STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME
WILDLIFE MANAGEMENT DIVISION
BIRD AND MAMMAL CONSERVATION PROGRAM

DISTRIBUTION, POPULATION SIZE, AND HABITAT FEATURES OF GIANT KANGAROO RATS IN THE NORTHERN SEGMENT OF THEIR GEOGRAPHIC RANGE

by

DANIEL F. WILLIAMS, MARY K. DAVIS, AND LAURISSA P. HAMILTON

1995

BIRD AND MAMMAL CONSERVATION PROGRAM REPORT 95-01

COVER

Front Cover: Giant kangaroo rat *(Dipodomys ingens).* Photo by D. F. Williams.

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DANIEL F. WILLIAMS[1,2/], MARY K. DAVIS[2/], AND LAURISSA P. HAMILTON[2/]

ABSTRACT

We inspected sites with potential habitat for giant kangaroo rats *(Dipodomys ingens)* in western Fresno and eastern San Benito counties between June and August 1992. In June 1993, we revisited sites to take tissue samples for genetic studies, and looked for and discovered additional giant kangaroo rat colonies. Seventy-nine giant kangaroo rat colonies were found; one colony became extinct between 1992 and 1993. Two of the six colonies previously (1980-89) located and monitored in the Panoche Hills were extirpated. Three other previously located colonies, two in the Tumey Hills and one between Arroyo Hondo and Cantua Creek, also had disappeared. Two colonies were discovered in Indian Valley in the Panoche Hills, an area that formerly had been inaccessible. The largest colonies were found on Panoche and Mugata fine sandy-loam soils, though small numbers of small colonies were found on a wide variety of soil textures. All colonies were located in annual grassland-dominated communities. The extant colonies occupied a total estimated area of 1,882.8 ha, which is almost 6.6 times greater than the 287 ha calculated from studies in the 1980's. The estimated population size for the study area in 1992-93 was 37,125, a substantial increase compared to a prior estimate of approximately 2,000 in 1980-I985. The increase resulted from a population irruption starting in summer 1991 at the end of a 5-year drought. This irruption was widespread in central California and involved many kinds of animals.

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RECOMMENDATIONS

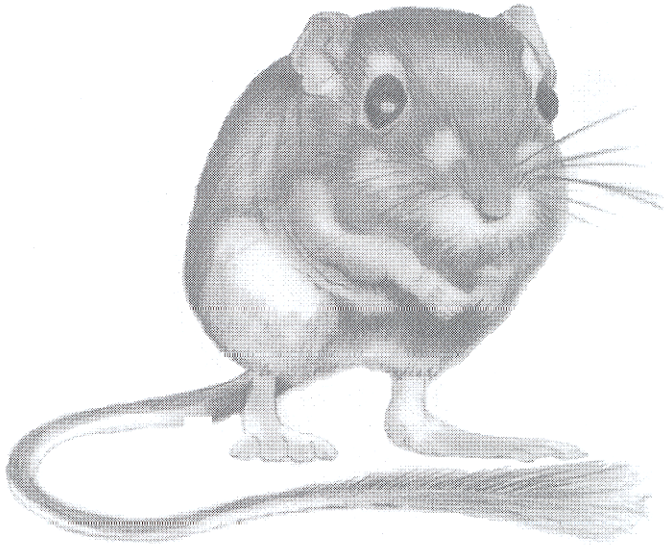
1. Recommend to the Wildlife Conservation Board that the 2,621-ha (6,476-acre) Silver Creek Ranch in San Benito County be purchased as an Ecological Reserve and dedicated to preserving giant kangaroo rats and other listed species.

2. Establish permanent population-monitoring plots at representative colonies of giant kangaroo rats throughout the region of western Fresno and eastern San Benito counties.

3. Initiate long-term population studies of giant kangaroo rats in western Fresno and eastern San Benito counties. Biannual population censuses should be conducted on livestock-grazed and nongrazed plots, and measurements of seed caches and differences in plant species composition and productivity on and around giant kangaroo rat precincts also should be made.

4. Establish a cooperative research program between the California Department of Fish and Game, USDI Fish and Wildlife Service, and USDI Bureau of Land Management and other entities to assess livestock grazing as management tools to maintain and enhance habitat for threatened and endangered species in San Joaquin Valley portion of San Benito County and western Fresno County.

CONTENTS



INTRODUCTION

The giant kangaroo rat *(Dipodomys ingens)* is a California- and Federally-listed endangered species whose habitat has been reduced and degraded, primarily by agricultural cultivation. By the late 1970's, habitat for giant kangaroo rats consisted of an estimated 11,145 ha, in six separate regions, and further fragmented within regions by cultivation, other developments, and inhospitable terrain. In the northern segment of the species geographic range, in western Fresno and eastern San Benito counties (Figure I), the inhabited area was estimated to be about 287 ha in 33 separate colonies in the late 1970's to mid 1980's (Williams 1992). Periodic visits to this area in the 1980's suggested that, overall, the size and vigor of these northern populations were low. We were concerned that if the populations did not respond to the ending of long-term drought and begin increasing, as they had on the Carrizo Plain in late spring and summer 1991 (Williams et al. 1993), the northern populations might be in imminent danger of extinction. We undertook an investigation to assess the population status and distribution of the giant kangaroo rat in colonies in the northern portion of the geographic range. Here we report the results of that study.

METHODS

In June-August 1992 in western Fresno and eastern San Benito counties, we inspected all potential habitat areas for giant kangaroo rats. All inhabited areas were inventoried. Inventories consisted of measuring the area and number of active burrow systems, and within colonies, soil type, plant community, slope, aspect, and elevation. In colonies extending over more than about 10 hectares, burrow counts were estimated from belt transects. Belt transects were surveyed by two people holding a 10-m tape between them and counting all active precincts as they walked a measured distance, usually 500 m. Belt transects were placed to represent the physical features and plant communities within the colony. Two to 11 belt transects were placed in colonies whose burrows could not be directly enumerated, depending upon the size and diversity of the area. In 1993, during reconnaissance for population genetics studies, seven additional colonies were located and measured.

An estimate of the number of giant kangaroo rats in each colony was calculated from the counts of active burrow systems (precincts) on the belt transects, as follows:

$$N_e = \left(n_t \left(\frac{A}{A_t} \right) \right) * C_f$$

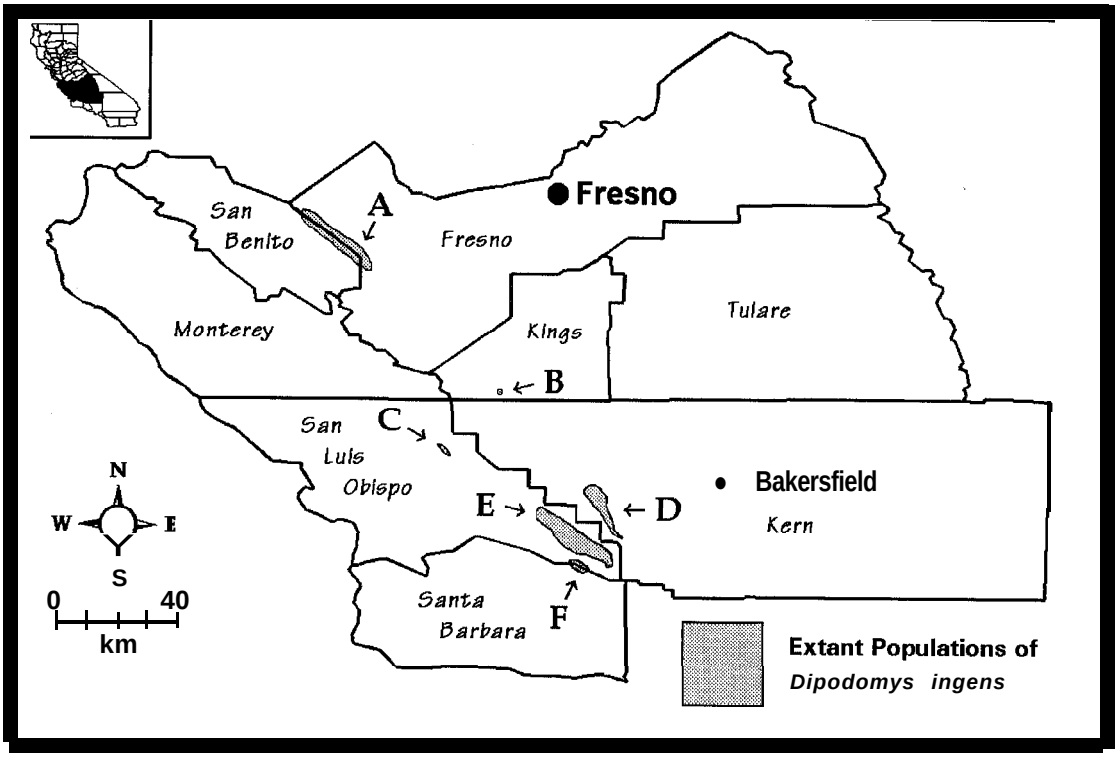


Figure 1. *Extant distribution of the giant kangaroo rat* (Dipodomys ingens). *A - northern population in Fresno and San Benito counties; B - Kettleman Hills population; C - San Juan Creek population; D - western Kern Co. population; E - Carrizo Natural Area population; F - Cuyama Valley population.*

where N_e is the estimated colony size; n_t is the number of active burrows on the transect, A is the estimated area of the colony, in ha, and A_t is the area of the transect, in ha, and C_f is a correction factor to adjust for unoccupied burrows that appear occupied and for counting two or more precincts when where only one is present. Based on our experiences on the Elkhorn and Carrizo plains where we have trapped monthly on plots since 1987, a correction factor of 0.67 generally is needed to have burrow counts closely represent the number of resident adults (natal burrows occupied by a mother and young thus would be counted as one resident adult). Further corrections were made for the largest colonies where burrows of giant kangaroo rats were not evenly spaced over the landscape. Estimated percentage of occupied area was multiplied by the estimated population size.

We livetrapped in only a few colonies where there was a mix of giant and Heermann's kangaroo rats *(D. heermanni).* The proportions of the two species were used to correct the estimate of population size for that colony.

Soil types were determined from unpublished maps and descriptions of soils in western Fresno and eastern San Benito counties (United States Soil Conservation Service). Additionally, soil samples were taken in each colony, but have not been analyzed.

RESULTS AND DISCUSSION

Distribution and Estimated Population Sizes

Locations and sizes of colonies and soil types are shown in Appendix I. Giant kangaroo rats were located in 79 colonies, one of which was extirpated by 1993 (number 51, Table 1). These colonies covered a total estimated area of 1,882.8 ha in 1993. The estimated population size for the study area ranged from 37,125 to 55,411, the lower value being from the formula using the correction factor of 0.67 and the higher value being the uncorrected estimate (Table 1). In this survey in Fresno and San Benito counties, we found more colonies of greater extent and higher densities than in previous surveys between 1980 and 1989 (Williams 1992 and unpubl. data). The increases probably were mostly due to a population irruption in 1991 and 1992 (Williams et al. 1993; also see newspaper account in Appendix II), though we gained access to discover and measure some colonies for the first time in 1992.

Newly discovered colonies were mostly close to existing colonies, and presumably were established during the general population irruption in 1991-1992. Two colonies discovered in and near Indian Valley in the Panoche Hills are relatively isolated from previously known colonies. This is an area we did not have access to in earlier studies. The largest colony (number 30), located at the southeastern end of Panoche Valley, was incompletely known previously because of lack of access to do a comprehensive survey. Two of the six colonies in the Panoche Hills, previously located and monitored between 1980 and 1985 (Williams 1992), were extirpated-only Heermann's kangaroo rats were captured at those sites in 1992. Though giant kangaroo rats occupied the other four sites in the Panoche Hills (colonies 1 and 2, Table 1 and Appendix I), and appeared to have increased and spread until the 4 colonies had merged, there was such a mix of Heermann's and giant kangaroo rats that we could not satisfactorily define the numbers and boundaries of colonies of the latter without greater trapping efforts than time and resources allowed.

