State of California
THE RESOURCES AGENCY
Department of Fish and Game

THE FRESNO KANGAROO RAT STUDY*
1974

by

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ABSTRACT

The Fresno kangaroo rat (Dipodomys nitratoides exilis), first collected in 1891, was thought to have become extinct until rediscovered in 1934 near Kerman, California. A search was made in 1972-73 within a 15-mile radius of the type locality of the Fresno kangaroo rat. Three populations were found near Raisin City and the continued existence of a population of Fresno kangaroo rats near Kerman was confirmed. All populations were found restricted to the alkali-sink plant community which is rapidly disappearing from western Fresno County. Much of the Raisin City habitat was destroyed in April, 1974, through land levelling and conversion of these native lands to crop land. Destruction of the remaining habitat of the Fresno kangaroo rat will result in extinction of this animal.

Examination of 758 museum specimens and chromosome analysis confirmed the presence of three subspecies of the San Joaquin kangaroo rat (Dipodomys nitratoides). The Fresno kangaroo rat is now threatened with extinction and the status of the Tipton kangaroo rat is undetermined.

* Supported by Federal Aid in Wildlife Restoration, Project W-54-R, "Special Wildlife Investigations" May, 1974. Job II-5.4 Final Report.

RECOMMENDATIONS

Based on the results of this study the following recommendations are made to assure continued survival of the Fresno kangaroo rat:

1. The Fresno kangaroo rat be declared endangered and immediate action be taken to seek its preservation.

2. The remaining native habitat northwest of Raisin City be acquired and established as an ecological reserve for the Fresno kangaroo rat.

3. A search for additional Fresno kangaroo rat populations be immediately undertaken.

4. The status of the Tipton kangaroo rat be determined.

INTRODUCTION

The type specimen of the Fresno kangaroo rat was collected by Vernon Bailey on September 23, 1891, four miles north of the railroad station in the town of Fresno (Merriam, 1894). Merriam described the new subspecies as Dipodomys merriami exilis. He also identified the Tipton kangaroo rat (D. m. nitratoides). In Grinnell's study of the kangaroo rats of California the Fresno kangaroo rat was named D. nitratoides exilis and a third subspecies of this genera of kangaroo rats was identified. This was the short nosed kangaroo rat (D. n. brevinasus) collected 19 miles southwest of Mendota, California (Grinnell, 1922).

The Fresno kangaroo rat was thought to have become extinct until a population was discovered near Kerman, Fresno County in 1934 (Culbertson, 1934). A dispute later developed over the taxonomy of the three subspecies of the San Joaquin kangaroo rat (Boolootian, 1954; Hall, 1959).

The natural history of D. n. exilis has been best explored by Cultbertson (1946). His study was undertaken in the alkali-sink plant community surrounding the town of Kerman. He concluded that the burrow systems are confined to slight elevations and that food storage is very limited. Boolootian (1954) hypothesized that elevated areas are beneficial to the survival of the kangaroo rat because it enables him to survive unfavorable conditions.

Awareness to the disappearance of the alkali-sink plant community of western Fresno County prompted the Department of Fish and Game to recommend to the Fish and Game Commission that they declare the Fresno kangaroo rat to be a rare mammal. This they did on May 21, 1971. A study to determine the current status of this animal was initiated in February, 1972.

OBJECTIVES AND SCOPE OF STUDY

Objectives of this study were to: (1) Determine the current population and distribution of the Fresno kangaroo rat and problems threatening its survival; and, (2) Resolve its taxonomic status.

The study became a two phased project. Efforts were first directed towards locating populations of D. nitratoides within the vicinity of Fresno, determining population dynamics and habitat preference, and identifying problems affecting survival of these populations. The second phase was to resolve the taxonomic status of the Fresno kangaroo rat.

STUDY METHODS

Distribution

To facilitate the search for populations of Fresno kangaroo rat an arbitrary 15 mile radius circle was drawn around its type locality (Map 1,

appended). The circle was then divided into quarters for ease of reference and the search was initiated in February, 1972.

The California Department of Water Resources in their land and water use studies photographed the San Joaquin Valley. These 1965 aerial photographs revealed the areas of native vegetation[1/] remaining in the area encompassed in the study. These areas were delineated on topographic maps. Approximately 80 percent of the native vegetation areas so recorded were visited. For each area, the following information was recorded: soil type, topographic features, vegetation, and presence of kangaroo rat burrows and tail "draggings."

