR	Simona-Upton association	
	Simona soil	Shallow
	Upton soil	Shallow
SY	Stony rolling land	Breaks
TF	Tonuco loamy fine sand	Sandy
WF	Wink fine sand	Deep Sand
WK	Wink loamy fine sand	Deep Sand

more than one soil series within a range site. Since the soil surveys were conducted at a low intensity, it is also possible to have undifferentiated, or complexes of, soil series. These soil complexes consist of two or more soil series and may contain more than one range site. Because no portion of the complex is sufficiently adequate in size for soil delineation at the mapping intensity, the range site descriptions also follow an undifferentiated status based on the most dominant soil in the complex.

Within the study site, six range sites have been identified. Three of the sites - sandy, deep sand, and sand hills - occupy most of the area. The shallow, loamy, and bottomland sites are found only occasionally. The loamy site, associated with the Largo soil series, is near the center of the study site. The shallow range site is in the northeastern corner and the bottomland site in the southwestern corner of the extensive study site.

No range site on the study area reflects its full potential. Because of past usage, there are often greater differences within a range site than between range sites on the study area. This is to be expected as the sand-derived soils that constitute most of the area are comparable in potential vegetation; they differ largely in the productive capacity and presence of selected species. Also, through retrogression these sites grade to a common denominator in species composition. On degenerated areas wind movement of surface sands often intermixes the characteristics of the sites. It is, therefore, difficult to distinguish site characteristics in the area.

Deep Sand Desert Grassland Range Site

This site is nearly level to rolling sandy plains with 0-12 percent slope. The soils are deep, fine sands, sometimes underlain by indurated caliche. They are rapidly permeable, have high available water holding

capacity, and a good plant-soil-air-water relationship. If unprotected by plant cover, the soils are highly susceptible to wind erosion, and large, active sand dunes may be formed.

Potentially, the site is an open grassland and tall and mid-grasses dominate the community. Grasses are bunch and rhizomatous types and include sand bluestem (Andropogon hallii), Havard panicum (Panicum havardii), and sandreed grass (Calamovilfa gigantea), which are especially adapted to the deep sandy soils. Frequent shifting of the sands may create considerable variation in the structure and composition of the plant community. Such plants as shinnery oak (Quercus havardii), sand sagebrush (Artemisia filifolia), and sandreed grass are well adapted and act as principle soil stabilizers. Pioneer species, including annuals and some of the dropseeds (Sporobolus spp.), dominate the less stable areas.

This range site is quite extensive on the study area. As a single site, in conjunction with undifferentiated mapping units, it occupies the largest area of any range site. Typically, it includes the Berino, Maljamar, Wink, Pyote and Palomas soils and their dominance in undifferentiated mapping units.

The general retrogression pattern results in replacement of the dominant tall grasses, e.g., sand bluestem, giant dropseed (Sporobolus giganteus), Havard panicum, and sandreed grass, with increaser species, e.g., mesa dropseed (Sporobolus flexuosus) and sand dropseed (Sporobolus cryptandrus). Pioneer species, including annual sandbur (Cenchrus pauciflorus), tridens (Erioneuron spp.), and annual forbs, become dominant components in deteriorated communities. Sand sage, shinnery oak, and mesquite (Prosopis glandulosa) also invade the site and form low, dense, woody canopies.

The extreme variation of vegetation on the study area ranges from active dunes near sampling location 3 to well-stabilized areas showing trace amounts of little bluestem (Schizachyrium scoparium) near locations 11 and 14. The most typical appearance of the site, vegetatively and topographically, is observed near locations 4, 5 and 6. These areas are often in an undifferentiated mapping unit with the sandy range site, but are dominated by deep sands.

Throughout the deep sands range site, considerable variation exists between the amount and cover of sand sage, shinnery oak, and mesquite. The amount present of each species is largely a function of environmental conditions at the time of increase of the woody plants, and the plant most favored has increased most rapidly. It is doubtful that competitive successional or retrogressive patterns have been present to any extent among the woody plants.

While not present on all areas of the deep sands range site, large amounts of broom snakeweed (Gutierrezia sarothrae), senecio (Senecio spartioides), wooly groundsel (Senecio longilobus), and wild buckwheat (Eriogonum annuum) were observed. These plants were also present on all the other sand-derived range sites and were a function of past environmental conditions. Recent dry years (early 1970's) resulted in a void, or opening, in the plant communities. High precipitation in 1974 and 1975 provided ideal growing conditions for these plants. The same moisture conditions provided above-normal growing conditions for annual sandbur. It is expected that densities and productive levels of the annual species will decline. However, the perennial species, e.g., broom snakeweed and wooly groundsel, may continue on a crest for several years since the deterioration of range sites has resulted in openings in the plant community available

for the establishment of new plants.

Sandy Desert Grassland Range Site

This site has nearly level to rolling topography with 0-6 percent slope, and is generally considered a sandy plains with occasional successions of stabilized dunes. The soils within the site are generally loamy fine sands to sands, 20 in. or more in depth, with rapid water infiltration. The good plant-soil-air-moisture relationship of these soils makes rainfall highly effective. The soils are highly susceptible to wind erosion if unprotected by plant cover.

Potentially, the site is an open grassland with mid-grasses dominant. A few short grasses and tall grasses are also present. Perennial forbs and occasional shrubs occur in association with the perennial grasses. Ephemerals are common and may occur seasonally as aspect dominants - especially on unstable soil areas within the plant community. Shinnery oak and sand sagebrush are primary soil stabilizers, and often occur on small stabilized dunes throughout the plant community.

The general pattern of retrogression results in rapid increases of mesa and sand dropseed as the limited amounts of giant dropseed, sand bluestem, and little bluestem are replaced. Further retrogression results in decreased plant cover, and perennial three awns (Aristida spp.), signal grass (Brachiaria ciliatissima), and numerous annuals become the dominant vegetation. Sand sagebrush and shinnery oak increase greatly, and mesquite, broom snakeweed, and senecio invade the site.

This range site is found in small isolated units throughout the study area. Generally, it is adjacent to the deep sands range site. The sandy range site is also present to varying degrees as part of the undifferentiated mapping unit of the deep sand-sandy range sites. In this situation, the

sandy range site generally occupies the more level, stabilized areas of the interdunes.¹ The sandy range site is generally the area occupied by sand sagebrush and shinnery oak, often in a hummocky topographic position.

Because of retrogression, it is difficult to identify areas of the sandy range site since the grass and the woody plant compositions are similar to those of the deep sands. However, there is generally less mesquite on the sandy site. While the sandy site is the primary position for high numbers of ephemerals, broom snakeweed, and senecio, the climatic conditions of the past two years and the state of retrogression have allowed a reasonably uniform distribution of herbaceous plants.

Sand Hills Desert Grassland Range Site

This range site occurs on deep, sandy, gently undulating, billowy stabilized dune soils, primarily of the Kermit series. Hills may be 25 ft high with a slope of 0-15 percent. The soils are loose, fine sands to a depth of 60 in. or more. Water intake is very rapid, runoff is minimal, and available water holding capacity is 3-4 in. The soils are very droughty and are highly subject to wind erosion.

The vegetative pattern for the sand hills range site is comparable to that of the deep sands. It is separate only because of differences in productive capacity. In general, the productive capacity of the sand hills site is approximately half that of the deep sands because of its more xeric nature. The reduced productivity results in more open area on the soil surface and thus greater erosion hazard.

The sand hills range site is generally located within an undifferentiated mapping unit and occurs with the deep sands range site. Under current conditions, little vegetative differences exist between the two. Generally, in the sand hills range site there is more yucca (Yucca campestris) and mesquite

¹ Interdunes are the low-lying areas interspersed among the dunes and hummocks.

and less sand sagebrush, shinnery oak, and broom snakeweed. The pattern of grasses and forbs is similar to that of the deep sand range site.

Generally the sand hills range site on the study area is only partially stabilized and is easily affected by wind movement.

Loamy Desert Grassland Range Site

This site occurs as nearly level to gently rolling topography with 0-3 percent slope. Soils are deep, medium textured, fine sandy loams to loams, usually underlain by caliche. The soils have moderately rapid permeability, and only after prolonged rainfall is runoff likely.

The potential vegetation on this site is an open grassland of mid- and short grasses with varying amounts of forbs. A few woody shrubs and yucca may be present. Ephemeral forbs are common and may give an aspect dominance.

As retrogression occurs, mesa and sand dropseeds increase strongly; black grama (Bouteloua eriopoda), plains bristlegrass (Setaria leucopila), Arizona cottontop (Trichachne californica) and bush muhly (Muhlenbergia porteri) decrease rapidly. Signal grass, perennial three awn, annual sandbur, and annual forbs gradually increase at the expense of the dropseeds. Woody plants, including sand sagebrush, catclaw (Acacia spp.), wolfberry (Lycium pallidum), lotebush (Condalia obtusafolia), javelinabrush (Condalia ericoides), and creosotebush (Larrea tridentata) gain prominence in deteriorated areas.

The loamy range site was observed only at the Red Tank, near locations 12 and 13. The site was depleted of herbaceous vegetation - possibly due to its proximity to water. On the periphery of the site, large amounts of creosote bush were present. Little sand sagebrush or shinnery oak was present. Snakeweed was present on the level areas in conjunction with fluff grass (Erioneuron pulchellum), and annual sandbur and occasional

dropseed plants were present on the dunes.

Shallow Desert Grassland Range Site

The site is level to gently rolling with 0-3 percent slope. The soils are shallow, fine sandy loam over indurated caliche, sandstone or gypsum, and caliche often occurs on the surface. The soils have a high infiltration rate and utilize small rains well. If the soils are not protected by vegetative cover, they are subject to wind erosion.

The potential vegetation is an open grassland dominated by short and mid-grasses. Black grama is a single species dominant on this range site. Perennial forbs and occasional woody plants are components of the vegetation. With retrogression, black grama, bush muhly, plains bristle grass, mesa dropseed, four-wing saltbush (Atriplex canescens), and many perennial forbs decline dramatically. Three awns, fluff grass, and annuals increase rapidly. Further retrogression results in increases or invasion of catclaw, javelina-brush, mesquite, and creosotebush.

Most of the shallow range site on the study area was in the northeast corner and was in the best condition of any of the area observed. Soils of the Upton, Simona, Potter, and Kimbrough series were present, and locations 7-10 were in the shallow range site.

While considerable amounts of burro grass (Scleropogon brevifolius), fluff grass, wooly groundsel, tridens, and snakeweed were present, there were reasonable amounts of silver bluestem (Bothriochloa saccharoides), bush muhly, black grama, and Arizona cottontop present. On deeper soil inclusions, vine mesquite (Panicum obtusum) was also present. No creosotebush was present, but small amounts of mesquite were.

Bottomland Desert Grassland Range Site

This site is on nearly level, shallow to deep soils with medium to

moderately fine texture. The soils have a moderate permeability and are present in flood plains subject to periodic flooding.

The mapping unit sampled contains a Simona-Bippus complex. Based on the soil, position of the landscape, and the vegetation at locations 1 and 2 near the James Ranch, it appeared that the specific stops were on shallow soils more consistent with the shallow range site.

Vegetative conditions show considerable retrogression with large amounts of mesquite at the lower positions grading into creosotebush on the slopes. There is very little hummocking of the mesquite. The dominant grasses currently are burro grass, three awns, and fluff grass. Reasonable amounts of bush muhly, plain bristle grass, and dropseeds are found within the creosotebush and mesquite plants. Black grama is quite low in abundance.

FAUNAL CHARACTERISTICS

Introduction

Communities are biological units defined in terms of flora, or fauna, or both. Only the faunal components of communities involved were studied during this investigation. Statements about the flora were restricted to vegetation types used to describe habitats. The names of the vegetation types (shinnery oak-mesquite, mesquite-grassland, mesquite-snakeweed, and creosote-grassland) were based on aspect and existing vegetation rather than potential vegetation.

The field work involved an extensive and an intensive survey. Primarily the extensive survey was to determine the vertebrates and ground-dwelling arthropods inhabiting certain habitats within the 72-sq mi study area. The intensive survey was a study of lizard, bird, and mammal densities on part of a 3-sq mi study area. Most of that study area is within the 72-sq mi area (Fig. 4-2).