Table 1. *Size and environmental features of* Dipodomys ingens *colonies. Size of colonies was estimated from counts of active precincts. Colony numbers are keyed to the numbers on maps in Appendix 1. More complete lists of soil types occurring within the colonies are given in Appendix 1.*

Colony	Soil	Community	Elev. (ft)	ha	Colony Size
1	Pits, gypsiferous complex	grassland, scattered shrubs	1,880	31.51	-
2	Pits, gypsiferous complex	grassland, scattered shrubs	2,100-2,200	68.96	-
3	Vaquero-Grazer Assoc.	grassland, scattered shrubs	1,720-l,760	21.41	418
4	Vaquero-Grazer Assoc.	grassland, scattered shrubs	1,800	2.66	39
5	Panoche Loam	grassland, scattered shrubs	1,240-1,280	98.50	-
6	Kettleman soils	grassland, scattered shrubs	1,634	0.62	2
7	Kettleman soils	grassland, scattered shrubs	1,600	0.87	21
8	Kettleman soils	grassland, scattered shrubs	1,480-l,520	0.72	7
9	Kettleman soils	grassland, scattered shrubs	1,440	1.02	9
10	Kettleman soils	grassland, scattered shrubs	1,320	1.57	21
11	Kettleman soils	grassland, scattered shrubs	1,360	0.60	8
12	Mugatu fine sandy loam	grassland, scattered shrubs	680	1 .00	19
13	Mugatu fine sandy loam	grassland, scattered shrubs	760	0.28	4
14	Mugatu fine sandy loam	grassland, scattered shrubs	720	0.18	2
15	Mugatu fine sandy loam	grassland, scattered shrubs	720	0.28	2
16	Mugatu fine sandy loam	grassland, scattered shrubs	720	0.26	5
17	Mugatu fine sandy loam	grassland, scattered shrubs	720	0.18	4
18	Mugatu fine sandy loam	grassland, scattered shrubs	680-720	1.35	16
19	Mugatu fine sandy loam	grassland, scattered shrubs	680	0.57	12
20	Mugatu fine sandy loam	grassland, scattered shrubs	640	111.67	878
21	Mugatu fine sandy loam	grassland, scattered shrubs	560-640	3.41	20
22	Mugatu fine sandy loam	grassland, scattered shrubs	560-600	2.35	28
23	Mugatu fine sandy loam	grassland, scattered shrubs	560	1.28	23
24	Guijarral sandy loam, Canos-Guijarral complex	grassland, scattered shrubs	680	6.12	31
25	Guijarral sandy loam, Canos-Guijarral complex	grassland, scattered shrubs	640-680	9.90	61
26	Guijarral sandy loam, Canos-Guijarral complex	grassland, scattered shrubs	680-800	15.01	86
27	Guijarral sandy loam, Canos-Guijarral complex	grassland, scattered shrubs	800	76.93	2,990
28	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,040	44.50	-
29	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,000-1,040	26.07	2,341
30	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,320-l,360	548.65	23,158
31	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,240.1,260	95.34	3,833
32	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,400-l,433	19.20	202
33	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,360	6.96	172
34	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,400	3.19	75
35	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,360-l,400	14.01	307
36	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,360-l,480	3.05	17
37	Kettleman loam, Panoche Sandy Loam	grassland, scattered shrubs	1,360-l,480	17.70	143
38	Mugata Fine Sandy loam, others	grassland, scattered shrubs	720	7.92	108
39	Mugata Fine Sandy loam, others	grassland, scattered shrubs	720	0.74	29
40	Mugata Fine Sandy loam, others	grassland, scattered shrubs	1,160-1,200	2.78	32
41	Mugata Fine Sandy loam, others	grassland, scattered shrubs	1,160	0.83	6
42	Mugata Fine Sandy loam, others	grassland, scattered shrubs	1,200-l,280	13.58	87
43	Mugata Fine Sandy loam, others	grassland, scattered shrubs	1,200	0.64	7
44	Mugata Fine Sandy loam, others	grassland, scattered shrubs	1,160.1,240	4.87	57
45	Mugata Fine Sandy loam, others	grassland, scattered shrubs	1,160	1.33	21
46	Mugata Fine Sandy loam, others	grassland, scattered shrubs	1,280	1.61	25
47	Mugata Fine Sandy loam, others	grassland, scattered shrubs	l,000-1,280	58.97	4,425
48	Mugata Fine Sandy loam, others	grassland, scattered shrubs	1,120	4.44	137

Table 1 (continued).

Colony	Soil	Community	Elev. (ft)	ha	Colony Size
49	Mugata Fine Sandy loam, others	grassland, scattered shrubs	840	249.64	9,835
50	Guijarral Sandy loam	grassland, scattered shrubs	660-700	221.47	5,045
51	Kettleman soils, exclose-xerorthents	grassland, scattered shrubs	1,720	0.36	0
52	Kettleman soils, exclose-xerorthents	grassland, scattered shrubs	2,440	1.43	20
53	Kettleman soils, exclose-xerorthents	grassland, scattered shrubs	2280	081	29
54	Kettleman soils, exclose-xerorthents	grassland, scattered shrubs	2,360	0.57	20
55	Kettleman soils, exclose-xerorthents	grassland, scattered shrubs	2,360	5.91	20
56	Exclose-xerorthents, scarp-badland assoc.	grassland	1,720	0.55	4
57	Exclose-xerorthents, scarp-badland assoc.	grassland	1,080-l,400	7.54	-
58	Exclose-xerorthents, scarp-badland assoc.	grassland	1,400	0.51	5
59	Exclose-xerorthents, scarp-badland assoc.	grassland	1,400-l,440	2.71	21
60	Exclose-xerorthents, scarp-badland assoc.	grassland	1,400-l,440	1.69	31
61	Exclose-xerorthents, scarp-badland assoc.	grassland	1,480	0.51	9
62	Exclose-xerorthents, scarp-badland assoc.	grassland	1,560	0.31	4
63	Exclose-xerorthents, scarp-badland assoc.	grassland	1,640	0.30	3
64	Exclose-xerorthents, scarp-badland assoc.	grassland	1,800	0.52	7
65	Exclose-xerorthents, scarp-badland assoc.	grassland	1,800	0.49	3
66	Exclose-xerorthents, scarp-badland assoc.	grassland	1.800	0.92	12
67	Exclose-xerorthents, scarp-badland assoc.	grassland	1,600-l,800	17.54	135
68	Exclose-xerorthents, scarp-badland assoc.	grassland	2,000	14.17	94
69	Exclose-xerorthents, scarp-bedland assoc.	grassland	1,920-l,960	1.37	19
70	Exclose-xerorthents, scarp-badland assoc.	grassland	1,720-1,800	1.35	49
71	Exclose-xerorthents, scarp-badland assoc.	grassland	1,440	2.14	-
72	Exclose-xerorthents, scarp-badland assoc.	grassland	920	0.92	20
73	Exclose-xerorthents, scarp-badland assoc.	grassland	2,240-2,280	0.97	28
74	Monoridge-exclose-badland assoc., others	grassland	1,960	0.90	-
75	Monoridge-exclose-badland assoc., others	grassland	1,680	0.50	24
76	Monoridge-exclose-badland assoc., others	grassland	1,480	0.97	26
77	Monoridge-exclose-badland assoc., others	grassland	1,860	3.82	25
78	Monoridge-exclose-badland assoc., others	grassland	1,840	1.26	24
79	Monoridge-exclose-badland assoc., others	grassland	1,940-2,000	5.15	11
	Totals			**1.882.82**	**55,411**

Three other colonies located previously (Williams 1992) had disappeared. Two of these were small, isolated colonies in the Tumey Hills. The other was comparatively large, (and presumably less vulnerable to extinction), but also more isolated than most colonies. It was located on the ridge between Arroyo Hondo and Cantua Creek and estimated to contain about 50 animals in 1986 (Williams and Tordoff 1986).

Habitat occupied by giant kangaroo rats in these two counties totaled about 1,882.8 ha, nearly 6.6 times greater than the 287 ha previously estimated from studies in the 1980's (Williams 1992). The estimated population size of 37,125 giant kangaroo rats compares with a previous estimate of about 2,000 in 1980-I985. Differences mostly reflect the great increase in population size in 1991-I993, because colonies were checked in 1985 and

1989 (D.F. Williams, unpubl. data), and were not as numerous, extensive in area, nor dense (Williams 1992).

Though these numbers are good news for the prospects of recovering the giant kangaroo rat from threats of extinction, the low points in cyclic population changes seen previously suggest that these colonies are vulnerable to extinction through demographic and genetic stochasticity, a fact underscored by the apparent extinction of a few colonies since the 1980's.

Habitat Associations

The largest colonies of giant kangaroo rats were located on Panoche and Mugata fine sandy loams, though small numbers were found on a great variety of soils, from finer-textured loams to soils composed mostly of fine chips of silt stones, pebbles, and other sizes of rocks (Table 1 and Appendix I). The universal feature of these soils was their friability, though the silt- and clay-loams are not very friable, especially when dry, and some of the rocky and gravelly soils are never very friable for small mammals. Clearly, the greatest proportions of the larger colonies were located on sandy loam soils.

All colonies were located in annual grassland-dominated communities (Figure 2). Scattered saltbushes *(Atriplex polycarpa, A. spinifera),* California ephedra *(Ephedra californica),* snakeweed *(Gutierrezia* sp.), buckwheat *(Eriogonum* spp.), goldenbush *(Haplopappus* sp.), and other shrubs occurred in low abundance in areas inhabited by giant kangaroo rats. Predominant grasses and forbs were mainly the nonnative red brome *(Bromus rubens)* and filaree *(Erodium cicutarium),* native annual fescue *(Vulpia microstachys)* and the introduced annual fescue *(V. myuros),* and native annual buckwheats *(Eriogonum* spp.). Perennial grasses included Indian ricegrass *(Achnatherum (= Oryzopsis) hymenoides;* very localized on loose, sandy soils), malpais blue grass *(Poa scrabella),* purple needlegrass *(Nassella (= Stipa) pulchra),* and saltgrass *(Distichlis spicata),* though none of the perennial grasses were abundant.

ACKNOWLEDGMENTS

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Figure 2. *Photograph of giant kangaroo rat habitat. The foreground is heavily-grazed annual grassland, with scattered spiny saltbushes (*Atriplex spinifera*) and snakeweed (Gutierrezia* sp.*). This area supports the greater numbers of giant kangaroo rats. In the background are heavier stands of saltbushes (including* A. polycarpa*) that support only scattered precincts of giant kangaroo rats. Photo by M. K. Davis and L. P. Hamilton.*

and Mammal Conservation Program, through Federal Section 6 Grant-in-Aid funding, and U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service in support of the San Joaquin Valley Endangered Species Recovery Planning Program.

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Williams, D.F. 1992. Geographic distribution and population status of the giant kangaroo rat, *Dipodomys ingens* (Rodentia, Heteromyidae). Pp. 301-328, *in* Endangered and sensitive species of the San Joaquin Valley, California: their biology, management, and conservation (D.F. Williams, S. Byrne, and T.A. Rado, eds.). The California Energy Commission, Sacramento, 388 pp.

Williams, D.F., and W. Tordoff, III. 1986. Martin Ranch Endangered wildlife survey. California Dep. Parks and Recreation, Sacramento, 22 pp.