Only a few of the areas within the survey were the alkali-sink plant community most characteristic of the habitat described for the Fresno kangaroo rat. These areas are shown on Map 1, appended. After all habitat had been surveyed in the southwest quarter, the five most likely habitat areas supporting kangaroo rats were selected as major trapping sites. Twenty traps were set for 3 nights or until D. nitratoides was caught. For the marginal habitats, trapping was limited to 5 traps set for 3 nights. The northwest quarter and southwest quarter were sampled in this manner. Although the northeast and southeast quarters were searched for kangaroo habitat, they were not trapped because of the absence of suitable habitat and kangaroo rat sign. Only once did the trapping extend beyond the 15 mile radius. This was an area 6.5 miles west of Kerman which was trapped for 1 night with 20 traps to confirm the presence of D. nitratoides as reported by Boolootian (1954).

Single entry live traps measuring 12" x 5" x 5" and manufactured by the National Live Trap Corporation were used. Traps were baited with rolled barley.

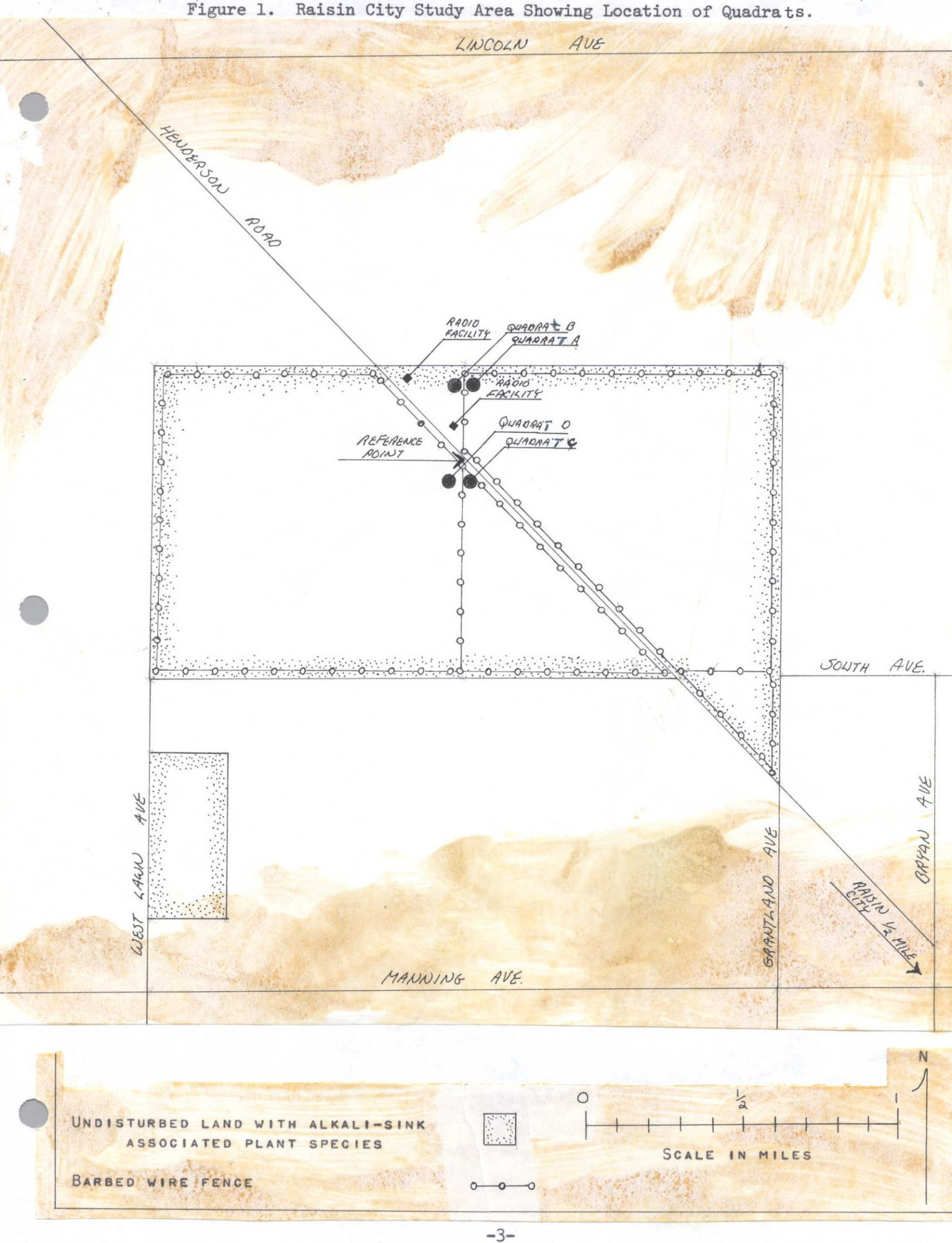
Habitat and Population Dynamics

A Fresno kangaroo rat population was found 2.5 miles northwest of Raisin City, Fresno County, California. It was here that a detailed study of the habitat and population dynamics of the rat was initiated. All the vegetation and rodent sampling within the selected study area was done within 200' x 200' areas, hereafter referred to as quadrats. Four quadrats were set as shown in Figure 1. Each pair of the four quadrats were set 400 feet apart on opposite sides of a fence line. To facilitate ease of data collection, the quadrats were no more than 1/4 mile from Henderson Road. The exact quadrat distance (less than 1/4 mile) from the road was chosen at random.