The amount of data that can be obtained from such surveys is limited to the time and manpower hours allotted. With those limitations in mind, certain goals were established prior to the investigation. They served as the purpose of the study, as follows:

1. Extensive survey-- begin a checklist of herptiles (amphibians and reptiles), birds, and mammals from each of the five habitats (shinnery oak-mesquite, mesquite-grassland, mesquite-snakeweed, creosote-grassland, and active dune land). Begin a checklist of ground-dwelling arthropods from the shinnery oak-mesquite habitat within the 72-sq mi study area.
2. Intensive survey-- determine densities of lizards, birds, and mammals from the shinnery oak-mesquite habitat within the 3-sq mi study area.

The following sections present and discuss the results of the field work planned and executed under the above set of goals and reasoning.

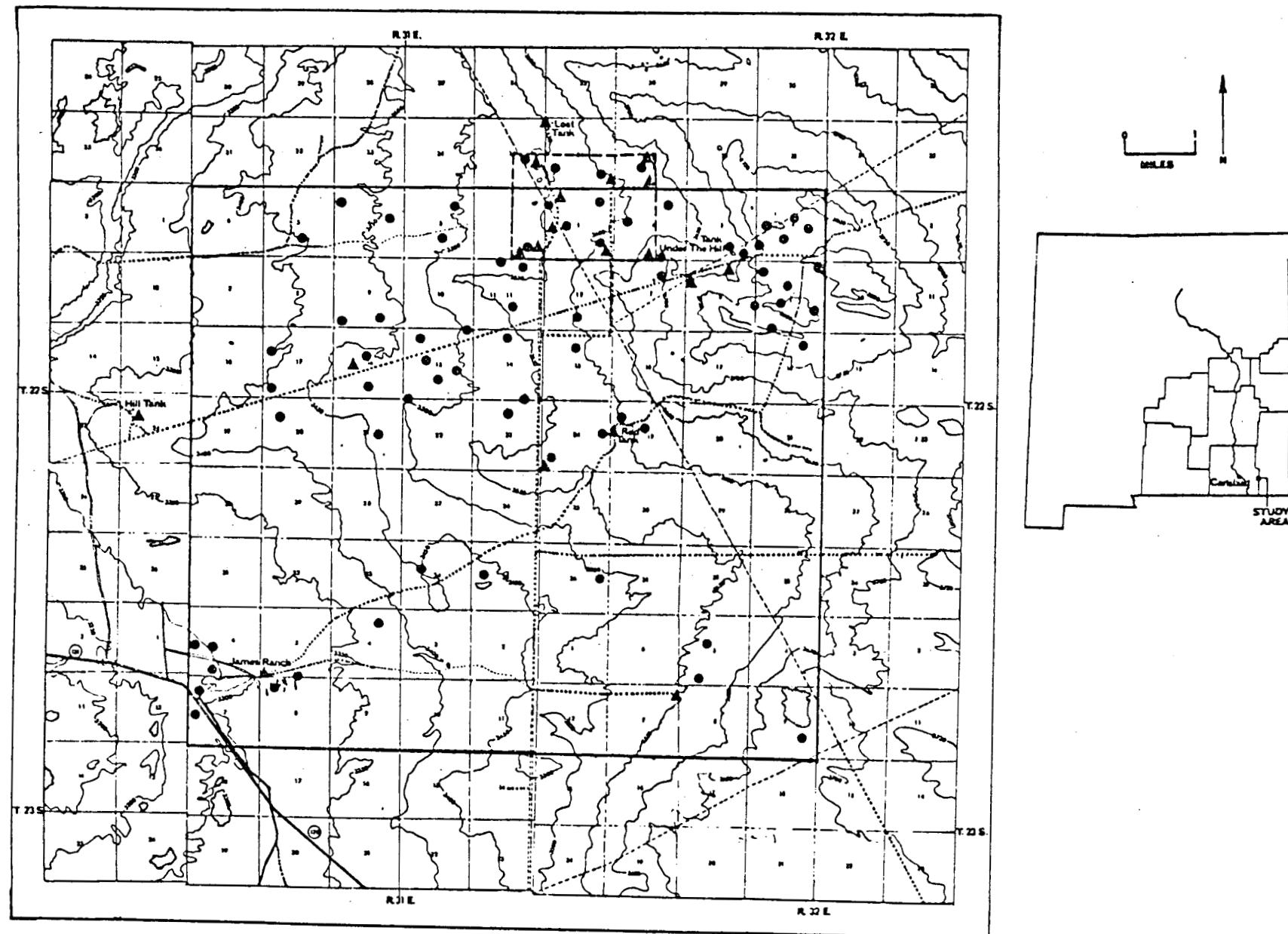


Fig. 4-2. Location of the extensive study area (solid line) and intensive study area (dashed line). Herptiles and mammals survey sites are indicated by solid circles; avian survey sites by solid triangles.

Methods

Arthropods

Ground-dwelling arthropods were surveyed in the shinnery oak-mesquite habitat. Fifty 1-quart canning jars were buried, open ends up, at ground level, 1 m apart along a relatively straight line. Paper cups were inserted, open ends up, into the jars. Each pit-fall trap was emptied of its contents 30 times over various day intervals from 6 September to 28 October 1975.

Herptiles

Extensive survey. Herptiles were observed, collected by hand, or killed with dust shot from the various habitats from 29 August 1975 to 15 April 1976. A representative of each species from the five areas was prepared for deposition in the Eastern New Mexico University (ENMU) Natural History Museum.

Intensive survey. Lizard densities were estimated by counting lizards directly with a cruise method described by Degenhardt (1966). The study was conducted from 9 September to 21 October 1975 on a 1-ha study plot marked off by stakes into 100 units, each 10 m by 10 m. Lizards were counted by walking the plot as shown in Fig. 4-3. Counting was started when sun-exposed soils reached 34° C as recorded by a Tri-R Electronic Thermometer. Degenhardt (1966) discussed the possible errors present in the method, but he concluded that "the resulting figure, though not necessarily a statistic, should be a number that may be obtained again with a high degree of uniformity by either the same or a different operator. Such a number is not of less value for future comparisons than one which attempts to estimate an actual parameter of the population."

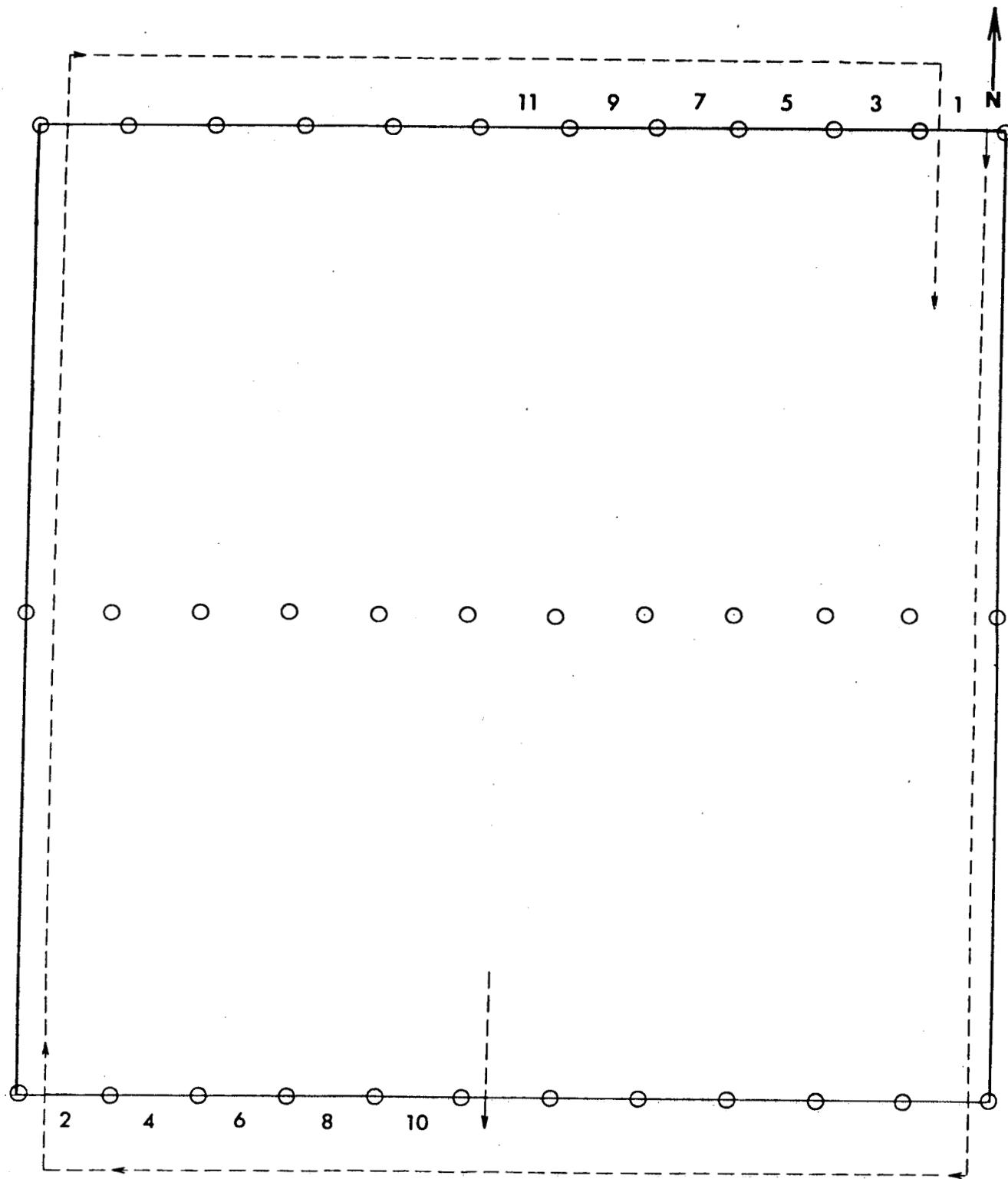


Figure 4-3. Drawing of the 1-ha study grid showing the route followed in censusing lizards. Numbers refer to the sequence in which rows were walked. Circles represent grid stakes.

Birds

Extensive survey. Each habitat was surveyed between 29 August 1975 and 27 March 1976. Most of the survey included observations on terrestrial areas, but tanks (metal or dirt) were also included. Two dirt tanks adjacent to the study area were included because birds from those tanks were expected to inhabit the study area.

Intensive survey. The roadside point census method (French 1970) was used to estimate bird densities from 7 September 1975 to 28 March 1976. The values obtained were not expected to represent absolute densities, and it was assumed that all species present at a given census station were equally detectable.

Two census periods per month were used rather than one as proposed by French (1970). (See Appendix C for explanation of the method and Fig. 4-2 for census station locations.) Twelve roadside stations were located in the shinnery oak-mesquite habitat. All stations were censused for two consecutive mornings and the afternoon between those mornings.

Monthly density values were determined by the following equation:

$$N = 100 (\bar{X}/T_A)$$

where N is the estimated number of individuals per species per 100 acres of a given community; \bar{X} is the average number of individuals per species; T_A is the total observable area (in acres) per community per species. After computations were complete, number of birds per 100 acres was converted to number of birds per 100 ha.

Mammals

Extensive survey. With Havahart and Sherman live traps, a minimum of 1000 trap nights was established in each habitat from 27 August 1975 to 29 February 1976. During that time, gopher traps were set wherever gopher sign was found within the five habitats. Representative specimens of each species

from the five areas were prepared as study skins.

Sight observations of animals and a search for tracks continued until 15 April 1976. Plaster of Paris casts were made of tracks. All casts and prepared skins were deposited in the ENMU Natural History Museum.

Intensive survey. Sherman live traps (3 by 3 by 9 in.) baited with rolled milo were used to sample small mammals. Two traps were placed at each of 100 stations spaced 10 m apart on a 90 by 90 m grid. Traps were kept open and supplied with bait for two prebait periods of three days each (13-15 and 21-23 October). Trapping was conducted during two periods of five days each (16-20 and 24-28 October). Traps were checked in the morning and evening during the trapping periods. Each captured mammal was ear tagged or toe clipped, weighed to the nearest 0.01 g on a Dial-O-Gram scale, and examined for sex and reproductive condition.