APPENDIX I

Locations, general soil types within the area occupied, general descriptions of the plant community, and estimated area (ha) of colonies are accompanied by topographic maps showing the boundaries of colonies. Blocks or lines within colonies show the approximate locations of belt transects. Dotted lines indicate that the boundaries of a colony could not be determined because of a mix of Heermann's and giant kangaroo rats and uncharacteristic precincts of giant kangaroo rats in the colony.

Dipodomys ingens

Quadrangle: Mercy Hot Springs

T: 14 S **R**: 11 E

Sections: 18, 20, and 29

County: Fresno

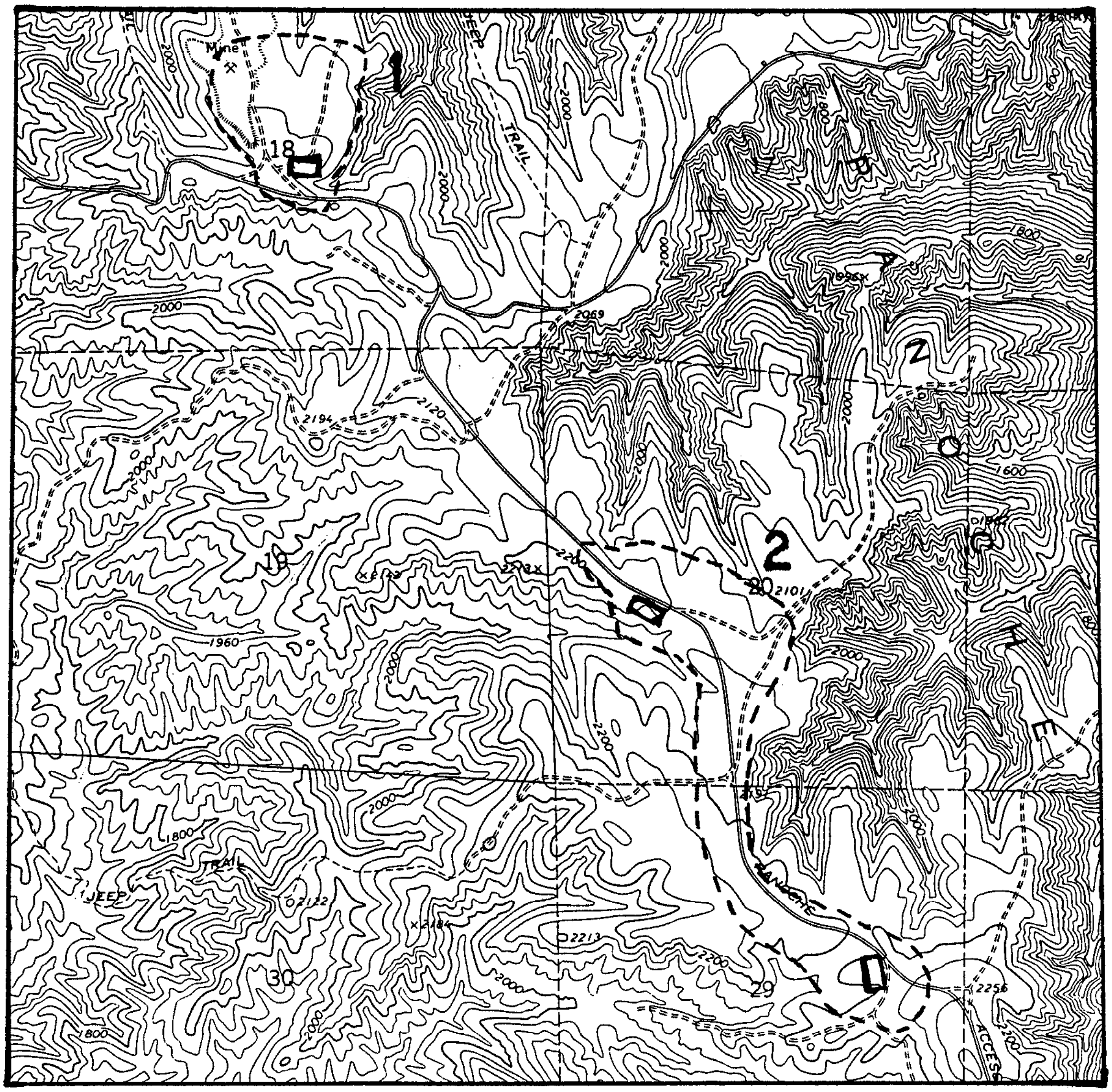
Soil type: Cyvar-Nodhill--Pits, gypsiferous complex.

Vegetation: Mainly annual grasses, forbs and scattered shrubs.

Colony size:

Colony number	Area (hectares)
1[A]	31.51
2[A]	68.96

[A]Colony boundaries estimated.


Mine
1
18
17
TRAIL
2069
2194
2120
2
20
2101
19
1960
1800
JEEP
TRAIL
2122
2213
30
29
2256

Dipodomys ingens

Quadrangle: Mercy Hot Springs and Panoche

T: 15 S **R:** 11 E

Sections: 8, 9, and 17

Counties: Fresno and San Benito

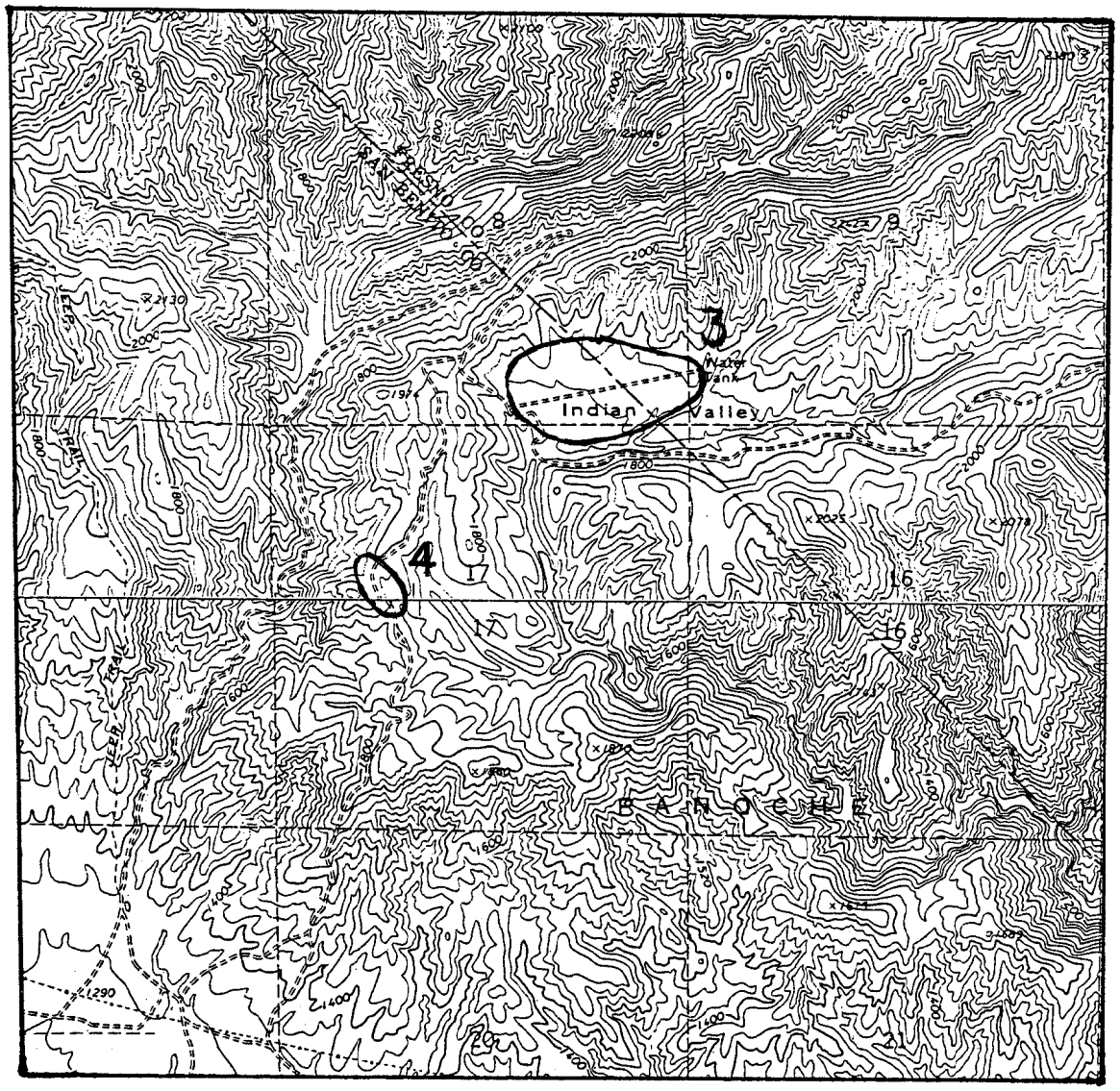
Soil type: Vaquero-Grazer association.

Vegetation: Mainly grasses, forbs and shrubs.

Colony size:

Colony number	Area (hectares)
3[B]	214.08
4[B]	26.62

[B]Total count of precincts.


3
Indian Valley
4
BASIN

Dipodomys ingens

Quadrangle: Panoche

T: 15 S **R:** 10 E and 11 E

Sections: 19 and 24

County: San Benito

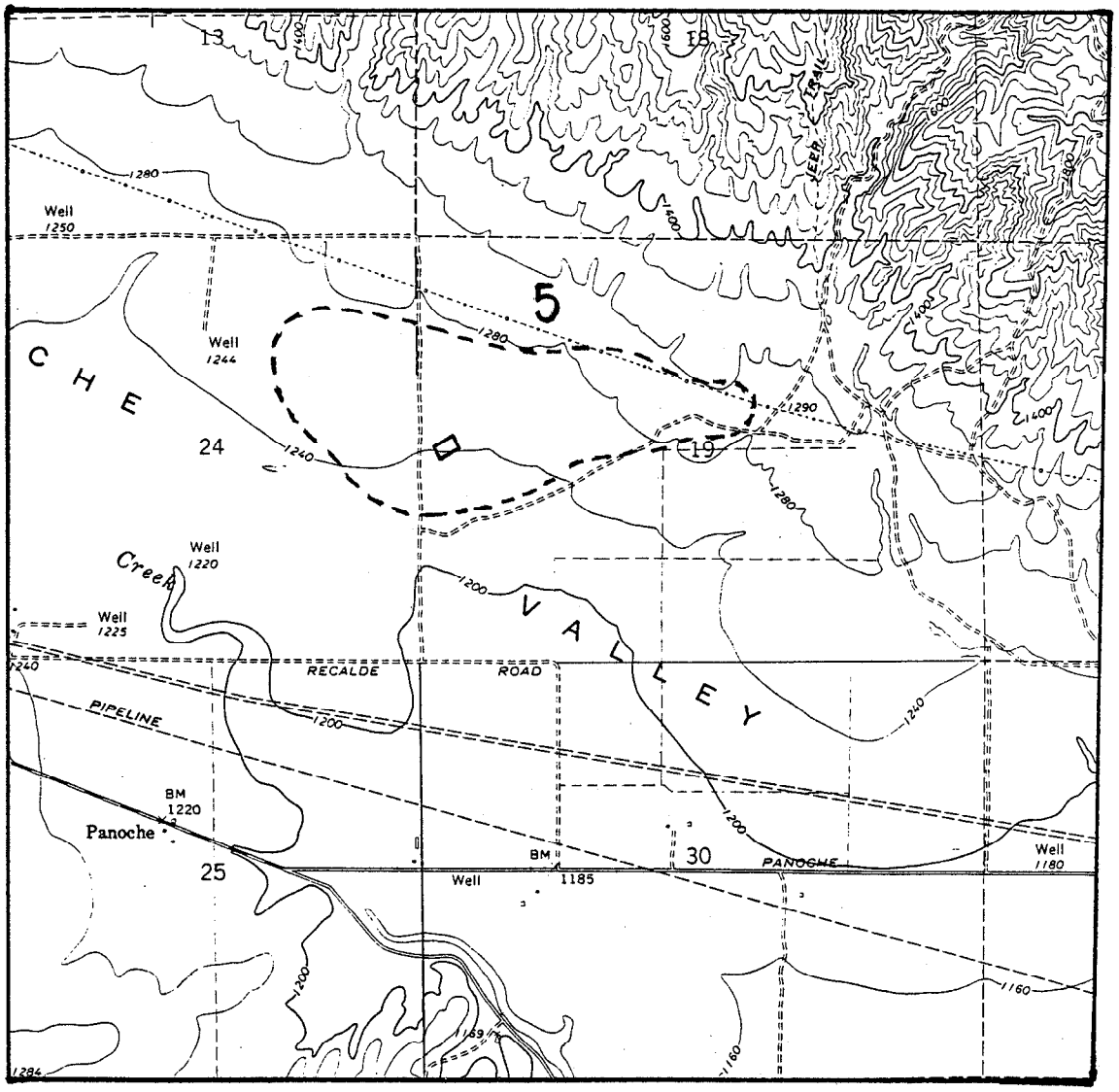
Soil type: Panoche loam.

Vegetation: Mainly annual grasses, forbs, and shrubs.

Colony size:

Colony number	Area (hectares)
5[A]	89.50

[A]Colony boundaries estimated.


13
18
JEEP TRAIL
1600
1400
1280
Well
1250
5
Well
1244
1290
CHE
24
19
1240
1280
Well
1220
Creek
1200
VALLEY
Well
1225
1240
RECALDE
ROAD
PIPELINE
1200
1240
BM
1220
Panoche
25
BM
30
PANOCHE
Well
1180
Well
1185
1200
1160
1160
1284

Dipodomys ingens

Quadrangle: Tumey Hills

T: 15 S **R:** 11 E

Sections: 23 and 26

County: Fresno

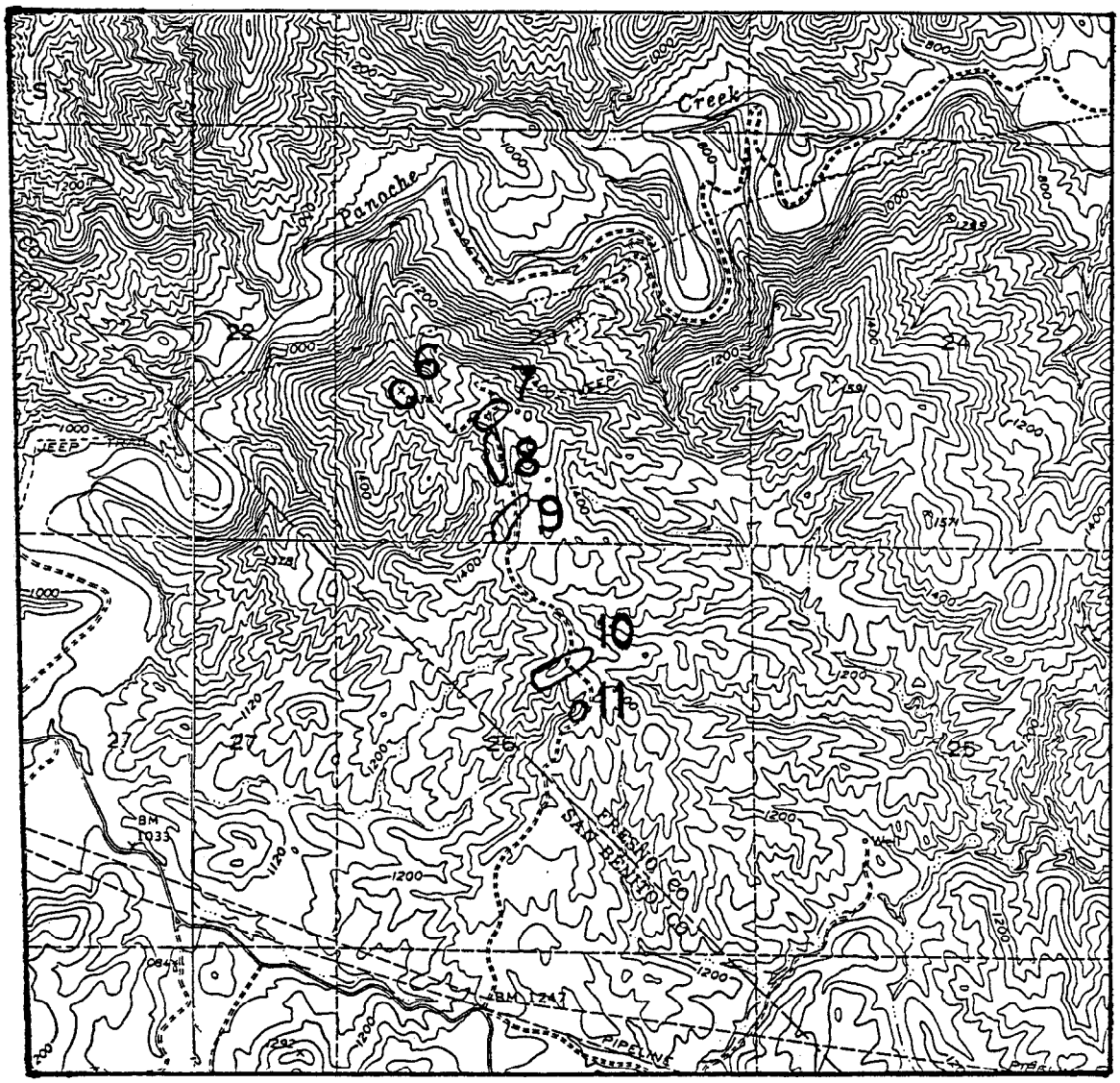
Soil type: Kettleman soils.

Vegetation: Mainly annual grasses, forbs, and shrubs.

Colony size:

Colony number	Area (hectares)
6[B]	6.17
7[B]	8.70
8[B]	7.21
9[B]	10.19
10[B]	15.69
11[B]	6.02

[B]Total count of precincts.


Creek
Panoche
JEEP
SAN BENITO CO.
FRESNO CO.
BM 1033
BM 1241
PIPELINE
6
7
8
9
10
11
22
23
24
25
26
27

Dipodomys ingens

Quadrangle: Tumey Hills and Chounet Ranch

T: 15 S **R**: 12 E

Sections: 16, 17, 18, 19, and 20

County: Fresno

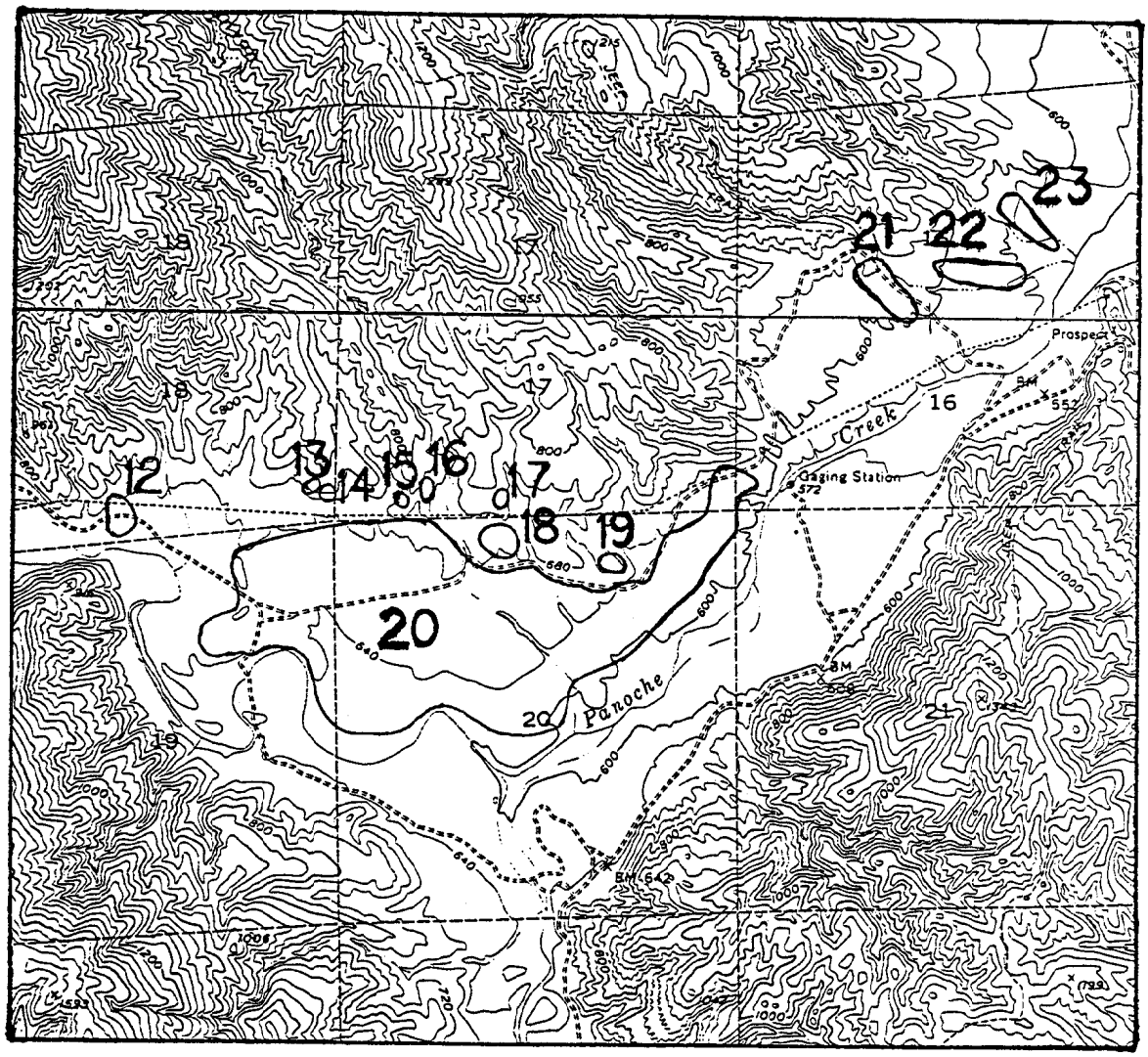
Soil type: Mugatu fine sandy loam.

Vegetation: Mainly annual grasses, forbs, and shrubs.

Colony size:

Colony number	Area (hectares)
12[B]	9.96
13[B]	2.83
14[B]	1.78
15[B]	2.83
16[B]	2.60
17[B]	1.78
18[B]	13.46
19[B]	5.65
20[B]	1116.72
21[B]	34.06
22[B]	23.50
23[B]	12.79

[B]Total count of precincts.


12
13
14
15
16
17
18
19
20
21
22
23
Creek
Gaging Station
Prospect
Panoche
BM 642

Dipodomys ingens

Quadrangle: Tumey Hills and Monocline Ridge

T: 15 S **R:**12 E

Sections: 14, 23, 25, and 26

County: Fresno

Soil type: Guijarral sandy loam and Canoas-Guijarral complex.