Indices denoting estimates for population size of lagomorphs and pocket gophers were obtained from the shinnery oak-mesquite habitat by a method described by French (1970). Gopher mounds were smoothed out on a 1-ha grid, and the number of freshly constructed mounds were counted 48 hours later. Following that count, the procedure was repeated for a second count. Lagomorph pellets were removed from 200 1-m² plots, each 10 m apart and positioned along a north-south line. The pellets on each plot were counted 15 days later.

Results and Discussion

Arthropods

Abundance of ground-dwelling arthropods was established for the shinnery oak-mesquite habitat from 6 September to 28 October 1975 (Table 4-2). The data are general, but they indicate the kinds of arthropods that are more abundant than others. Relative to insects, arachnids were low in number.

Table 4-2. Families of ground-dwelling arthropods captured in pit-fall traps at various day intervals.

Taxa	September		October	
	6-15	16-30	1-15	16-28
Class Insecta				
Order Orthoptera				
Family Gryllacrididae	3	3	3	4
Family Gryllidae	33	32	18	2
Family Mantidae				2
Order Hemiptera				
Family Reduviidae				1
Order Coleoptera				
Family Cicindelidae		1	2	
Family Carabidae	121	138	59	63
Family Histeridae	1			
Family Elateridae			1	
Family Lathridiidae	2			
Family Tenebrionidae	190	160	110	55
Family Scarabaeidae	24	2		
Family Curculionidae			4	2
Family Scolytidae			3	5
Order Neuroptera				
Family Myrmeleontidae			4	2
Order Hymenoptera				
Family Mutillidae	6	1	3	
Family Formicidae	7	73	3	24
Class Arachnida				
Order Scorpionida	3	4	3	1
Order Solpugida	1			
Order Araneida	1	4	3	2

The most abundant insect families were the Gryllidae, Carabidae, and Tenebrionidae. The formicid counts were probably under-estimated, since many formicids could crawl out of the pit-fall traps.

Vertebrates

Ecological information for herptiles, birds and mammals recorded during the extensive survey is presented in Appendix C. The information includes common and scientific names, habitat, trophic levels, a general description of food types, and the observation record.

Various sources of published information include species of herptiles, birds, and mammals on or near the study area that were not recorded during the study. Those species are listed in Table C-4, Appendix C.

Herptiles

Extensive survey. Because of a latitudinal position and high temperatures of the study area, a diverse herptilian fauna was expected. However, since the survey was conducted in the fall and winter, the list was low in number of species. Both aquatic and terrestrial herptiles were expected because four dirt tanks exist on the study area.

Herptilian species that were recorded are listed in Table C-1, Appendix C. Although four aquatic turtles may occupy the area (Table C-4, Appendix C), only the land terrapine, the western box turtle (Terrapene ornata), was observed. Although amphibians were not observed, several amphibian species could be expected during a spring survey. The side-blotched lizard (Uta stansburiana) was the most common lizard and occurred in all five habitats. The western whiptail (Cnemidophorus tigris) was the second most common lizard. The common snakes were those expected: the western hognose (Heterodon nasicus), coach whip (Masticophis flagellum), gopher snake (Pituophis melanoleucus) and western rattlesnake (Crotalus viridis).

Less common species included the night snake (Hypsiglena torquata), western diamondback rattlesnake (Crotalus atrox), and massasauga (Sistrurus catenatus). At least 13 other species of snakes may occupy the study area (Table C-4, Appendix C). Further surveys during spring and early summer would verify the existence of many of those species.

Intensive survey. The densities of four species of lizards were estimated (Table 4-3). Again, the fall survey may not have supplied data representative of the true percentage composition of lizards in the shinnery oak-mesquite habitat.

Juvenile lizards are very common in the fall; this was particularly true of the side-blotched lizard. It had a density of 14.5 juveniles per ha and 11.2 adults per ha. The density of the Texas horned lizard (Phrynosoma cornutum) was 0.087 per ha, that of the lesser earless lizard (Holbrookia maculata) was 0.087 per ha, and that of the western whiptail lizard was 0.65 per ha.

The shinnery oak-mesquite habitat seemed more suitable to the side-blotched lizard than to other lizards such as the Texas horned lizard, the lesser earless lizard, and the western whiptail lizard. The Texas horned lizard usually prefers flat habitat with open areas between vegetation (Stebbins 1954). Open areas between vegetation are also preferred by the lesser earless lizard (Gennaro 1972) and western whiptail (Stebbins 1954). Tinkle (1967) stated that the side-blotched lizard "would demonstrate the avoidance of thick vegetation." However, the rich growth of plants in the shinnery oak-mesquite habitat was not too thick for the side-blotched lizard, but a more open vegetative pattern was apparently preferred for foraging and thermoregulatory purposes by the other three lizards.

Table 4-3. Census results of lizards during the intensive survey.

Species	Individuals counted for 23 days*	Lizards per ha
Texas Horned Lizard Juveniles	2	0.087
Side-blotched Lizard Adults	257	11.2
Juveniles	334	14.5
Total	591	25.7
Lesser Earless Lizard Adults	2	0.087
Western Whiptail Lizard Adults	14	
Juveniles	1	
Total	15	0.65
Unidentified	41	1.78
Total Number of Lizards	651	28.3

*From 9 September to 21 October 1975.

Birds

Extensive survey. A total of 72 bird species was recorded during the survey from 29 August 1975 to 27 March 1976. The total did not include all the summer breeding birds (Table C-2, Appendix C).

The highest monthly count for the survey occurred in October. At that time, 19 year-round residents, 12 nonbreeding winter residents, 5 migrants, and 6 summer residents were counted.

The major part of the avian fauna consisted of perching birds. Very few aquatic birds were sighted. Among raptors, seven species of hawks, three species of owls, and one species of vulture were recorded. Scaled Quail and Mourning Doves were very common and were observed each month. These and others, such as the White-necked Raven, Loggerhead Shrike, Western Meadowlark, Pyrrhuloxia, Lark Bunting, Cassin's Sparrow, Vesper Sparrow, and White-crowned Sparrow, made up an avian fauna that was very common throughout the study area.

Intensive Survey. Estimated densities of avian species per 100 ha are shown in Table 4-4. The data describe the avian composition of the shinnery oak-mesquite habitat. Because that habitat occupies more area than others described for this study, the avian density data may be applied to most of the 72-sq mi study area for the time period involved.

The following birds had high densities: Scaled Quail, Mourning Dove, Loggerhead Shrike, Western Meadowlark, Pyrrhuloxia, Lark Bunting, Vesper Sparrow, Cassin's Sparrow, Black-throated Sparrow, and White-crowned Sparrow. The Swainson's Hawk, Marsh Hawk, and Sparrow Hawk were never more numerous than 1 per 100 ha, but their sightings were consistent.

Few aquatic birds were sighted even with a dirt tank included in the census. Many other species were represented by low densities in only one

Table 4-4. Estimated densities of avian species per 100 ha during the intensive survey. Census was taken from 7 September 1975 to 28 March 1976.

Species	Month					
	S	O	N	D	J	F
DUCKS:						
Mallard, <u>Anas platyrhynchos</u>					<1	
Green-winged Teal, <u>Anas carolinensis</u>					<1	
Blue-winged Teal, <u>Anas discors</u>					<1	
HAWKS AND ALLIES:						
Turkey Vulture, <u>Cathartes aura</u>				<1	<1	
Red-tailed Hawk, <u>Buteo jamaicensis</u>						<1 <1
Swainson's Hawk, <u>Buteo swainsoni</u>				<1	<1 <1	<1 <1 <1
Ferruginous Hawk, <u>Buteo regalis</u>						<1 <1
Harris' Hawk, <u>Parabuteo unicinctus</u>					<1	
Marsh Hawk, <u>Circus cyaneus</u>				<1	<1 <1	<1 <1 <1 <1
Sparrow Hawk, <u>Falco sparverius</u>				<1	<1	<1 <1 <1 <1
QUAILS:						
Scaled Quail, <u>Callipepla squamata</u>	4	3	7	4	3	3 6
CRANES:						
Sandhill Crane, <u>Grus canadensis</u>					<1	
DOVES:						
Mourning Dove, <u>Zenaidura macroura</u>	19	7	5	4	1	
CUCKOOS:						
Yellow-billed Cuckoo, <u>Coccyzus americanus</u>					<1	
Roadrunner, <u>Geococcyx californianus</u>				<1	<1	<1 <1
OWLS:						
Burrowing Owl, <u>Speotyto cunicularia</u>						<1
WOODPECKERS:						
Ladder-backed Woodpecker, <u>Dendrocopos scalaris</u>						<1 1
PERCHING BIRDS:						
Western Kingbird, <u>Tyrannus verticalis</u>					<1	
Scissor-tailed Flycatcher, <u>Muscivora forficata</u>					<1	
Say's Phoebe, <u>Sayornis saya</u>					<1 <1	
Western Empidonax Flycatcher, <u>Empidonax difficilis</u>					<1 1	
Western Wood Pewee, <u>Contopus sordidulus</u>					<1	
Cliff Swallow, <u>Petrochelidon pyrrhonota</u>					<1	
Blue Jay, <u>Cyanocitta cristata</u>					<1	
White-necked Raven, <u>Corvus cryptoleucus</u>	1	<1				<1 <1

Table 4-4. (Cont.)

Species	Month					
	S	O	N	D	J	F
House Wren, <u>Troglodytes aedon</u>			<1			1
Carolina Wren, <u>Thryothorus ludovicianus</u>			<1			1
Cactus Wren, <u>Campylorhynchus brunneicapillus</u>				1		1 1
Mockingbird, <u>Mimus polyglottos</u>	1	<1				
Brown Thrasher, <u>Toxostoma rufum</u>			<1			
Curve-billed Thrasher, <u>Toxostoma curvirostre</u>			<1			
Crissal Thrasher, <u>Toxostoma dorsale</u>			<1			
Sage Thrasher, <u>Oreoscoptes montanus</u>			<1			
Loggerhead Shrike, <u>Lanius ludovicianus</u>	4	3	3	2	4	3 4
Myrtle Warbler, <u>Dendroica coronata</u>		<1	<1			
Audubon's Warbler, <u>Dendroica auduboni</u>			<1			
Wilson's Warbler, <u>Wilsonia pusilla</u>			2			
Eastern Meadowlark, <u>Sturnella magna</u>			<1	1	1	1
Western Meadowlark, <u>Sturnella neglecta</u>		<1	2	12	5	12 11 6
Bullock's Oriole, <u>Icterus bullockii</u>			<1			
Brown-headed Cowbird, <u>Molothrus ater</u>			<1			
Pyrrhuloxia, <u>Pyrrhuloxia sinuata</u>	1	4	7	10	4	4 6
House Finch, <u>Carpodacus mexicanus</u>					1	
Pine Siskin, <u>Spinus pinus</u>					1	31 2 19
American Goldfinch, <u>Spinus tristis</u>					3	2
Green-tailed Towhee, <u>Chlorura chlorura</u>			1	2		
Rufous-sided Towhee, <u>Pipilo erythrrophthalmus</u>			<1	1		
Lark Bunting, <u>Calamospiza melanocorys</u>	10	9	7	21	9	12 25
Baird's Sparrow, <u>Ammodramus bairdii</u>			<1			
Vesper's Sparrow, <u>Pooecetes gramineus</u>	1	8	9	6	3	1 10
Lark Sparrow, <u>Chondestes grammacus</u>			<1			
Cassin's Sparrow, <u>Aimophila cassinii</u>	11	6	5	3	1	1
Black-throated Sparrow, <u>Amphispiza bilineata</u>	1	1	1		4	1 3
Sage Sparrow, <u>Amphispiza belli</u>					<1	4
Oregon Junco, <u>Junco oreganus</u>					1	1
Clay-colored Sparrow, <u>Spizella pallida</u>		<1	<1			
Brewer's Sparrow, <u>Spizella breweri</u>			<1			
White-crowned Sparrow, <u>Zonotrichia leucophrys</u>	9	9	18	16	12	8

or a few months. Most of these were summer breeders (sighted prior to migration), or migrants.