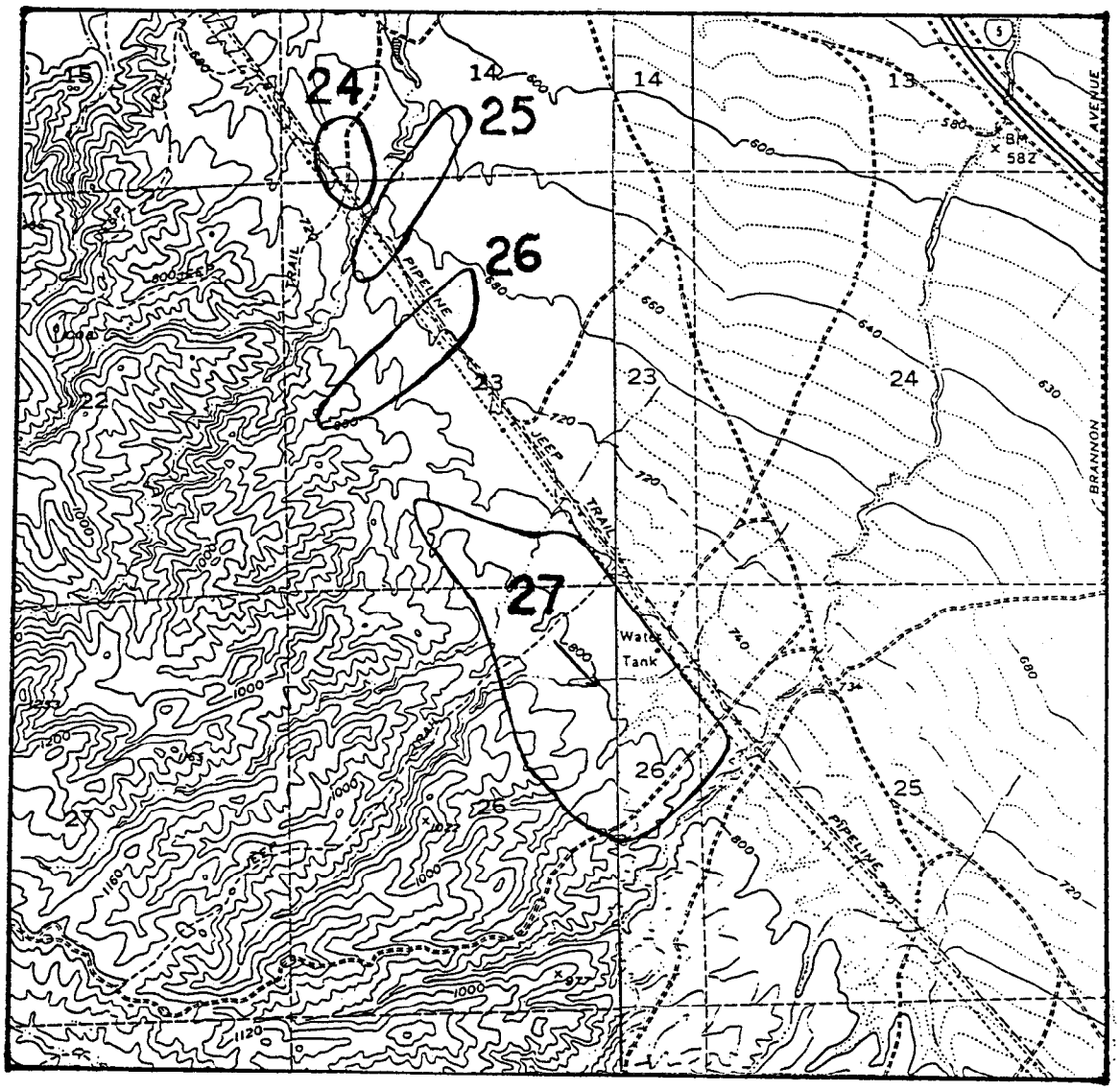
Vegetation: Mainly annual grasses, forbs, and shrubs.

Colony size:

Colony number	Area (hectares)
24[B]	61.20
25[B]	98.97
26[B]	150.06
27[C]	769.32

[B]Total count of precincts.

[C]number estimated from 0.5 hectare transects.


24
25
26
27
TRAIL
PIPELINE
JEEP TRAIL
Water Tank
BM 582
BRANNON AVENUE
PIPELINE

Dipodomys ingens

Quadrangle: Tumey Hills and Panoche

T: 15 S and 16 S **R:** 11 E

Sections: 1, 2, 3, 11, 26, 27, 28, 34, 35, and 36

County: San Benito

Soil type: Kettleman loam and Panoche sandy loam.

Vegetation: Mainly annual grasses and forbs.

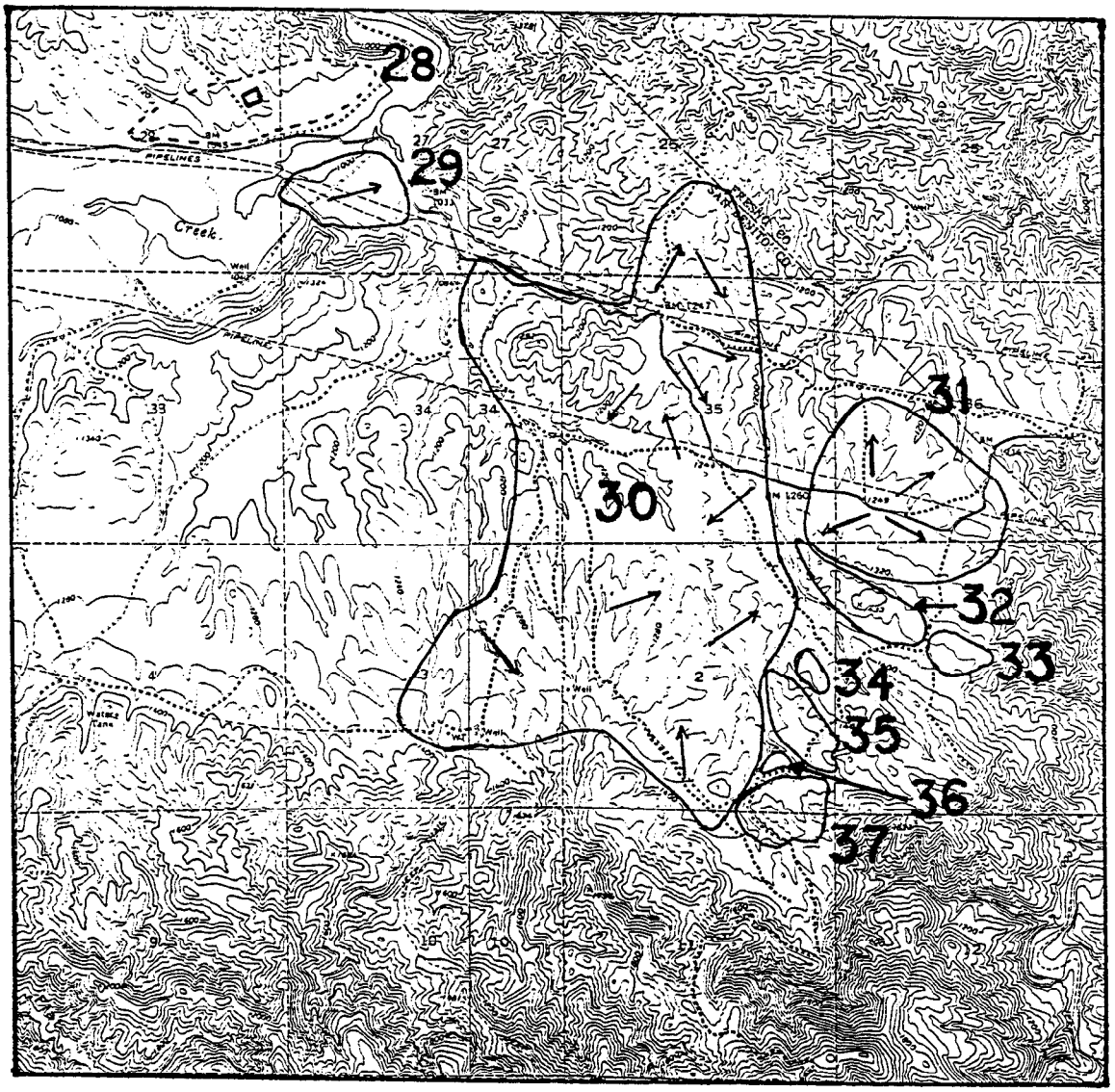
Colony size:

Colony number	Area (hectares\
28[A]	44.50
29[c]	260.70
30[c]	5486.51
31[C]	953.43
32[B]	191.99
33[B]	69.60
34[B]	31.90
35[B]	140.09
36[B]	30.49
37[B]	176.97

[A]Colony boundaries estimated.

[B]Total count of precincts.

[C]number estimated from 0.5 hectare transects.


28
29
30
31
32
33
34
35
36
37
PIPELINES
Creek

Dipodomys ingens

Quadrangle: Tumey Hills

T: 15 S **R**: 12 E

Sections: 21, 27, 28, 32, 33, and 34

County: Fresno

Soil type: Mugata fine sandy loam. Cerini-Torrifluvents, skeletal Fluvaquents. Exclose-Xerorthents, scarp-Grazer association.

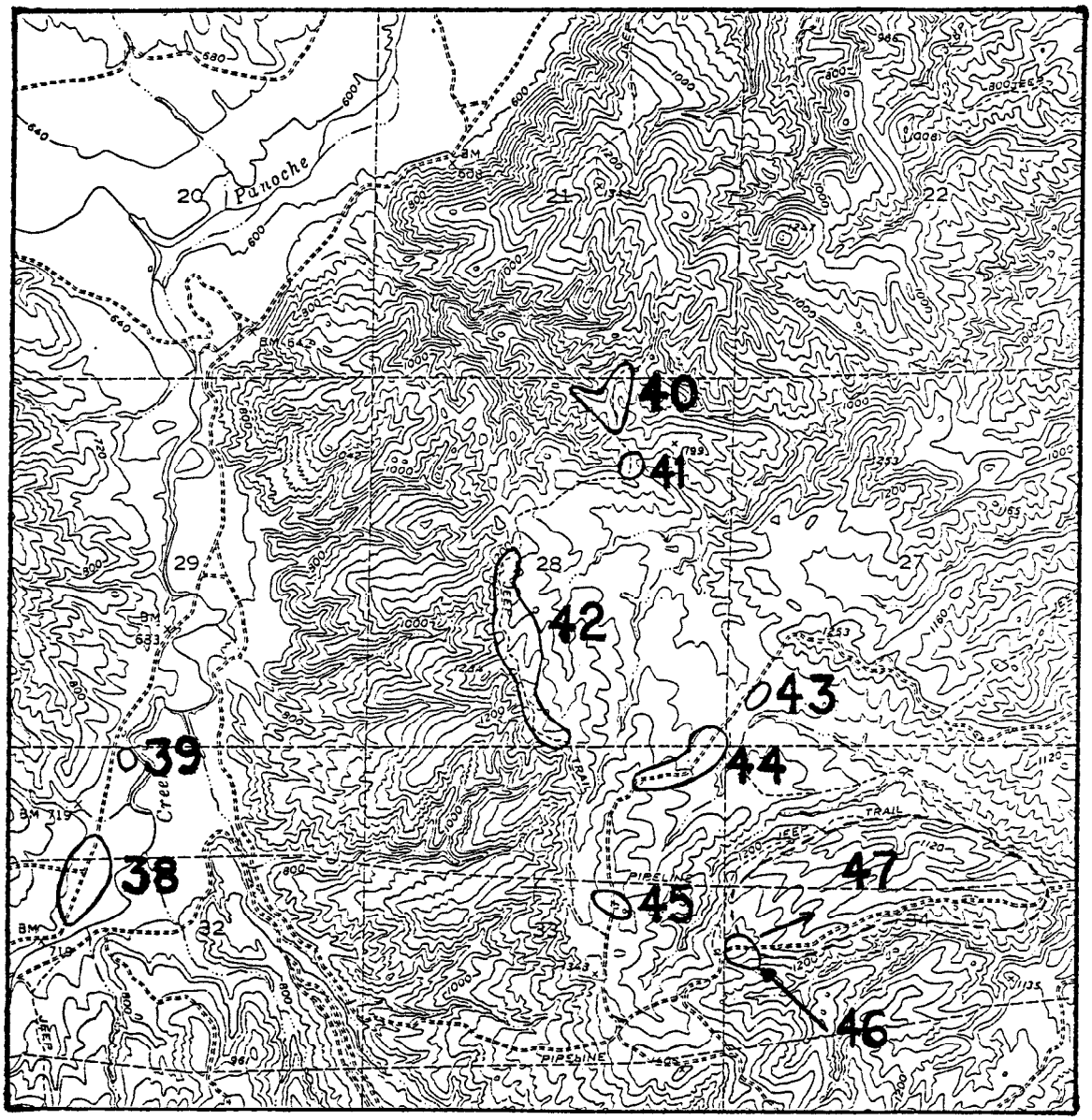
Vegetation: Mainly annual grasses, forbs, and shrubs.

Colony size:

Colony number	Area (hectares)
38[B]	79.19
39[B]	7.36
40[B]	27.81
41[B]	8.25
42[B]	13.58
43[B]	6.39
44[B]	48.71
45[B]	13.31
46[B]	1.61
47[A]	58.97

[A]Colony boundaries estimated.

[B]Total count of precincts.


Paroche
20
21
22
29
28
27
32
40
41
42
43
44
45
46
47
38
39
TRAIL
JEEP
PIPELINE

Dipodomys ingens

Quadrangle: Tumey Hills and Monocline Ridge

T: 15 S **R:** 12 E and 13 E

Sections: 25, 26, 31, 34, 35, and 36

County: Fresno

Soil type: Mugatu fine sandy loam and Exclose-Xerorthents, scarp-Grazer association. Guijarral sandy loam and Canoas-Guijarral complex.

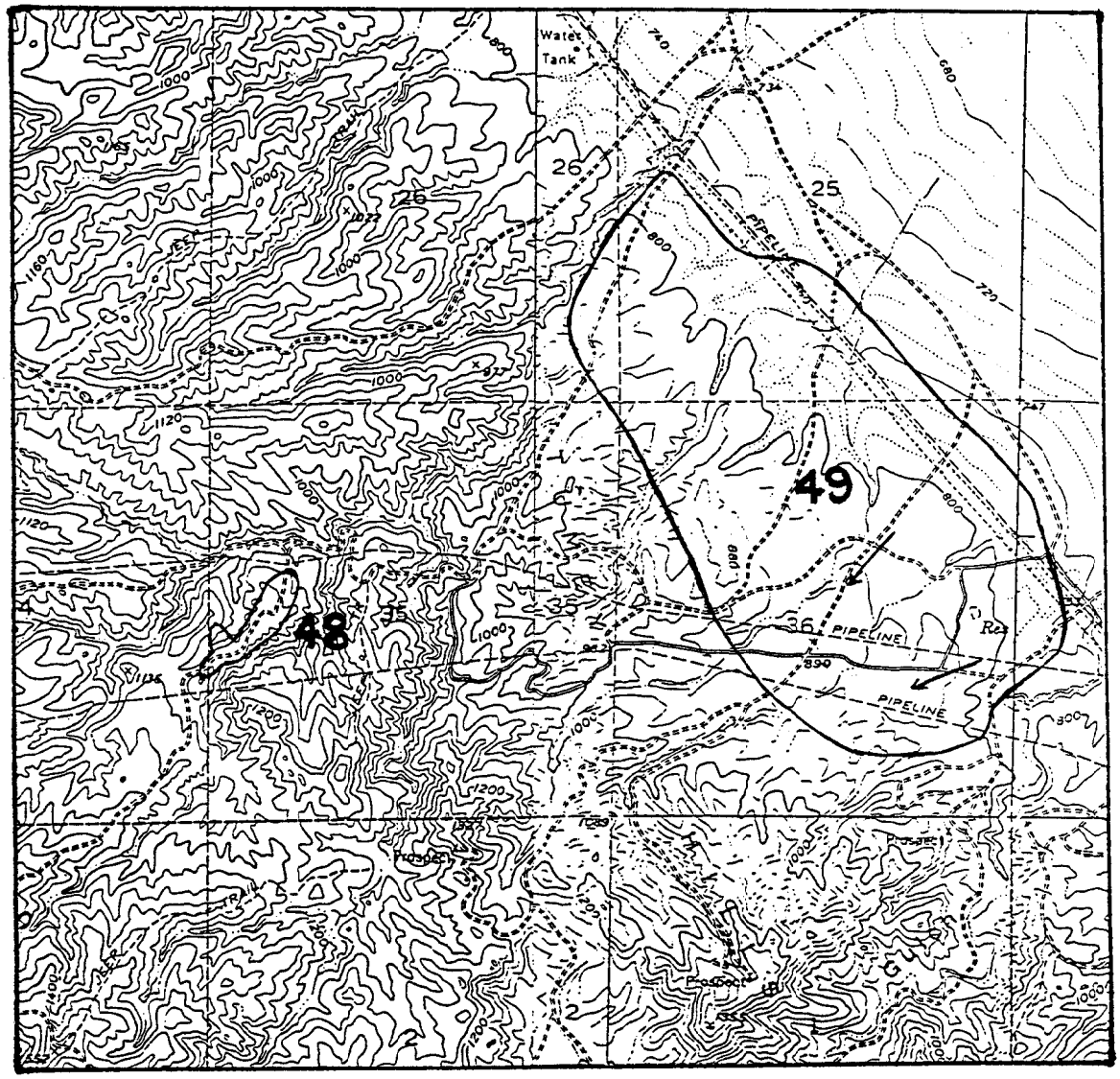
Vegetation: Mainly annual grasses, forbs, and shrubs.

Colony size:

Colony number	Area (hectares)
48[A]	44.39
49[B]	2496.38

[A]Colony boundaries estimated.

[B]Total count of precincts.


Water Tank
49
48
PIPELINE
PIPELINE
PIPELINE
26
25
36
35

Dipodomys ingens

Quadrangle: Monocline Ridge

T: 15 S and 16 S **R:** 13 E

Sections: 3, 4, 5, 6, 10, 11, and 31

County: Fresno

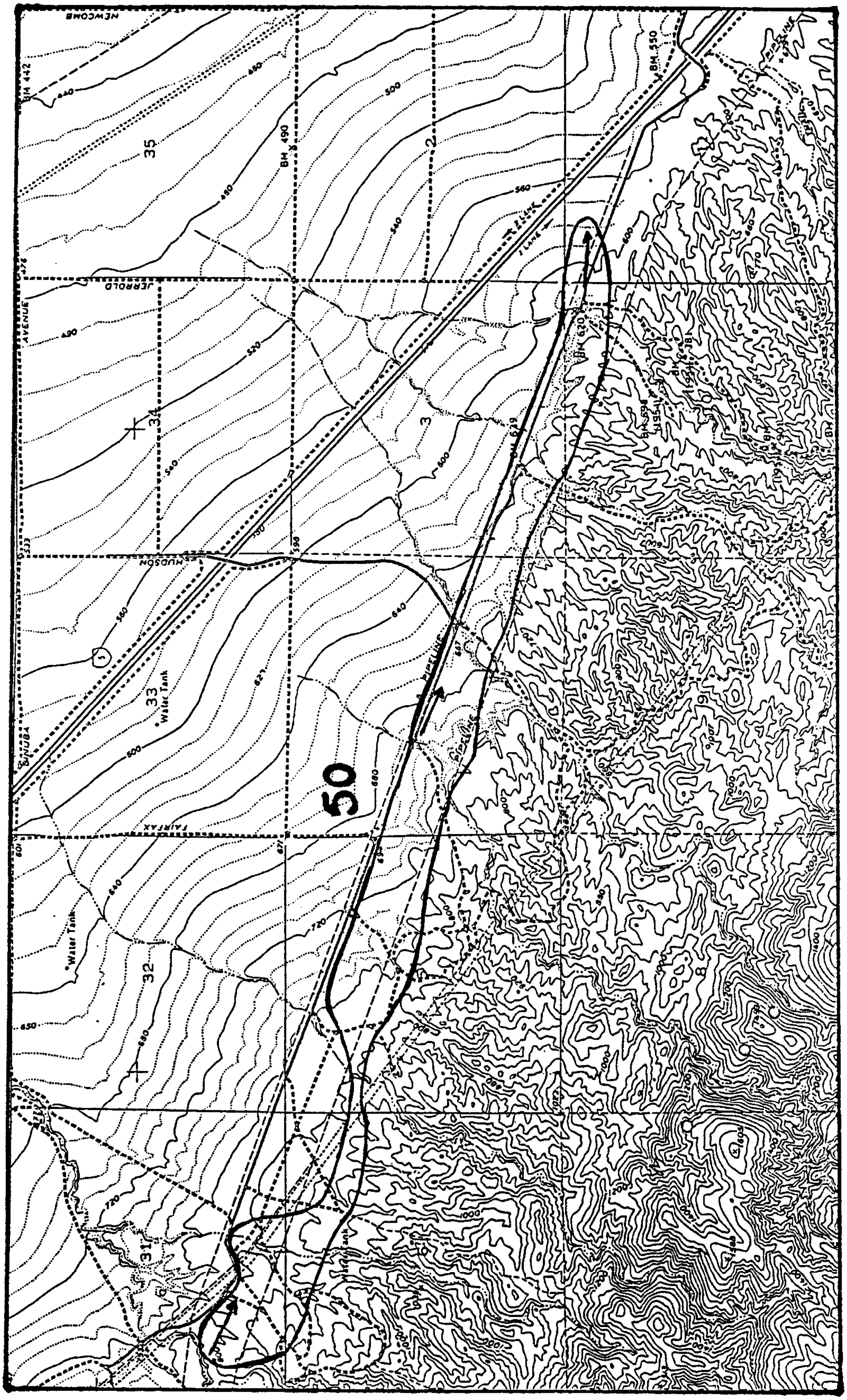
Soil type: Canoas-Guijarral complex. Guijarral sandy loam.

Vegetation: Mainly annual grasses, forbs, and shrubs.

Colony size:

Colony number	Area (hectares)
50[A]	2214.71

[A]Colony boundaries estimated.


50
NEWCOMB
JERROLD
AVENUE
HUDSON
FAIRFAX
PIPELINE
Water Tank
BM 490
BM 630
35
34
33
32
31
2
3

Dipodomys ingens

Quadrangle: Tumey Hills

T: 16 S **R:** 12 E

Sections: 9 and 22

County: Fresno and San Benito

Soil type: Kettleman soils. Exclose-Xerorthents, scarp-Grazer association.