The chance that certain species were on the survey site at other than the time of the observation or that species were on the survey site, but not seen, is evident when the densities of certain residents are examined. These include the Roadrunner, the Burrowing Owl, the Ladder-backed Wood-pecker, and the White-necked Raven.

Mammals

Extensive survey. Since the ground squirrels are the only known hibernators among the terrestrial mammals on the study area, all the nonhibernators were available for a census during the fall and winter survey (Table C-3, Appendix C). One of the two species of ground squirrel, the spotted ground squirrel (Spermophilus spilosoma), was censused in early fall in the shinnery oak-mesquite habitat during the intensive study.

Some mammals were captured or observed in all five habitats. Those include the desert cottontail (Sylvilagus auduboni), blacktail jackrabbit (Lepus californicus), northern grasshopper mouse (Onychomys leucogaster), southern plains woodrat (Neotoma micropus), porcupine (Erethizon dorsatum), and coyote (Canis latrans). Although the badger (Taxidea taxus), striped skunk (Mephitis mephitis), bobcat (Lynx rufus), and mule deer (Odocoileus hemionus) were expected to occupy all the habitats, evidence of these species were not observed in all five areas.

Other species demonstrated affinities for certain habitats. The southwestern part of the study area has vegetation transitional to the Chihuahuan Desert along the Pecos River Valley. The Merriam kangaroo rat (Dipodomys merriami) and desert pocket mouse (Perognathus penicillatus) are inhabitants of the Chihuahuan Desert. They were recorded on the study

area in habitats similar to those found in or peripheral to the Chihuahuan Desert. Those habitats include creosote-grassland, mesquite-grassland and active dune land. The white-throated woodrat (Neotoma albicula) prefers rocky foothills and river drainages. The animal was recorded from habitats common to such areas. Those include creosote-grassland and mesquite-grassland.

The remainder of the study area is grassland. Some of the fauna present demonstrated a preference for a particular soil structure. The spotted ground squirrel, plains pocket mouse (Perognathus flavescens), and Ord's kangaroo rat (Dipodomys ordii) preferred habitats with sandy soils such as the shinnery oak-mesquite and active dune land. The bannertail kangaroo rat (Dipodomys spectabilis) preferred compact soils commonly found in creosote-grassland and mesquite-grassland. The silky pocket mouse (Perognathus flavus) seemed to prefer compact soils wherever they occurred. The white-footed mouse (Peromyscus leucopus) was collected from both sandy and compact soils and did not show a habitat preference. Since the western harvest mouse (Reithrodontomys megalotis) was captured only once, it is impossible to make a statement about its habitat preference.

Intensive survey. Census data collected from the grid site provided information for species composition, density, movements, and recapture success of small mammals in the shinnery oak-mesquite habitat (Tables 4-5, 4-6, and 4-7). The habitat has a sandy substrate. The small mammals inhabiting that type all have affinities for sandy substrate and are typical grassland dwellers (Findley et al. 1975, Gennaro 1968).

The Ord's kangaroo rat and the plains pocket mouse had the highest densities on the grid. Those densities (per ha) were 8.4 and 7.9 (Table 4-5), respectively.

The stability of the populations of Ord's kangaroo rat and plains

Table 4-5. Small mammal census data from the 90 by 90 m study grid during the intensive survey. Data include estimated number of individuals, N, using Hayne (1949); number of individuals marked, N_m ; density per ha, D; mean weight (g), \bar{W} ; biomass (g) per ha, B; numbers by sex, M = male, F = female; and reproductive status, RS. Reproductive status is given in stages as follows: 1-immature, 2-inactive adults, 3-active adults (includes lactating females), and 4-pregnant females.

Species	N	N_m	D	\bar{W}	B	M	F	RS			
								1	2	3	4
Spotted Ground Squirrel	8.2	10	2.7	107.8	291	8	2	4	6		
Plains Pocket Mouse	12.9	11	7.9	10.3	81.4	7	4	2	7	2	
Ord's Kangaroo Rat	15.6	19*	8.4	64.1	538.4	12	7	4	12	3	
Northern Grasshopper Mouse	10.3	15**	3.3	35.6	117.5	8	7	8	1	2	4
Southern Plains Woodrat	3.1	3	1.3	152.1	197.7	1	2	2		1	

* One specimen died.

**Four specimens died.

Table 4-6. Small mammal recapture success (R) for the intensive survey.

Species	16-20 Oct. 1975		24-28 Oct. 1975*	
	R**	%	R	%
Spotted Ground Squirrel	4/5	80	5/9	55.6
Plains Pocket Mouse	2/5	40	2/11	18.2
Ord's Kangaroo Rat	13/13	100	15/18	83.3
Northern Grasshopper Mouse	5/6	83.3	7/13	53.8
Southern Plains Woodrat	1/2	50	2/3	66.0

* The number of captures during the second period are the total number of captures for both periods; but the number of recaptures during the second period apply only to that period.

**Recapture success (R) is the number of animals recaptured relative to the number of animals marked.

Table 4-7. Average movements of small mammals on the study grid during the intensive survey. Measurements are in meters.

Species	Sample size	Mean	Range
Spotted Ground Squirrel	22	42	10-85
Plains Pocket Mouse	9	19	10-27
Ord's Kangaroo Rat	52	23	10-79
Northern Grasshopper Mouse	29	43	10-89
Southern Plains Woodrat	4	33	10-81

plains pocket mouse was analyzed in relation to their average movements and recapture success (Tables 4-6 and 4-7). Brant (1962) stated that many factors alter movement patterns. Two factors are breeding and food availability. The short census period probably eliminated mortality as an important influencing factor on recapture success. Recapture success was higher for Ord's kangaroo rat than the plains pocket mouse (Table 4-6). Comparison of mean movement and percentage recapture of Ord's kangaroo rat indicated a stable population on the grid and, consequently, minimum immigration or emigration. Average movements and recapture success for the plains pocket mouse were less than the other species on the grid. Therefore, a stable population is implied with respect to movements, but a high degree of immigration or emigration is implied with respect to recapture success. However, Ord's kangaroo rat may have been attracted to the live traps, and the plains pocket mouse may have avoided those traps.

Certain population parameters, i.e., density, recapture success, and average movements, for the spotted ground squirrel were similar to parameters for the northern grasshopper mouse. However, the two species were not active concurrently. The spotted ground squirrel is diurnal, and the northern grasshopper mouse is nocturnal. Consequently, the similarity of parameters is probably a result of chance. Although the average movements were high for both species, the percentage recapture success indicates that immigration or emigration for both species was minimal.

The number of southern plains woodrats captured was too low to comment on the estimated parameters. However, two active nests were on the edge of the grid, and one nest was inside the grid. The recorded captures and movements are probably from woodrats from two of those nests, since the woodrats were caught next to the nests and moved to them when released. The presence

of the nests indicate population stability. The grid probably cut through part of the woodrat home ranges.

The census period was conducted only in October; therefore, peaks of reproduction cannot be commented on. The spotted ground squirrels showed no signs of reproductive activity because the census was conducted before their seasonal hibernation. All the other small mammals showed signs of reproductive activity.

Indices of activity were obtained for pocket gophers and lagomorphs during the intensive survey in the shinnery oak-mesquite habitat. Since only the plains pocket gopher (Geomys bursarius) was captured in that habitat, it was assumed that the mounds counted belonged to that species. Both the desert cottontail and black-tailed jackrabbit were sighted in the surveyed habitat. Because pellets of the two species could not be distinguished with certainty, the counts for both species were combined. The average number of gopher mounds per 48 hours was 39 per ha. The average number of lagomorph pellets was 1.82 per m^2 (18,200 per ha). These data are of value only if they are compared to indices taken from the same place during subsequent years.

Endangered Species and Subspecies

State Game Commission's Regulation No. 563, 24 January 1975, lists endangered species and subspecies for New Mexico. The endangered category is divided into two groups: Group 1--species and subspecies whose prospects of survival or recruitment in New Mexico are in jeopardy, and Group 2--species and subspecies whose prospects of survival or recruitment within the state are likely to be in jeopardy within the foreseeable future.

Baird's Sparrow (Ammodramus bairdii), from Group 2, was the only animal in either group recorded on the study area and was observed on

19 October 1975. However, published records indicate several other species or subspecies could possibly occur on or near the study area (Table C-4, Appendix C), as follows:

Group 1

Birds: (Southern) Bald Eagle, Haliaeetus leucocephalus leucocephalus
Peregrine Falcon, Falco peregrinus anatum
Aplomado Falcon, Falco femoralis septentrionalis

Group 2

Amphibians: (Eastern) Barking Frog, Eleutherodactylus augusti latrans
(Blanchard's) Cricket Frog, Acris crepitans blanchardi

Reptiles: (Sanddune) Sagebrush Lizard, Sceloporus graciosus arenicolous

Birds: Mississippi Kite, Ictinia mississippiensis
Osprey, Pandion haliaetus carolinensis
Red-headed Woodpecker, Melanerpes erythrocephalus caurinus
Bell's Vireo, Vireo bellii sspp.
Varied Bunting, Passerina versicolor sspp.
McCown's Longspur, Calcarius mccowni

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APPENDIX A

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APPENDIX B

TAXONOMY OF SOILS SAMPLED FOR CHEMICAL ANALYSIS



APPENDIX B. TAXONOMY OF SOILS SAMPLED FOR CHEMICAL ANALYSIS

Aridisols: includes soils Berino, Simona, Wink and Pyote.

Aridisols are those soils which have no water available to mesophytic plants for prolonged periods. There is no period of as long as 90 days when moisture is continuously available and the soil is warm.

Aridisols have one or more pedogenic horizons that may have formed in the present environment or that may be relict from a former pluvial period. The horizons may be the result of translocation and accumulation of salts, carbonates, or silicate clays, or of cementation by carbonates or silica. Moisture regimes are dominantly aridic.

Typic Haplargids: Berino series (BB & BA)

Aridisols which have no evidence of current groundwater within one meter, no appreciable cementation by silica, little organic matter or available moisture, and little evidence of soil movement. Typic Haplargids have no lithic contact within 50 cm of the surface. Many have argillic horizons and a Ca horizon within 20-25 cm of the surface.

Arenic Ustalfic Haplargids: Pyote series (PU)

Aridisols having a thick sandy epipedon and a moisture regime marginal to an ustic regime. They have formed in sandy sediments and have alluvial accumulations of silicate clays forming an argillic horizon.

Typic Paleorthids: Simona series (SM)

Aridisols having an ochric epipedon or cambic horizon or both over a petrocalcic horizon, have little organic matter or available water, and do not have an argillic horizon. They are restricted to the drier part of the range of Aridisols.

Typic Calciorthids: Wink series (WK)

Aridisols that show no ground water effects within the upper one meter, no appreciable cementation by silica, have little organic matter or available moisture, no shallow hard rock, and no evidence of engulfment of a former argillic horizon by the calcic horizon. They are mostly calcareous in all subhorizon except in sandy soils which may be noncalcareous to about 25 cm. The calcic horizon has a high content of carbonates particularly in the parent material.

Entisols: Kermit series (KM)

Entisols are soils that show little or no development of pedogenic horizons. They are either very young soils such as those found on steep, actively eroding slopes or floodplains, or very old and consist mainly of quartz or other mineral that doesn't alter to form horizons. The only evidences of pedogenic alteration are small accumulations of organic matter in the upper 25 cm, and a slight loss of and concentration of clay in the upper 12 cm.

Typic Torripsamments: Kermit series (KM)

Entisols having little available moisture, no evident cementation by silica, and a moderately thick regolith. They have no lithic contact within 50 cm of the surface. Many are dunes, some stabilized and some moving.

APPENDIX C

BIOTIC CHARACTERISTICS

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BIRD CENSUS METHOD

The Roadside Point Census Method (French, 1970) was used in this study.

The first point was located by random choice and all sequential stations were located one-half mile from the first. At each station, all birds sighted within a full circle sweep during a five minute interval were recorded.

Bird density per month was computed by using equations 1-5 below.*

It is assumed that a bird with a total length of 3 in. can be seen at 100 ft using 7 X 50 binoculars. The average length of a species being constant, the distance a species is observable can be determined using the ratio:

$$D = 100S/3 \quad (1)$$

where D = observable distance in ft

S = average length of the species in inches.