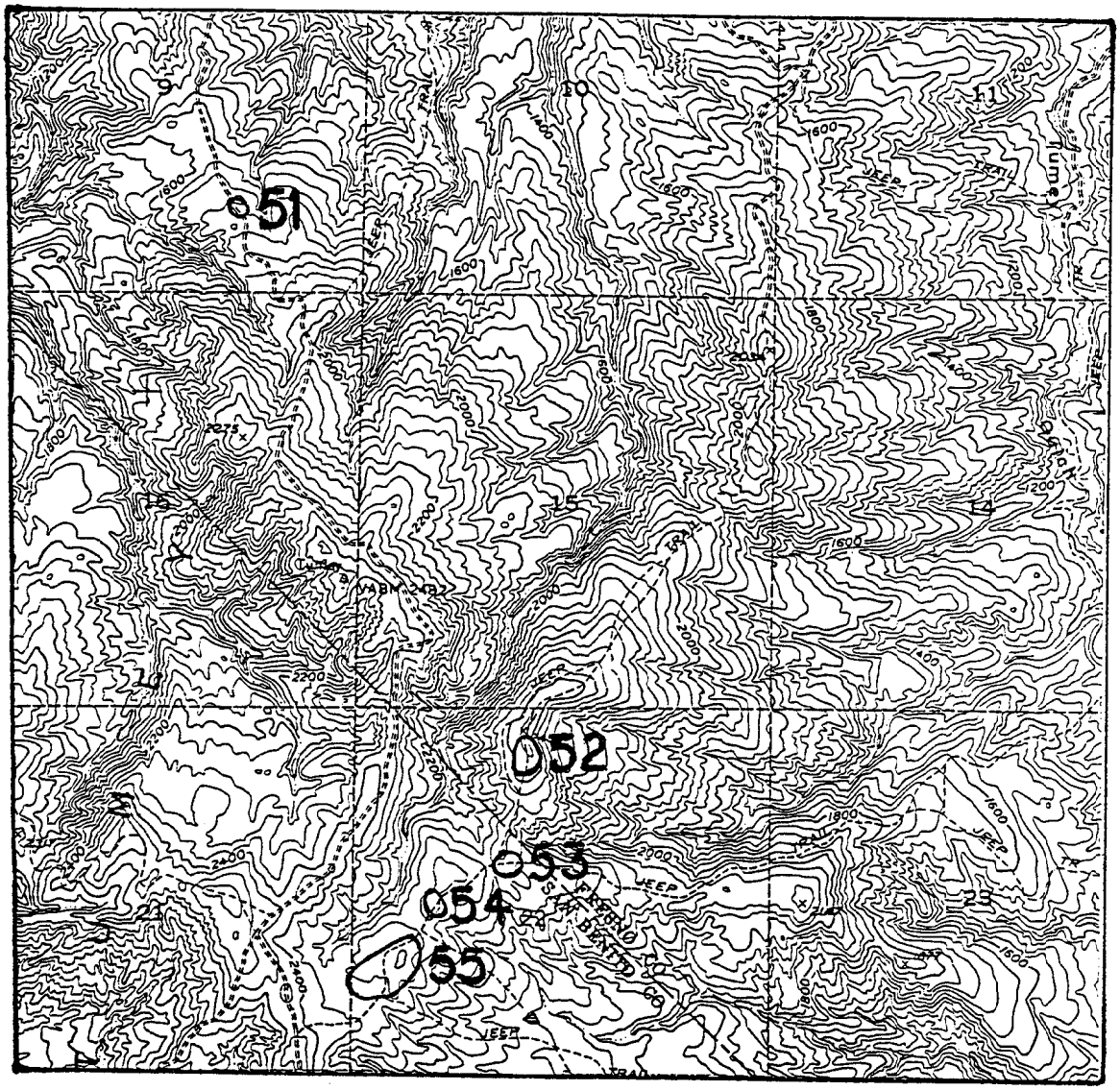
Vegetation: Mainly annual grasses and forbs.

Colony size:

Colony number	Area (hectares)
51[A]	3.57
52[B]	1.43
53[B]	0.81
54[B]	0.57
55[B]	5.91

[A]Colony boundaries estimated.

[B]Total count of precincts.


051
052
053
054
055
JEEP
TRAIL
1600
1800
2000
2200
2400

Dipodomys ingens

Quadrangle: Monocline Ridge and Tumey Hills

T: 16 S R: 12 E

Sections: 1, 10, 12, and 13

County: Fresno

Soil type: Exclose-Xerorthents, scarp-Badland association.

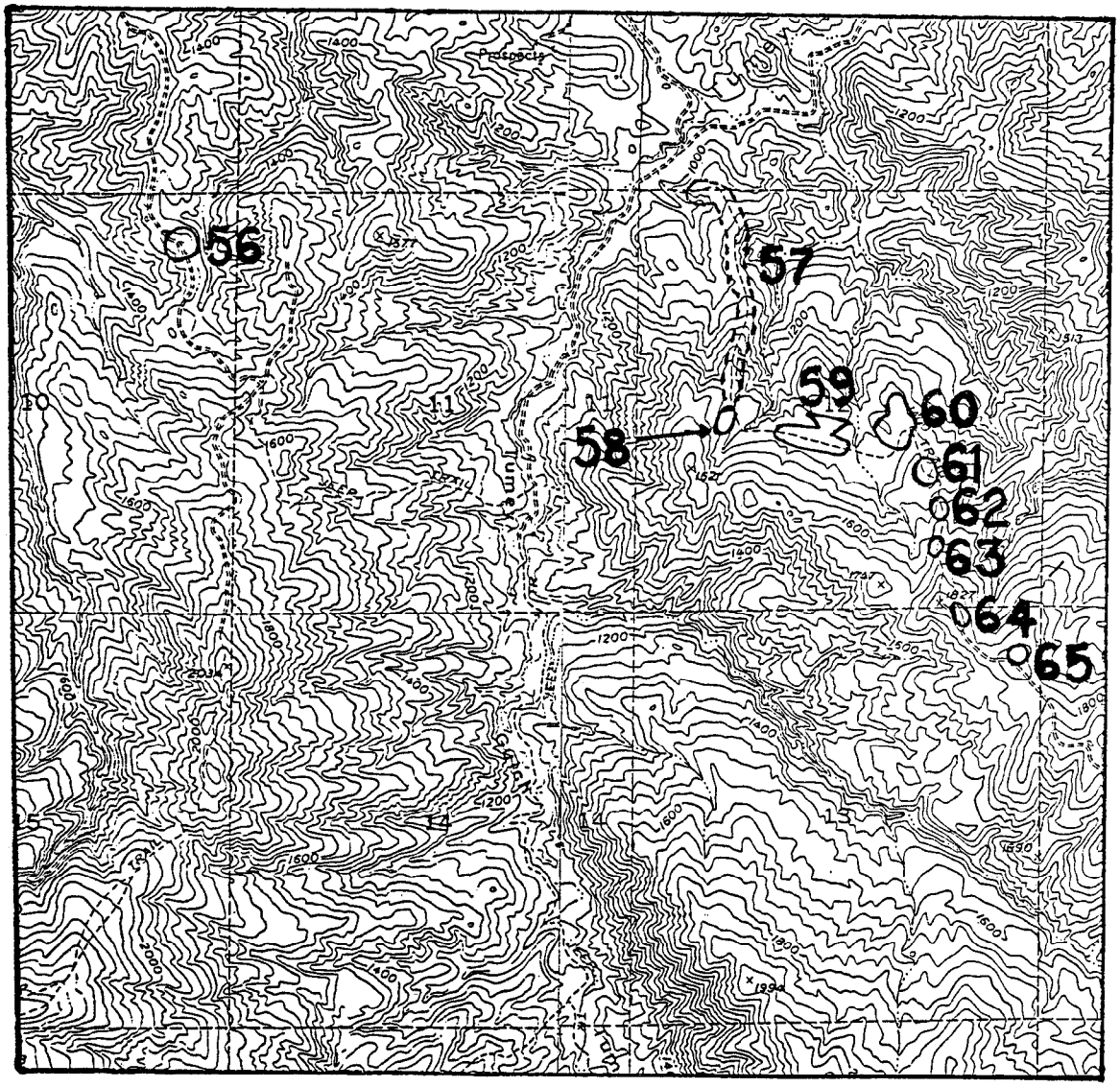
Vegetation: Mainly annual grasses and forbs.

Colony size:

Colony number	Area (hectares)
56[B]	5.50
57[A]	7.51
58[B]	5.06
59[B]	27.07
60[B]	16.88
61[B]	5.13
62[B]	3.12
63[B]	2.97
64[B]	5.21
65[B]	4.91

[A]Colony boundaries estimated.

[B]Total count of precincts.


56
57
58
59
60
61
62
63
64
65

Dipodomys ingens

Quadrangle: Monocline Ridge

T: 16 S **R**: 13 E

Sections: 16, 17, 18, 20, 21, and 30

County: Fresno

Soil type: Exclose-Xerothents, scarp-Badland association.

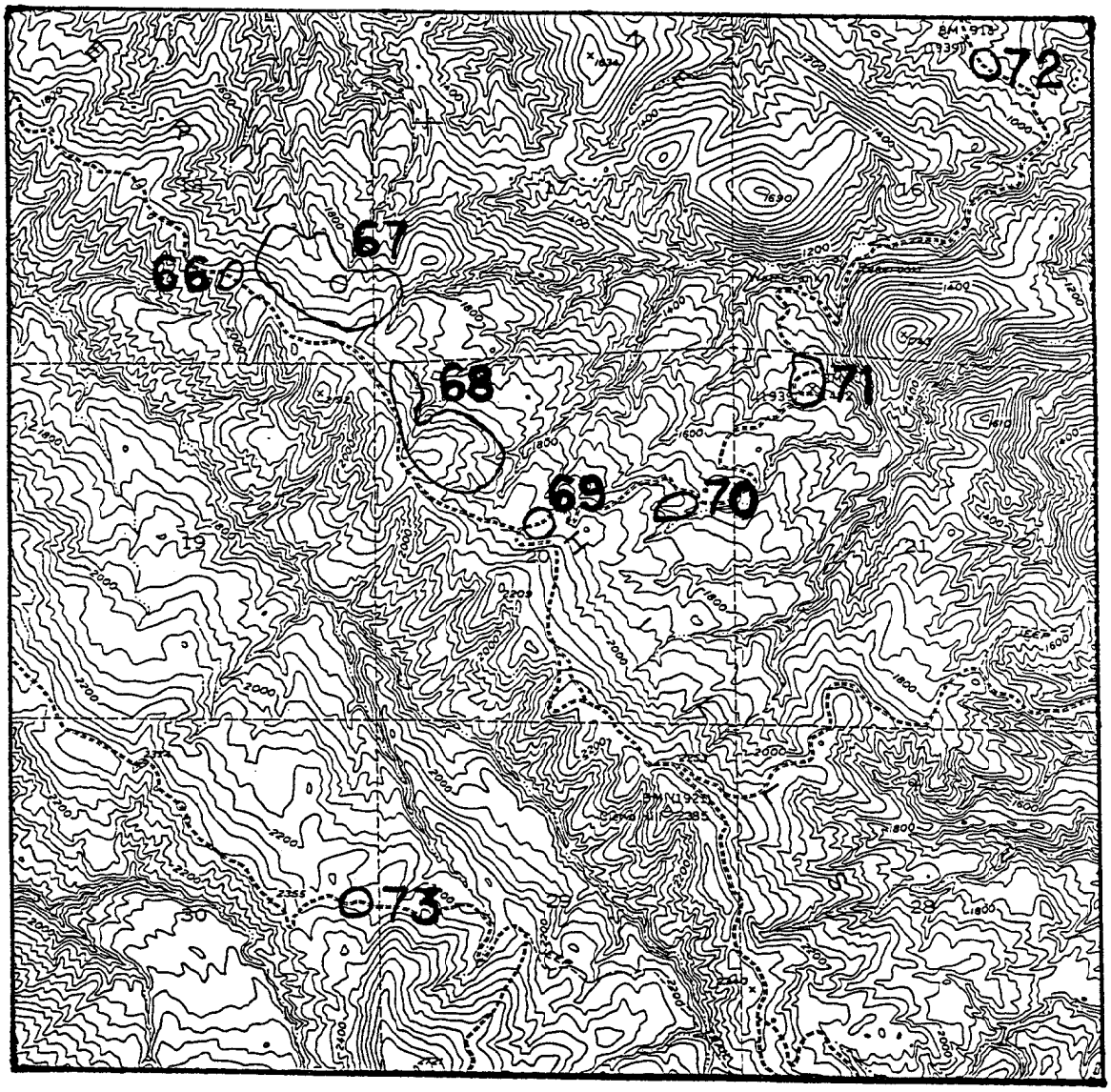
Vegetation: Mainly annual grasses and forbs.

Colony size:

Colony number	Area (hectares)
66[B]	9.22
67[B]	175.41
68[B]	141.65
69[B]	13.68
70[B]	13.53
71[A]	2.14
72[A]	0.92
73[B]	9.67

[A]Colony boundaries estimated.