The area, in acres, in which a species can be seen is:

$$A = \pi D^2 / 43,560 \text{ sq ft per acre} \quad (2)$$

where A = the observable area (in acres) per species for one census station.

For more than one census station per community, the area is:

$$T_A = A \cdot H \quad (3)$$

where T_A = the total observable area in acres per species for the community

H = the number of census stations per community.

The average number of individuals per species sighted in each community is:

$$\bar{X} = n/c \quad (4)$$

where n = total number of individuals per species sighted in each community

c = the number of times the census was conducted per month.

The density per species is:

$$N = 100(\bar{X}/T_A) \quad (5)$$

where N = estimated number of individuals per species per 100 acres of a given community.

*Source: Maze (1974)

Table C-1. Herptile species list for the extensive survey. Habitats where species occur are designated: SOM = shinnery oak-mesquite, CG = creosote-grassland, MG = mesquite-grassland, MS = mesquite-snakeweed, ADL = active dune land. All species are resident. Trophic levels C₁, C₂, C₃ refer to primary, secondary, and tertiary consumers, respectively. All other symbols are explained in the footnote.

Species	Habitat	Trophic level	Food type	Status		Observation Record						
				Abundance		A	S	O	N	D	J	F
HERPTILES:												
Western Box Turtle <i>Terrapene ornata</i> (Agassiz)	SOM MG ADL	C ₁ C ₂ C ₃ *	P,F,I	C		S	0	0				
Leopard Lizard <i>Crotaphytus wislizeni</i> Baird and Girard	ADL	C ₂ C ₃	I,SV	UC								S
Lesser Earless Lizard <i>Holbrookia maculata</i> Girard	SOM	C ₂ C ₃	I	UC		C						
Side-blotched Lizard <i>Uta stansburiana</i> Baird and Girard	SOM CG MG MS ADL	C ₂ C ₃	I	VC	S	C	C	0	0			
Texas Horned Lizard <i>Phrynosoma cornutum</i> (Harlan)	SOM	C ₂ C ₃	I	UC		S	C					
Western Whiptail Lizard <i>Cnemidophorus tigris</i> Baird and Girard	SOM CG ADL	C ₂ C ₃	I	C	0	S	C					0
Sixlined Racerunner <i>Cnemidophorus sexlineatus</i> (Linnaeus)	SOM	C ₂ C ₃	I	UC		S	C					
Western Hognose Snake <i>Heterodon nasicus</i> Baird and Girard	SOM	C ₂ C ₃	I,SV	C		S	0					
Coach Whip <i>Masticophis flagellum</i> (Shaw)	SOM	C ₂ C ₃	I,SV	C		S						0
Gopher Snake <i>Pituophis melanoleucus</i> (Bairville)	SOM	C ₂ C ₃	SV	C		S						0
Night Snake <i>Hypsiglena torquata</i> Gunther	SOM	C ₂ C ₃	SV	UC		S						
Massasauga <i>Sistrurus catenatus</i> (Rafinesque)	SOM	C ₃ C ₂	SV	UC		S						
Western Diamondback Rattlesnake <i>Crotalus atrox</i> Baird and Girard	SOM	C ₃ C ₂	SV	UC		S						
Western Rattlesnake <i>Crotalus viridis</i> (Rafinesque)	SOM MG ADL	C ₃ C ₂	SV	C	S	0	0	0				0

*Trophic levels (C₁, C₂, or C₃) are listed in the order of their relative importance in the forage habits of the species. The level listed first is most important. Data for trophic levels were obtained from Stebbins (1954, 1966), Blair *et al.* (1968), and Maze (1974).

Table C-1. (Cont.)

Food Type:

P = plant tissue
F = fruit
I = invertebrates
SV = small vertebrates

Status:

Abundance:

VC = very common: abundant
C = common: regularly present, abundant but sporadic occurrence
UC = uncommon: seen once; evidence that species is present

Observation Record:

Observations for each month are presented from 29 August (A) 1975 to 15 April (A) 1976.

S = specimen(s) of species collected
C = species censused
O = species observed but not censused
I = tracks, vocalizations, or other signs indicative of presence of species

Table C-2. Bird species list for the extensive survey. Habitats where species occur are designated: SOM = shinnery oak-mesquite, CG = creosote-grassland, MG = mesquite-grassland, MS = mesquite-snakeweed, ADL = active dune land, and A = aquatic (dirt or metal tank). All species are resident. Trophic levels C_1 , C_2 , C_3 refer to primary, secondary and tertiary consumers, respectively. All other symbols are explained in the footnote.

Species	Habitat	Trophic level	Food type	Status		Observation Record								
				A	S	A	S	O	N	D	J	F	M	
AQUATIC BIRDS:														
Cattle Egret <u><i>Bubulcus ibis</i></u> (Linnaeus)	SOM	$C_3C_2^*$	SAV	UC	M							O		
DUCKS:														
Mallard <u><i>Anas platyrhynchos</i></u> (Linnaeus)	A	$C_1C_2C_3$	P,I, SV	I	R							C		
Green-winged Teal <u><i>Anas carolinensis</i></u> (Gmelin)	A	$C_1C_2C_3$	P,I, SV	I	N							C		
Blue-winged Teal <u><i>Anas discors</i></u> (Linnaeus)	A	$C_1C_2C_3$	P,I, SV	I	M							C		
HAWKS AND ALLIES:														
Turkey Vulture <u><i>Cathartes aura</i></u> (Linnaeus)	SOM CG MG MS ADL	C_3C_2	C	C	B	O	C	C						
Red-tailed Hawk <u><i>Buteo jamaicensis</i></u> (Gmelin)	SOM CG MG MS	(C_2C_3)	SB, SM	C	R			C	C	C	C	C	C	C
Swainson's Hawk <u><i>Buteo swainsoni</i></u> (Bonaparte)	SOM CG MG MS	(C_2C_3)	SB, SM	C	R			C	C	C	C	C	C	C
Ferruginous Hawk <u><i>Buteo regalis</i></u> (Gray)	SOM MG	(C_2C_3)	SB, SM	C	R			O	C	C	O			
Harris' Hawk <u><i>Parabuteo unicinctus</i></u> (Temminck)	SOM MG MS	(C_2C_3)	SB, SM	C	R	O	C				O	O	O	
Marsh Hawk <u><i>Circus cyaneus</i></u> (Linnaeus)	SOM CG MG MS ADL	(C_2C_3)	SM	C	N	O	O	O	C	C	O	O	O	O
Prairie Falcon <u><i>Falco mexicanus</i></u> (Schlegel)	CG	(C_2C_3)	SB, SM	UC	N	O								
Sparrow Hawk <u><i>Falco sparverius</i></u> (Linnaeus)	SOM CG MG MS ADL	(C_2C_3)	I, SV	C	R	O	C	C	C	C	C			
QUAILS AND ALLIES:														
Bobwhite <u><i>Colinus virginianus</i></u> (Linnaeus)	SOM MS	C_1	F, S	C	R							O	I	
Scaled Quail <u><i>Callipepla squamata</i></u> (Vigors)	SOM CG MG MS	C_1	F, S	VC	R	O	O	O	O	O	O	O	O	O

Table C-2. (Cont.)

Species	Habitat	Trophic level	Food type	Status		Observation Record							
				A	S	A	S	O	N	D	J	F	
CRANES:													
Sandhill Crane <i>Grus canadensis</i> (Linnaeus)	SOM MG	(C ₂ C ₃)	I,SV	C	N							C	
DOVES:													
Mourning Dove <i>Zenaidura macroura</i> (Linnaeus)	SOM CG MG MS ADL	C1	F,S	VC	R	O	O	C	C	O	C	O	C
CUCKOOS:													
Yellow-billed Cuckoo <i>Coccyzus americanus</i> (Linnaeus)	SOM	(C ₂ C ₃)	I	I	B								
Roadrunner <i>Coccyzus californianus</i> (Lesson)	SOM MG MS	(C ₂ C ₃)	I,SV	C	R	O	O	O	O	O	C	C	
OWLS:													
Barn Owl <i>Tyto alba</i> (Scopoli)	MG	C ₂ C ₃	SM	UC	R							O	
Great Horned Owl <i>Bubo virginianus</i> (Gmelin)	MG ADL(D)**	(C ₂ C ₃)	SM	UC	R							O	
Burrowing Owl <i>Speotyto cunicularia</i> (Molina)	SOM MG	(C ₂ C ₃)	SM	C	R	O						C	
NIGHT HAWKS:													
Poor-will <i>Phalaenoptilus nuttallii</i> (Audubon)	SOM	(C ₂ C ₃)	I	UC	B	O	S						
KINGFISHERS AND WOODPECKERS:													
Belted Kingfisher <i>Megaceryle alcyon</i> (Linnaeus)	A	C ₃ C ₂	FI	UC	R	O							
Red-shafted Flicker <i>Colaptes cafer</i> (Gmelin)	MG MS	C ₂ C ₃	I	C	R							O	
Ladder-backed Woodpecker <i>Dendrocopos scalaris</i> (Wagler)	SOM MG MS ADL(D)	(C ₂ C ₃)	I	C	R	O	O	O	O	O	C		
PERCHING BIRDS:													
Western Kingbird <i>Tyrannus verticalis</i> (Say)	SOM CG MG MS	(C ₂ C ₃)	I	C	B	O	C						
Scissor-tailed Flycatcher <i>Muscivora forficata</i> (Gmelin)	SOM CG MG MS	(C ₂ C ₃)	I	C	B	O							
Say's Phoebe <i>Sayornis saya</i> (Bonaparte)	SOM MS	(C ₂ C ₃)	I	C	R	O	O	O	O	O			97

Table C-2. (Cont.)

Species	Habitat	Trophic level	Food type	Status		Observation Record							
				A	S	A	S	O	N	D	J	F	M
Western Empidonax Flycatcher <i>Empidonax difficilis</i> (Baird)	SOM	(C ₂ C ₃)	I		I	B		S	C				
Western Wood Pewee <i>Contopus sordidulus</i> (Slater)	SOM MG MS	(C ₂ C ₃)	I		C	B	O	C					
Horned Lark <i>Eremophila alpestris</i> (Linnaeus)	MG	C ₁ C ₂ C ₃	S, I	UC	R				O				
Cliff Swallow <i>Petrochelidon pyrrhonota</i> (Vieillot)	SOM	C ₂ C ₃	I		I	B		C					
Blue Jay <i>Cyanocitta cristata</i> (Linnaeus)	SOM	(C ₁ C ₂ C ₃)	S, F, I	I	N			C					
White-necked Raven <i>Corvus cryptoleucus</i> (Couch)	SOM CG MG MS ADL	(C ₁ C ₂ C ₃)	S, I C	VC	R	O	O	O	O	O	C		
House Wren <i>Troglodytes aedon</i> (Vieillot)	SOM	C ₂ C ₃	I	C	B		C		C		C		
Carolina Wren <i>Thryothorus ludovicianus</i> (Latham)	SOM MG MS	C ₂ C ₃	I	C	R		O	C	O				
Cactus Wren <i>Campylorhynchus brunneicapillus</i> (Lafresnaye)	SOM MG MS	C ₂ C ₃	I	C	R		C	C	C				
Mockingbird <i>Mimus polyglottos</i> (Linnaeus)	SOM CG MG, MS	(C ₂ C ₃)	I	C	R	O	C	O					
Brown Thrasher <i>Toxostoma rufum</i> (Linnaeus)	SOM	(C ₂ C ₃)	I	I	R		C						
Curve-billed Thrasher <i>Toxostoma curvirostre</i> (Swainson)	SOM MG	(C ₂ C ₃)	I	C	R		C	O	O				
Crissal Thrasher <i>Toxostoma dorsale</i> (Henry)	SOM MS	(C ₂ C ₃)	I	C	R		C		O				
Sage Thrasher <i>Oreoscoptes montanus</i> (Townsend)	SOM MG	(C ₂ C ₃)	I	C	N		C		O				
Loggerhead Shrike <i>Lanius ludovicianus</i> (Linnaeus)	SOM CG MG MS	(C ₂ C ₃)	I, SV	VC	R	O	O	C	O	O	O		
Starling <i>Sturnus vulgaris</i> (Linnaeus)	ADL(D)	(C ₂ C ₃)	I	C	N			O					
Myrtle Warbler <i>Dendroica coronata</i> (Linnaeus)	SOM	(C ₂ C ₃)	I	I	M		C	C					

Table C-2. (Cont.)

Species	Habitat	Trophic level	Food type	Status		Observation Record						
				A	S	A	S	O	N	D	J	F
<u>Audubon's Warbler</u> <i>Dendroica auduboni</i> (Townsend)	SOM	(C ₂ C ₃)	I	C	B	O	C					
<u>Wilson's Warbler</u> <i>Wilsonia pusilla</i> (Wilson)	SOM MG	(C ₂ C ₃)	I	C	M	C						
<u>House Sparrow</u> <i>Passer domesticus</i> (Linnaeus)	ADL(D)	(C ₂ C ₃)	I	C	R			O				
<u>Eastern Meadowlark</u> <i>Sturnella magna</i> (Linnaeus)	SOM MG MS	(C ₂ C ₃)	I	C	R	C	C	C	C			
<u>Western Meadowlark</u> <i>Sturnella neglecta</i> (Audubon)	SOM MG MS	(C ₂ C ₃)	I	VC	R	O	O	O	O	C	O	C
<u>Red-winged Blackbird</u> <i>Agelaius phoeniceus</i> (Linnaeus)	ADL(D)	(C ₂ C ₃)	I	UC	R			O				
<u>Bullock's Oriole</u> <i>Icterus bullockii</i> (Swainson)	SOM	(C ₂ C ₃)	I	I	B	C						
<u>Brewer's Blackbird</u> <i>Euphagus cyanocephalus</i> (Wagler)	SOM ADL(D)	(C ₂ C ₃)	I	C	N		O					
<u>Brown-headed Cowbird</u> <i>Molothrus ater</i> (Boddaert)	SOM ADL(D)	C ₂ C ₃	I	C	R	O	O					
<u>Pyrrhuloxia</u> <i>Pyrrhuloxia sinuata</i> (Bonaparte)	SOM CG MG MS	C ₁ (C ₂ C ₃)	S,F, I	VC	R	O	O	O	O	C	O	O
<u>House Finch</u> <i>Carpodacus mexicanus</i> (Muller)	SOM MG MS	C ₁ (C ₂ C ₃)	S,F, I	C	R	O	O	O				
<u>Pine Siskin</u> <i>Spinus pinus</i> (Wilson)	SOM MG MS	C ₁ (C ₂ C ₃)	S,F, I	C	N	S	O	C	O	O		
<u>American Goldfinch</u> <i>Spinus tristis</i> (Linnaeus)	SOM MG MS	C ₁ (C ₂ C ₃)	S,F, I	C	N	S	O	O	O			
<u>Green-tailed Towhee</u> <i>Chlorura chlorura</i> (Audubon)	SOM	C ₁ (C ₂ C ₃)	S,F, I	I	N	C	C					
<u>Rufous-sided Towhee</u> <i>Pipilo erythrophthalmus</i> (Linnaeus)	SOM	C ₁ (C ₂ C ₃)	S,F, I	I	R	C	C					
<u>Lark Bunting</u> <i>Calamospiza melanocorys</i> (Stejneger)	SOM CG MG MS	(C ₁ C ₂ C ₃)	S,F, I	VC	R	O	O	O	O	C	O	O
<u>Savannah Sparrow</u> <i>Passerculus sandwichensis</i> (Gmelin)	SOM MG	(C ₁ C ₂ C ₃)	S,F, I	C	N	O	O					

Table C-2. (Cont.)

Species	Habitat	Trophic level	Food type	Status		Observation Record							
				A	S	A	S	O	N	D	J	F	M
Baird's Sparrow <i>Ammodramus bairdii</i> (Audubon)	SOM	(C ₁ C ₂ C ₃)	S,F, I	I	N							C	
Vesper's Sparrow <i>Pooecetes gramineus</i> (Gmelin)	SOM MG MS	(C ₁ C ₂ C ₃)	S,F, I	VC	N			S	C	C	O	C	O
Lark Sparrow <i>Chondestes grammacus</i> (Say)	SOM	(C ₁ C ₂ C ₃)	S,F, I	I	B			C					
Cassin's Sparrow <i>Aimophila cassini</i> (Woodhouse)	SOM CG MG MS	(C ₁ C ₂ C ₃)	S,F, I	VC	B	O	S	O	C	C	C	C	C
Black-throated Sparrow <i>Amphispiza bilineata</i> (Cassin)	SOM MG	(C ₁ C ₂ C ₃)	S,F, I	C	N			C	C	C		C	C
Sage Sparrow <i>Amphispiza belli</i> (Cassin)	SOM MG MS	(C ₁ C ₂ C ₃)	S,F, I	C	N			O	C			C	
Oregon Junco <i>Junco oreganus</i> (Townsend)	SOM MG	(C ₁ C ₂ C ₃)	S,F, I	C	N			O	C			C	
Clay-colored Sparrow <i>Spizella pallida</i> (Swainson)	SOM	(C ₁ C ₂ C ₃)	S,F, I	I	M			C	C				
Brewer's Sparrow <i>Spizella breweri</i> (Cassin)	SOM	(C ₁ C ₂ C ₃)	S,F, I	I	N			C	O				
White-crowned Sparrow <i>Zonotrichia leucophrys</i> (Forster)	SOM CG MS MS	(C ₁ C ₂ C ₃)	S,F, I	VC	N	O	C	C	O	C	O	C	
				Total (72)		10	37	42	28	24	22	31	27

*Trophic levels (C₁, C₂, or C₃) are listed in the order of their relative importance in the forage habits of the species. The level listed first is most important. Parentheses indicate that the levels are equally important. Data for trophic levels were obtained from Chandler (1966) and Maze (1974).

**Actually a metal tank near a dwelling in the active dune land habitat.

Food Type:

- P = plant tissue
- F = fruits
- S = seeds
- I = invertebrates
- SV = small vertebrates
- SAV = small aquatic vertebrates
- SB = small birds
- SM = small mammals
- C = carrion
- FI = fish

Table C-2. (Cont.)

Status:

A = Abundance:

VC = very common; abundant

C = common; regularly present, abundant but sporadic occurrence

UC = uncommon; seen once, evidence that species is present

I = censused on the intensive survey site. See Table 4-3 for their densities.

S = Seasonal:

R = resident throughout the year

B = breeding (or summer) resident

N = non-breeding (or winter) resident

M = migrant

Observation Record:

Observations for each month are presented from 29 August (A) 1975 to 27 March (M) 1976.

S = specimen(s) of species collected

C = species censused

O = species observed but not censused

I = tracks, vocalizations or other signs indicative of presence of species

Table C-3. Mammal species list for the extensive survey. Habitats where species occur are designated: SOM = shinnery oak-mesquite, CG = creosote-grassland, MG = mesquite-grassland, MS = mesquite-snakeweed, ADL = active dune land. All species are resident. Trophic levels C_1 , C_2 , C_3 refer to primary, secondary, and tertiary consumers, respectively. All other symbols are explained in the footnote.

Species	Habitat	Trophic level	Food type	Status Abundance	Observation Record							
					A	S	O	N	D	J	F	M
LAGOMORPHS:												
Desert Cottontail <i>Sylvilagus auduboni</i> (Baird)	SOM MG CG MS ADL	C_1^*	P	VC	0	0	0	0	0	0	0	0
Blacktail Jackrabbit <i>Lepus californicus</i> Gray	SOM MG CG MS ADL	C_1	P	VC	0	0	0	0	0	0	0	0
RODENTS:												
Spotted Ground Squirrel <i>Spermophilus spilosoma</i> Bennett	SOM	$C_1C_2C_3$	P,S,IV,SV	VC	S	C	O					
Plains Pocket Gopher <i>Geomys bursarius</i> (Shaw)	SOM	C_1	R	C	O	S	O	C	O	O		
Silky Pocket Mouse <i>Perognathus flavus</i> Baird	SOM MG CG	$C_1(C_2C_3)$	S,P,IV	C	S	C	O	S	O	O		
Plains Pocket Mouse <i>Perognathus flavescens</i> Merriam	SOM	$C_1(C_2C_3)$	S,P,IV	UC	S	C	O	S				
Hispid Pocket Mouse <i>Perognathus hispidus</i> Baird	MG MS	$C_1(C_2)$	S,P,IV	UC	S	S	S	O				
Desert Pocket Mouse <i>Perognathus penicillatus</i> Woodhouse	ADL	$C_1(C_2C_3)$	S,P,IV	C	S							
Ord's Kangaroo Rat <i>Dipodomys ordii</i> Woodhouse	MS ADL	C_1	P,S	VC	S	C	O	S	O			
Bannertail Kangaroo Rat <i>Dipodomys spectabilis</i> Merriam	MG CG	C_1	P,S	VC	S	O	I	O	O			
Merriam Kangaroo Rat <i>Dipodomys merriami</i> Mearns	CG MG	C_1	P,S	VC	S	O	O	S	O			
Western Harvest Mouse <i>Reithrodontomys megalotis</i> (Baird)	MG	C_1C_2	P,IV	UC								O
White-footed Mouse <i>Peromyscus leucopus</i> (Rafinesque)	SOM MG CG ADL	$C_1(C_2C_3)$	S,F,IV	C	S	S	O	O				
Northern Grasshopper Mouse <i>Onychomys leucogaster</i> (Wied-Neuwied)	SOM CG MG MS ADL	$C_1C_2C_3$	S,IV,SV	VC	S	C	O	S	S	O		
Hispid Cotton Rat <i>Sigmodon hispidus</i> Say and Ord	SOM MG	$C_1(C_2)$	P	C	S	O	O	O	O			

Table C-3. (Cont.)

Species	Habitat	Trophic level	Food type	Status		Observation Record
				Abundance	A S O N D J F M A	
Southern Plains Woodrat <i>Neotoma micropus</i> Baird	SOM ADL MG MS CG	C ₁	S, F, P	C	S O O O O O	
White-throated Woodrat <i>Neotoma albiventer</i> Hartley	MG	C ₁	S, P	UC		S
Porcupine <i>Erethizon dorsatum</i> (Linnaeus)	SOM MG MS CG	C ₁	P	UC	I I	
CARNIVORES:						
Coyote <i>Canis latrans</i> Say	SOM CG MG MS ADL	C ₂ C ₃ (C ₁)	V, IV, P	VC	I O O O O I	
Badger <i>Taxidea taxus</i> (Schreber)	SOM	C ₂ C ₃	SM	UC	I I	
Striped Skunk <i>Mephitis mephitis</i> (Schreber)	SOM	(C ₂ C ₃)C ₁	C, P	C	I I	
Bobcat <i>Lynx rufus</i> (Schreber)	SOM	C ₂ C ₃	V	UC	I	
UNGULATES:						
Mule Deer <i>Odocoileus hemionus</i> (Rafflesque)	SOM	C ₁	P	C	I I	O O I

*Trophic levels (C₁, C₂, or C₃) are listed in the order of their relative importance in the forage habits of the species. The level listed first is most important. Parentheses indicate that the levels are equally important. Data for trophic levels were obtained from Burt and Grossenheider (1964), Maze (1974), and Findley *et al.* (1975).

Food Type:

P = plant tissue
F = fruits
S = seeds
R = roots and tubers
IV = invertebrates
SV = small vertebrates
V = vertebrates
SM = small mammals
C = carrion

Status:

Abundance:

VC = very common: abundant
C = common: regularly present, abundant but sporadic occurrence
UC = uncommon: seen once; evidence that species is present

Observation Record:

Observations for each month are presented from 27 August (A) 1975 to 15 April (A) 1976.
S = specimen(s) of species collected
C = species censused
O = species observed but not censused
I = tracks, vocalization, or other signs indicative of presence of species

Table C-4. Vertebrate species list for those species occurring on or near the study area but not observed during this study. The species were reported in published materials such as Aday and Gennaro (1973), Carlsbad Caverns National Park Staff (1965), Hall and Kelson (1959), Hubbard (1970), Stebbins (1954, 1966), Tanner (1975), and Tinkle (1967).