[B]Total count of precincts.


66
67
68
69
70
71
72
73

Dipodomys ingens

Quadrangle: Monocline Ridge and Ciervo Mountain

T: 16 S and 17 S **R:** 13 E

Sections: 3, 27, 33, 34, and 35

County: Fresno

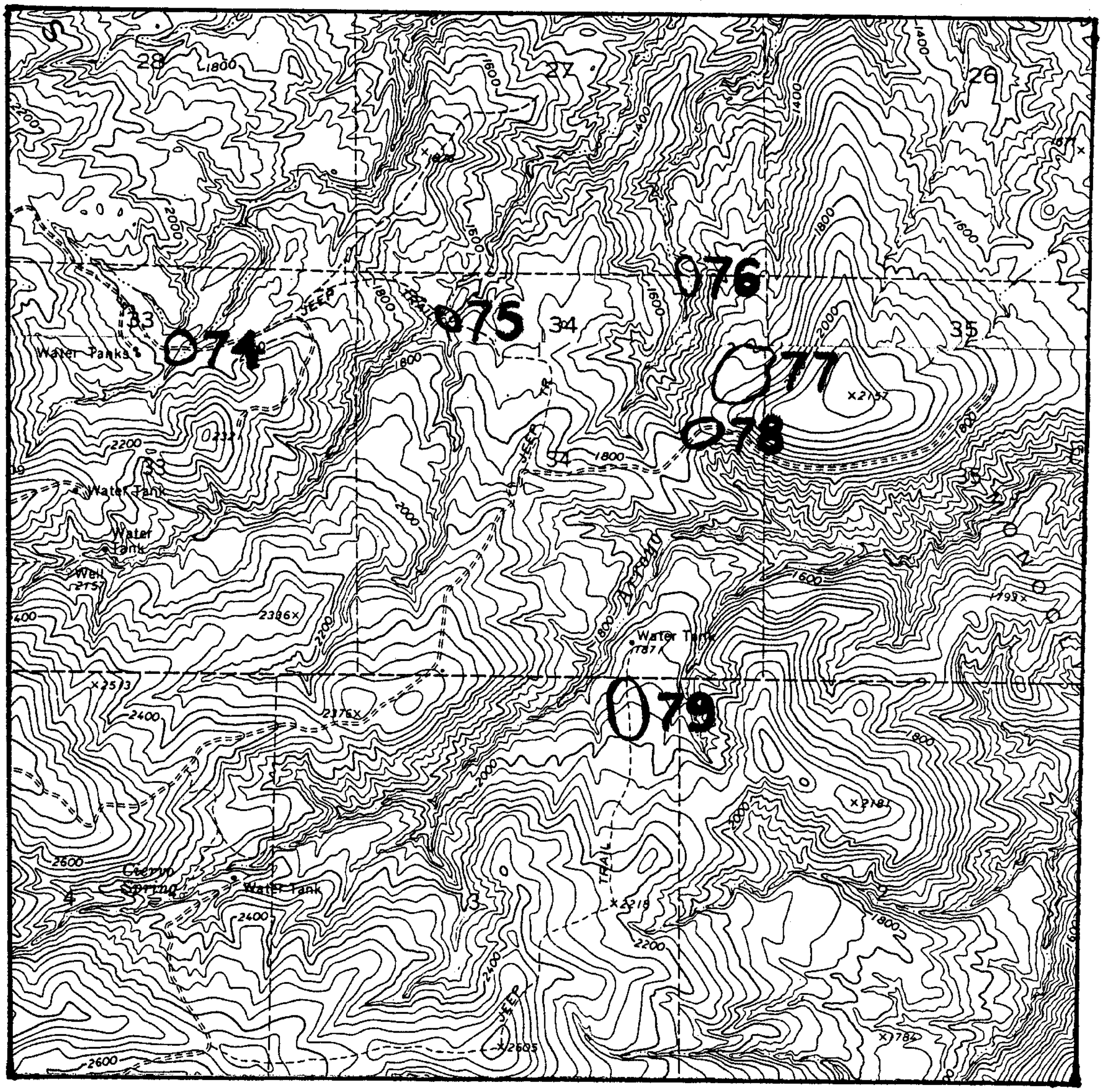
Soil type: Monoridge-Exclose-Badland association. Belgarra-xerothents, scarp association. Monver-Monoridge association.

Vegetation: Mainly annual grasses and forbs.

Colony size:

Colony number	Area (hectares)
74[A]	0.90
75[A]	0.50
76[A]	0.97
77[A]	3.82
78[A]	1.26
79[A]	5.15

[A]Colony boundaries estimated.



74
75
76
77
78
79
Water Tanks
Water Tank
Water Tank
Well
Water Tank
Cervo Spring
Water Tank
JEEP
TRAIL

APPENDIX II

The following is a newspaper account of the population irruption of rodents that occurred in the general study area in 1991 and 1992, based on our observations (Williams et al. 1993; unpubl. data). It is included to document the rarity of this event. In the article and accompanying photographs, animals identified as white-footed mice *(Peromyscus* spp.) are actually McKittrick pocket mice *(Perognathus inornatus neglectus),* based on the photos. We found that the population increases involved all species of rodents in the area, but that only the kangaroo rat and pocket mouse populations exhibited irruptive increases.

Robert Dyer/Telegram-Tribune

Eben McMillan found that a bucket of water makes a good mouse trap — no cheese needed.

Needed: 1,000 cats

By Phil Dirkx
Telegram-Tribune

It's the invasion of the deer mice and kangaroo rats.

It sounds like a science fiction movie but it's been real life in the arid, sparsely populated northeastern region of this county.

During many nights this summer the ground has been alive with thousands, maybe millions, of mice and kangaroo rats. They come out after sunset and disappear before dawn.

"It's a plague of mice," said rancher and naturalist Eben McMillan.

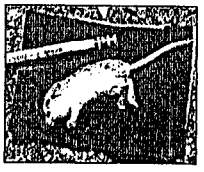
"If I was the only one to see it, I'd be afraid to tell it," said rancher Henry Twisselman.

Twisselman, 85, and McMillan, almost 85, both have lived in that area all their lives and have never seen such large mice and rat populations.

They both live south of Cholame -- McMillan on Gillis Canyon Road and Twisselman on Bitterwater Road. The mice and rats have also inundated ranches in the Carrisa Plains farther south.

McMillan calls the smallest of the invaders white-foot mice. They're also called deer mice, said Brenda Protopapas, agricultural biologist with the county Department of Agriculture.

The kangaroo rats are small brown rodents that are sometimes called long-tail rats.



An unfortunate victim of mass mouse suicide by drowning.

Many of the rodents don't survive their nightly forays and are found dead in partially full buckets and barrels of water.

Grant and Flossie Anderson of Bitterwater Road said they found 43 drowned mice in a half-full barrel of water near their barn one mid-July morning. Since then they've been finding about 40 dead mice in the barrel every two or three days.

About five miles south of their house they looked into a ranch water trough and found 162 dead kangaroo rats.

Flossie Anderson said she now puts a half-full coffee can of water under her ranch house and finds eight or nine dead mice in it every morning.

She said she's never seen any thing like this in the 46 years she'd lived there and her husband said he remembers having lots of mice and rats one year in the early '30, "but nowhere near like this."

Doug Wreden lives farther south on the Carrisa Plains. He said he's been catching about 100 mice per night for the past 3½ months in buckets of water.

But just lately he's noticed the catch is starting to slack off.

"It's overwhelming," he said, "to imagine herds of them," swarming around his place at night.

When Wreden drives at night on Bitterwater Road he sees the mice and kangaroo rats swarming across the pavement. The owl population is way up too, he said, but they haven't eaten enough mice to make a noticeable difference.

Wreden recently laid a 100-foot-long brick walk near his house, he said, but in three weeks 50 feet of it had caved in because so many kanagroo rats had burrowed under it.

His lawn is full of mouse holes, he said, and the mice and rats eat the grass.

"I haven't had to mow it all summer," he said.

They eat other kinds of vegetation and they chew the insulation off the wires on parked cars, he said.

They also get into his house where they chew through wood and shred other things. "They're into everything," he said.

But Twisselman said he hasn't

Please see Mice, A-4

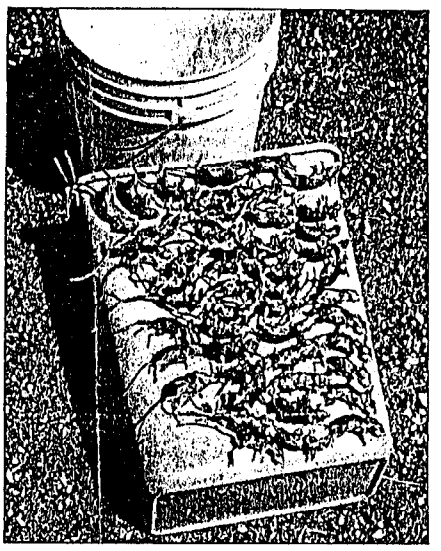


Photo by Eben McMillan

Cholame area resident Eben McMillan took this photo of the mice that drowned themselves in this pail of water one night.

Mice

Continued from A-1

been bothered around his house. "We've got 25 cats," he said.

"We have a cat problem because I won't kill them (the cats)."

Twisselman said people frequently abandon cats near his house. He not only won't kill them, but he buys food for them. The cats usually eat three sacks of dry food in two weeks, he said, but lately they've hardly touched it. They've be feasting on mice.

But they aren't getting fat, he said. Instead they are now in poor condition, he said, because they aren't getting a balanced diet, just mainly protein.

The mice and rats are eating pasture grass, Twisselman said. "The grass is dissappearing," he said. "They're raising the dickens."

McMillan, who lives farther north than the others, said he first noticed the mice population explosion on Aug. 1, while driving home from a barbecue on the Carrisa Plains.

While traveling about 20 miles on Bitterwater Road that night, his grandson counted 507 mice and kangaroo rats crossing the road, he said.

Then he started noticing dead mice each morning in a 5-gallon plastic bucket of water in his yard. The number kept increasing. When it reach about 55 he put out a second bucket.

The most he found in the two buckets in one night, he said, was 157, and the catch has been declining lately.

The ranchers aren't sure how the mice get into the buckets — whether they can climb metal and plastic or whether than just jump in.

McMillan also wonders why they jump into the water at all. They don't have to have water, he said, because their bodies can manufacture their own water from the starchy dry seeds they eat. He feels being overpopulated may interfere somehow with this ability or their instincts.

But the big mystery is why the rodent population exploded this year. Wreden believes it was the good rains last winter and the good grass and feed crop they produced.

But Twisselman said there have been good feed years in the past without a flood of mice and kangaroo rats.

McMillan wonders if the planting of vineyards a few miles away may have made a difference.

He also thinks the seeds and grass this year may have just the right nutritional value to encourage rapid reproduction. Energy is produced by the vegetation, he said.

He expects the plague of mice will soon disappear of its own accord.

"Nature controls the number of animals," he said.

McMillan said the whole thing makes thinking people "believe there's something out there we don't fully understand."

Agricultural biologist Protopapas said she got a similar explanation from the state Food and Agriculture Department.

"Everything just worked this year in that area," she said, "the moisture, weather conditions, grass cover and food supply."

Ground squirrels, meadow mice and other rodents are flourishing as well, she said.

So this year the deer mice and kangaroo rats can be fat and sassy and repoduce at their maximum rate.

A female deer mouse matures in five or six weeks and can produce two to four litters each year with three to five young in each litter, Protopapas said.

"But if there's a drought this winter the numbers could crash," she said.

And rancher Wreden sees a possible long-term benefit from this year's rodent plague.

"They're aerating the ground," he said. "They're creating enough holes that we could get some penetration of any moisture we get."