Common name	Scientific name	Author
AMPHIBIANS:		
Tiger Salamander	<u>Ambystoma tigrinum</u>	(Green)
Couch's Spadefoot	<u>Scaphiopus couchi</u>	Baird
Western Spadefoot	<u>Scaphiopus hammondi</u>	Baird
Central Plains Spadefoot	<u>Scaphiopus bombifrons</u>	Cope
Woodhouse's Toad	<u>Bufo woodhousei</u>	Girard
Texas Toad	<u>Bufo compactilus</u>	Wiegmann
Great Plains Toad	<u>Bufo cognatus</u>	Say
Little Green Toad	<u>Bufo debilis</u>	Girard
Desert Toad	<u>Bufo punctatus</u>	Baird and Girard
Barking Frog	<u>Eleutherodactylus augusti</u>	(Duges)
Cricket Frog	<u>Acris gryllus</u>	Le Conte
Leopard Frog	<u>Rana pipiens</u>	Schreber
Bull Frog	<u>Rana catesbeiana</u>	Shaw
REPTILES:		
Common Snapping Turtle	<u>Chelydra serpentina</u>	Linnaeus
Yellow Mud Turtle	<u>Kinosternon flavescens</u>	(Agassiz)
Pond Slider	<u>Pseudemys scripta</u>	(Schoepff)
Spiny Soft-shelled Turtle	<u>Trionyx spiniferus</u>	Lesueur
Collared Lizard	<u>Crotaphytus collaris</u>	(Say)
Greater Earless Lizard	<u>Holbrookia texana</u>	(Troschel)
Eastern Fence Lizard	<u>Sceloporus undulatus</u>	(Latreille)
Sagebrush Lizard	<u>Sceloporus graciosus</u>	Baird and Girard
Round-tailed Horned Lizard	<u>Phrynosoma modestum</u>	Girard
Checkered Whiptail	<u>Cnemidophorus tessellatus</u>	(Say)
Spotted Whiptail	<u>Cnemidophorus sacki</u>	Wiegmann
Little Striped Whiptail	<u>Cnemidophorus inornatus</u>	Baird
Great Plains Skink	<u>Eumeces obsoletus</u>	(Baird and Girard)
Texas Blind Snake	<u>Leptotyphlops dulcis</u>	(Baird and Girard)
Plain-bellied Water Snake	<u>Natrix erythrogaster</u>	(Forster)
Checkered Garter Snake	<u>Thamnophis marcianus</u>	(Baird and Girard)
Ribbon Snake	<u>Thamnophis sauritus</u>	(Linnaeus)
Common Garter Snake	<u>Thamnophis sirtalis</u>	(Linnaeus)

Table C-4: (Cont.)

Common name	Scientific name	Author
Corn Snake	<u>Elaphe guttata</u>	(Linnaeus)
Glossy Snake	<u>Arizona elegans</u>	Kennicott
Common King Snake	<u>Lampropeltis getulus</u>	Linnaeus
Milk Snake	<u>Lampropeltis triangulum</u>	(Linnaeus)
Long-nosed Snake	<u>Rhinocheilus lecontei</u>	Baird and Girard
Ground Snake	<u>Sonora episcopa</u>	Kennicott
Western Hooked-nosed Snake	<u>Ficimia cana</u>	(Cope)
Great Plains Black-headed Snake	<u>Tantilla nigriceps</u>	Kennicott
BIRDS:		
Common Loon	<u>Gavia immer</u>	(Brunnich)
Horned Grebe	<u>Podiceps auritus</u>	(Linnaeus)
Eared Grebe	<u>Podiceps caspicus</u>	(Hablitzl)
Western Grebe	<u>Aechmophorus occidentalis</u>	(Lawrence)
Pied-billed Grebe	<u>Podilymbus podiceps</u>	(Linnaeus)
White Pelican	<u>Pelecanus erythrorhynchos</u>	(Gmelin)
Double-crested Cormorant	<u>Phalacrocorax auritus</u>	(Lesson)
Great Blue Heron	<u>Ardea herodias</u>	(Linnaeus)
Green Heron	<u>Butorides virescens</u>	(Linnaeus)
Little Blue Heron	<u>Florida caerulea</u>	(Linnaeus)
Common Egret	<u>Casmerodius albus</u>	(Linnaeus)
Snowy Egret	<u>Leucophoyx thula</u>	(Molina)
Louisiana Heron	<u>Hydranassa tricolor</u>	(Muller)
Black-crowned Night Heron	<u>Nycticorax nycticorax</u>	(Linnaeus)
Yellow-crowned Night Heron	<u>Nyctanassa violacea</u>	(Linnaeus)
Least Bittern	<u>Ixobrychus exilis</u>	(Gmelin)
American Bittern	<u>Botaurus lentiginosus</u>	(Rackett)
Wood Ibis	<u>Mycteria americana</u>	(Linnaeus)
White-faced Ibis	<u>Plegadis chihi</u>	(Vieillot)
Whistling Swan	<u>Olor columbianus</u>	(Ord)
Canada Goose	<u>Branta canadensis</u>	(Linnaeus)
White-fronted goose	<u>Anser albifrons</u>	(Scopoli)
Snow Goose	<u>Chen hyperborea</u>	(Pallas)
Blue Goose	<u>Chen caerulescens</u>	(Linnaeus)
Ross' Goose	<u>Chen rossii</u>	(Cassin)
Gadwall	<u>Anas strepera</u>	(Linnaeus)

Table C-4. (Cont.)

Common name	Scientific name	Author
Pintail	<u>Anas acuta</u>	(Linnaeus)
Cinnamon Teal	<u>Anas cyanoptera</u>	(Vieillot)
American Widgeon	<u>Mareca americana</u>	(Gmelin)
Shoveler	<u>Spatula clypeata</u>	(Linnaeus)
Wood Duck	<u>Aix sponsa</u>	(Linnaeus)
Redhead	<u>Aythya americana</u>	(Eyton)
Ring-necked Duck	<u>Aythya collaris</u>	(Donovan)
Canvasback	<u>Aythya valisineria</u>	(Wilson)
Lesser Scaup	<u>Aythya affinis</u>	(Eyton)
Common Goldeneye	<u>Bucephala clangula</u>	(Linnaeus)
Bufflehead	<u>Bucephala albeola</u>	(Linnaeus)
Ruddy Duck	<u>Oxyura jamaicensis</u>	(Gmelin)
Hooded Merganser	<u>Lophodytes cucullatus</u>	(Linnaeus)
Common Merganser	<u>Mergus merganser</u>	(Linnaeus)
Red-breasted Merganser	<u>Mergus serrator</u>	(Linnaeus)
Mississippi Kite	<u>Ictinia mississippiensis</u>	(Wilson)
Goshawk	<u>Accipiter gentilis</u>	(Linnaeus)
Sharp-shinned Hawk	<u>Accipiter striatus</u>	(Vieillot)
Cooper's Hawk	<u>Accipiter cooperii</u>	(Bonaparte)
Harlan's Hawk	<u>Buteo harlani</u>	(Audubon)
Zone-tailed Hawk	<u>Buteo albonotatus</u>	(Kaup)
Rough-legged Hawk	<u>Buteo lagopus</u>	(Pontoppidan)
Golden Eagle	<u>Aquila chrysaetos</u>	(Linnaeus)
Bald Eagle	<u>Haliaeetus leucocephalus</u>	(Linnaeus)
Osprey	<u>Pandion haliaetus</u>	(Linnaeus)
Peregrine Falcon	<u>Falco peregrinus</u>	(Tunstall)
Aplomado Falcon	<u>Falco femoralis</u>	(Temminck)
Pigeon Hawk	<u>Falco columbarius</u>	(Linnaeus)
Lesser Prairie Chicken	<u>Tympanuchus pallidicinctus</u>	(Ridgway)
Harlequin Quail	<u>Cyrtonyx montezumae</u>	(Vigors)
Ring-necked Pheasant	<u>Phasianus colchicus</u>	(Linnaeus)
Virginia Rail	<u>Rallus limicola</u>	(Vieillot)
Sora	<u>Porzana carolina</u>	(Linnaeus)
Purple Gallinule	<u>Porphyrrula martinica</u>	(Linnaeus)
Common Gallinule	<u>Gallinula chloropus</u>	(Linnaeus)
American Coot	<u>Fulica americana</u>	(Gmelin)

Table C-4. (Cont.)

Common name	Scientific name	Author
Semipalmated Plover	<u>Charadrius semipalmatus</u>	(Bonaparte)
Snowy Plover	<u>Charadrius alexandrinus</u>	(Linnaeus)
Killdeer	<u>Charadrius vociferus</u>	(Linnaeus)
Mountain Plover	<u>Eupoda montana</u>	(Townsend)
Black-bellied Plover	<u>Squatarola squatarola</u>	(Linnaeus)
Common Snipe	<u>Capella gallinago</u>	(Linnaeus)
Long-billed Curlew	<u>Numenius americanus</u>	(Bechstein)
Upland Plover	<u>Bartramia longicauda</u>	(Bechstein)
Spotted Sandpiper	<u>Actitis macularia</u>	(Linnaeus)
Solitary Sandpiper	<u>Tringa solitaria</u>	(Wilson)
Greater Yellowlegs	<u>Totanus melanoleucus</u>	(Gmelin)
Lesser Yellowlegs	<u>Totanus flavipes</u>	(Gmelin)
Pectoral Sandpiper	<u>Erolia melanotos</u>	(Vieillot)
Baird's Sandpiper	<u>Erolia bairdii</u>	(Coues)
Dunlin	<u>Erolia alpina</u>	(Linnaeus)
Long-billed Dowitcher	<u>Limnodromus scolopaceus</u>	(Say)
Stilt Sandpiper	<u>Micropalama himantopus</u>	(Bonaparte)
Western Sandpiper	<u>Ereunetes mauri</u>	(Cabanis)
Marbled Godwit	<u>Limosa fedoa</u>	(Linnaeus)
Sanderling	<u>Crocethia alba</u>	(Pallas)
American Avocet	<u>Recurvirostra americana</u>	(Gmelin)
Black-necked Stilt	<u>Himantopus mexicanus</u>	(Muller)
Wilson's Phalarope	<u>Steganopus tricolor</u>	(Vieillot)
Northern Phalarope	<u>Lobipes lobatus</u>	(Linnaeus)
Franklin's Gull	<u>Larus pipixcan</u>	(Wagler)
Bonaparte's Gull	<u>Larus philadelphia</u>	(Ord)
Sabine's Gull	<u>Xema sabini</u>	(Sabine)
Forster's Tern	<u>Sterna forsteri</u>	(Nuttall)
Least Tern	<u>Sterna albifrons</u>	(Pallas)
Black Tern	<u>Chlidonias niger</u>	(Linnaeus)
Band-tailed Pigeon	<u>Columba fasciata</u>	(Say)
White-winged Dove	<u>Zenaidura asiatica</u>	(Linnaeus)
Ground Dove	<u>Columbigallina passerina</u>	(Linnaeus)
Inca Dove	<u>Scardafella inca</u>	(Lesson)
Screech Owl	<u>Otus asio</u>	(Linnaeus)
Flammulated Owl	<u>Otus flammulatus</u>	(Kaup)

Table C-4. (Cont.)

Common name	Scientific name	Author
Spotted Owl	<u>Strix occidentalis</u>	(Xantus)
Long-eared Owl	<u>Asio otus</u>	(Linnaeus)
Short-eared Owl	<u>Asio flammeus</u>	(Pontoppidan)
Whip-poor-will	<u>Caprimulgus vociferus</u>	(Wilson)
Common Nighthawk	<u>Chordeiles minor</u>	(Foster)
Lesser nighthawk	<u>Chordeiles acutipennis</u>	(Hermann)
Chimney Swift	<u>Chaetura pelasgica</u>	(Linnaeus)
White-throated Swift	<u>Aeronautes saxatalis</u>	(Woodhouse)
Black-chinned Hummingbird	<u>Archilochus alexandri</u>	(Bourcier and Mulsant)
Broad-tailed Hummingbird	<u>Selasphorus platycercus</u>	(Swainson)
Rufous Hummingbird	<u>Selasphorus rufus</u>	(Gmelin)
Yellow-shafted Flicker	<u>Colaptes auratus</u>	(Linnaeus)
Golden-fronted Woodpecker	<u>Centurus aurifrons</u>	(Wagler)
Red-headed Woodpecker	<u>Melanerpes erythrocephalus</u>	(Linnaeus)
Acorn Woodpecker	<u>Melanerpes formicivorus</u>	(Swainson)
Lewis' Woodpecker	<u>Asyndesmus lewisi</u>	(Gray)
Yellow-bellied Sapsucker	<u>Sphyrapicus varius</u>	(Linnaeus)
Williamson's Sapsucker	<u>Sphyrapicus thyroideus</u>	(Cassin)
Hairy Woodpecker	<u>Dendrocopos villosus</u>	(Linnaeus)
Eastern Kingbird	<u>Tyrannus tyrannus</u>	(Linnaeus)
Cassin's Kingbird	<u>Tyrannus vociferans</u>	(Swainson)
Great Crested Flycatcher	<u>Myiarchus crinitus</u>	(Linnaeus)
Ash-throated Flycatcher	<u>Myiarchus cinerascens</u>	(Lawrence)
Eastern Phoebe	<u>Sayornis phoebe</u>	(Latham)
Black Phoebe	<u>Sayornis nigricans</u>	(Swainson)
Traill's Flycatcher	<u>Empidonax traillii</u>	(Audubon)
Hammond's Flycatcher	<u>Empidonax hammondi</u>	(Xantus)
Dusky Flycatcher	<u>Empidonax oberholseri</u>	(Phillips)
Olive-sided Flycatcher	<u>Nuttallornis borealis</u>	(Swainson)
Vermilion Flycatcher	<u>Pyrocephalus rubinus</u>	(Boddaert)
Violet-green Swallow	<u>Tachycineta thalassina</u>	(Swainson)
Tree Swallow	<u>Iridoprocne bicolor</u>	(Vieillot)
Bank Swallow	<u>Riparia riparia</u>	(Linnaeus)
Barn Swallow	<u>Hirundo rustica</u>	(Linnaeus)
Purple Martin	<u>Progne subis</u>	(Linnaeus)
108 Steller's Jay	<u>Cyanocitta stelleri</u>	(Gmelin)

Table C-4. (Cont.)

Common name	Scientific name	Author
Scrub Jay	<u>Aphelocoma coerulescens</u>	(Bosc)
Black-billed Magpie	<u>Pica pica</u>	(Linnaeus)
Common Raven	<u>Corvus corax</u>	(Linnaeus)
Piñon Jay	<u>Gymnorhinus cyanocephalus</u>	(Wied)
Clark's Nutcracker	<u>Nucifraga columbiana</u>	(Wilson)
Plain Titmouse	<u>Parus inornatus</u>	(Gambel)
Verdin	<u>Auriparus flaviceps</u>	(Sundevall)
Common Bushtit	<u>Psaltriparus minimus</u>	(Townsend)
White-breasted Nuthatch	<u>Sitta carolinensis</u>	(Linnaeus)
Red-breasted Nuthatch	<u>Sitta canadensis</u>	(Linnaeus)
Pygmy Nuthatch	<u>Sitta pygmea</u>	(Vigors)
Brown Creeper	<u>Certhia familiaris</u>	(Linnaeus)
Dipper	<u>Cinclus mexicanus</u>	(Swainson)
Winter Wren	<u>Troglodytes troglodytes</u>	(Linnaeus)
Long-billed Marsh Wren	<u>Telmatodytes palustris</u>	(Wilson)
Canon Wren	<u>Catherpes mexicanus</u>	(Swainson)
Rock Wren	<u>Salpinctes obsoletus</u>	(Say)
Catbird	<u>Dumetella carolinensis</u>	(Linnaeus)
Robin	<u>Turdus migratorius</u>	(Linnaeus)
Hermit Thrush	<u>Hylocichla guttata</u>	(Pallas)
Swainson's Thrush	<u>Hylocichla ustulata</u>	(Nuttall)
Eastern Bluebird	<u>Sialia sialis</u>	(Linnaeus)
Western Bluebird	<u>Sialia mexicana</u>	(Swainson)
Mountain Bluebird	<u>Sialia corrugoides</u>	(Bechstein)
Townsend's Solitaire	<u>Myadestes townsendi</u>	(Audubon)
Blue-gray Gnatcatcher	<u>Polioptila caerulea</u>	(Linnaeus)
Golden-crowned Kinglet	<u>Regulus satrapa</u>	(Lichtenstein)
Ruby-crowned Kinglet	<u>Regulus calendula</u>	(Linnaeus)
Water Pipit	<u>Anthus spinoletta</u>	(Linnaeus)
Sprague's Pipit	<u>Anthus spragueii</u>	(Audubon)
Bohemian Waxwing	<u>Bombycilla garrulus</u>	(Linnaeus)
Cedar Waxwing	<u>Bombycilla cedrorum</u>	(Vieillot)
Phainopepla	<u>Phainopepla nitens</u>	(Swainson)
Bell's Vireo	<u>Vireo bellii</u>	(Audubon)
Gray Vireo	<u>Vireo vicinior</u>	(Coues)

Table C-4. (Cont.)

Common name	Scientific name	Author
Solitary Vireo	<u>Vireo solitarius</u>	(Wilson)
Warbling Vireo	<u>Vireo gilvus</u>	(Vieillot)
Black-and-white Warbler	<u>Mniotilta varia</u>	(Linnaeus)
Orange-crowned Warbler	<u>Vermivora celata</u>	(Say)
Nashville Warbler	<u>Vermivora ruficapilla</u>	(Wilson)
Virginia's Warbler	<u>Vermivora Virginiae</u>	(Baird)
Parula Warbler	<u>Parula americana</u>	(Linnaeus)
Yellow Warbler	<u>Dendroica petechia</u>	(Linnaeus)
Black-throated Blue Warbler	<u>Dendroica caerulescens</u>	(Gmelin)
Townsend's Warbler	<u>Dendroica townsendi</u>	(Townsend)
Black-throated Green Warbler	<u>Dendroica virens</u>	(Gmelin)
Grace's Warbler	<u>Dendroica graciae</u>	(Baird)
Ovenbird	<u>Seiurus aurocapillus</u>	(Linnaeus)
Northern Waterthrush	<u>Seiurus noveboracensis</u>	(Gmelin)
Kentucky Warbler	<u>Oporornis formosus</u>	(Wilson)
MacGillivray's Warbler	<u>Oporornis tolmiei</u>	(Townsend)
Yellowthroat	<u>Geothlypis trichas</u>	(Linnaeus)
Yellow-breasted Chat	<u>Icteria virens</u>	(Linnaeus)
American Redstart	<u>Setophaga ruticilla</u>	(Linnaeus)
Bobolink	<u>Dolichonyx oryzivorus</u>	(Linnaeus)
Yellow-headed Blackbird	<u>Xanthocephalus xanthocephalus</u>	(Linnaeus)
Red-winged Blackbird	<u>Agelaius phoeniceus</u>	(Linnaeus)
Hooded Oriole	<u>Icterus cucullatus</u>	(Swainson)
Scott's Oriole	<u>Icterus parisorum</u>	(Bonaparte)
Boat-tailed Grackle	<u>Cassidix mexicanus</u>	(Gmelin)
Western Tanager	<u>Piranga ludoviciana</u>	(Wilson)
Hepatic Tanager	<u>Piranga flava</u>	(Vieillot)
Summer Tanager	<u>Piranga rubra</u>	(Linnaeus)
Cardinal	<u>Richmondena cardinalis</u>	(Linnaeus)
Rose-breasted Grosbeak	<u>Pheucticus ludovicianus</u>	(Linnaeus)
Black-headed Grosbeak	<u>Pheucticus melanocephalus</u>	(Swainson)
Blue Grosbeak	<u>Guiraca caerulea</u>	(Linnaeus)
Indigo Bunting	<u>Passerina cyanea</u>	(Linnaeus)
Lazuli Bunting	<u>Passerina amoena</u>	(Say)
Varied Bunting	<u>Passerina versicolor</u>	(Bonaparte)
Painted Bunting	<u>Passerina ciris</u>	(Linnaeus)

Table C-4. (Cont.)

Common name	Scientific name	Author
Dickcissel	<u>Spiza americana</u>	(Gmelin)
Evening Grosbeak	<u>Hesperiphona vespertina</u>	(Cooper)
Cassin's Finch	<u>Carpodacus cassini</u>	(Baird)
Lesser Goldfinch	<u>Spinus psaltria</u>	(Say)
Red Crossbill	<u>Loxia curvirostra</u>	(Linnaeus)
Brown Towhee	<u>Pipilo fuscus</u>	(Swainson)
Grasshopper Sparrow	<u>Ammodramus savannarum</u>	(Gmelin)
Rufous-crowned Sparrow	<u>Aimophila ruficeps</u>	(Cassin)
Slate-colored Junco	<u>Junco hyemalis</u>	(Linnaeus)
Gray-headed Junco	<u>Junco caniceps</u>	(Woodhouse)
Baird's Sparrow	<u>Ammodramus bairdii</u>	(Audubon)
Tree Sparrow	<u>Spizella arborea</u>	(Wilson)
Chipping Sparrow	<u>Spizella passerina</u>	(Bechstein)
Field Sparrow	<u>Spizella pusilla</u>	(Wilson)
Black-chinned Sparrow	<u>Spizella atrogularis</u>	(Cabanis)
Harris' Sparrow	<u>Zonotrichia querula</u>	(Nuttall)
Golden-crowned Sparrow	<u>Zonotrichia atricapilla</u>	(Gmelin)
White-throated Sparrow	<u>Zonotrichia albicollis</u>	(Gmelin)
Fox Sparrow	<u>Passerella iliaca</u>	(Merrem)
Lincoln's Sparrow	<u>Melospiza lincolni</u>	(Audubon)
Swamp Sparrow	<u>Melospiza georgiana</u>	(Latham)
Song Sparrow	<u>Melospiza melodia</u>	(Wilson)
McCown's Longspur	<u>Rhynchophanes mccownii</u>	(Lawrence)
Chestnut-collared Longspur	<u>Calcarius ornatus</u>	(Townsend)
MAMMALS:		
Desert Shrew	<u>Notiosorex crawfordi</u>	(Coues)
Cave Myotis	<u>Myotis velifer</u>	(J.A. Allen)
Yuma Myotis	<u>Myotis yumanensis</u>	(H. Allen)
Long-eared Myotis	<u>Myotis evotis</u>	(H. Allen)
Fringed Myotis	<u>Myotis thysanodes</u>	Miller
Long-legged Myotis	<u>Myotis volans</u>	(H. Allen)
California Myotis	<u>Myotis californicus</u>	(Audubon and Bachman)
Silver-haired Bat	<u>Lasionycteris noctivagans</u>	(Le Conte)
Western Pipistrel	<u>Pipistrellus hesperus</u>	(H. Allen)
Big Brown Bat	<u>Eptesicus fuscus</u>	(Palisot de Beauvois)
Red Bat	<u>Lasiurus borealis</u>	(Muller)

Table C-4. (Cont.)

Common name	Scientific name	Author
Townsends' Big-eared Bat	<u>Plecotus townsendii</u>	Cooper
Hoary Bat	<u>Lasiurus cinereus</u>	(Palisot de Beauvois)
Pallid Bat	<u>Antrozous pallidus</u>	(Le Conte)
Mexican Free-tailed Bat	<u>Tadarida brasiliensis</u>	(Geoffroy Saint Hilaire)
Pocketed Free-tailed Bat	<u>Tadarida femorosacca</u>	(Merriam)
Big Free-tailed Bat	<u>Tadarida macrotis</u>	(Gray)
Mexican Ground Squirrel	<u>Spermophilus mexicanus</u>	Erxleben
Yellow Faced Pocket Gopher	<u>Pappogeomys castanops</u>	(Baird)
Plains Harvest Mouse	<u>Reithrodontomys montanus</u>	(Baird)
Deer Mouse	<u>Peromyscus maniculatus</u>	(Wagner)
White-tailed Deer	<u>Odocoileus virginianus</u>	Zimmerman
Pronghorn	<u>Antilocapra americana</u>	(Ord)

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