A plant survey of the 4 quadrat was undertaken on March 25, 1972. Each quadrat was sampled systematically with an inclined point frame. At each sampling place (sampling places were approximately 45 feet from

1/ Fallow field vegetation and native vegetation are difficult to separate in aerial photographs.

Figure 1. Raisin City Study Area Showing Location of Quadrats.



another sampling place) 10 points were sampled and plant species hit were recorded. Each quadrat had 20 "sampling places" thus, 200 points. The vegetative cover was then calculated for each quadrat and expressed in percent.

Trapping was begun on February 10, 1972 for Quadrats A and B, and on April 6, 1972 for Quadrats C and D. The trapping was continued until December 31, 1972. Twenty-five traps were set in each quadrat. These traps were spaced 40 feet apart with 5 traps in each row and 5 traps in each column. The "square" (run-lines from the 4 corner traps) of traps thus measured 160 feet on each side. This "square" was then situated in the middle of the quadrant. The traps were individually numbered for easy reference. The series of traps were operated from dusk to dawn for 4 days running. Kangaroo rats caught were sexed, weighed, toe clipped using Melchior and Iwen's (1965) system, and released. The same information was also recorded on recaptures.

Rodent population density estimations for each quadrat were calculated by Eberhardt's (1969) method in which

$$N = \frac{(n_1 + 2n_2)\ (n_1 \times n_2)}{2n_2}$$

N is the population estimate,

n_1 is the number of animals captured in both periods, and

n_2 is all other animals captured.

It should be pointed out that Eberhardt's method of trapping called for a prebaiting period and movement of the traps after the marking period. This was not done. In the population density estimates it was assumed that sampling area per quadrat was 40,000 square feet.

The number of rats per acre was obtained by first dividing 43,560 square feet (feet per acre) into 160,000 square feet (total area of the 4 quadrats). The result was then divided by the estimated number of animals present in the 4 quadrats for the trapping period. The estimated number in the 2 square mile, Raisin City study area, was obtained by multiplying the number of rats per acre by 1,280 (number of acres in 2 square miles).

Systematics

Once the presence of *D. nitratoides* was confirmed the live trapping efforts were directed towards resolving the taxonomic status of this genus. Through literature search and correspondence specimen collections were located and requests made to receive these on loan for examination. Received were 758 specimens from the following collections: United States Biological Survey; California State University, Fresno; Museum of Vertebrate Zoology,

University of California, Berkeley; Los Angeles County Museum; and, private collections of R. A. Boolootian and W. Hoffman.

Recorded from specimen tags of each collection were collection number, date, sex, locality, weight, total length, tail length, and hind foot length. Cranial measurements were taken on each specimen as well as ear measurements. The mid-dorsal pelage shade was quantified using a photo-electric reflectometer.

To aid in data interpretation, 671 museum specimens of D. nitratoides from 79 different localities were examined. These specimens were separated into 3 age categories (juvenile, young adult, and adult) by Lidicker's (1960) method of age classification. The months in which females with embryos present were also noted.

In order to facilitate data handling 70 specimen locations were grouped into 13 specific geographical localities. Care was taken not to group specific localities across previously established taxonomic geographical boundaries. The mean, range, and standard deviation were computed for the 14 measurements of the specimens which had been grouped into the 13 geographical localities. Duncan's multiple range test for unequal sample sizes as used by McGuigan (1968) was adopted to identify significant differences (at the 5 percent level). All of the above computations (excepting range) were performed by a CAC 3150 computer at the California State University, Fresno. The programs ST1310 and ST1502 were written by Ronald Langley.

Chromosome Analysis

Six different specimens of D. nitratoides from three different areas were trapped and analyzed for chromosome constitution. The metaphase chromosomes of bone marrow cells were prepared for analysis by Patton's (1967) method. An average of 10 metaphase cells per individual were counted to determine the specimen's diploid number. In no case did variation from the diploid number chosen exceed 18 percent.

Chromosomes were arbitrarily paired with their presumed homologous chromosomes. Size and shape determined which chromosomes were paired. In the case of a polymorphic autosome, it was paired with its speculated homologue. After the chromosomes were paired they were grouped morphologically using a three class system based on relative chromosome arm ratios.

Details of the systematics of Dipodomys nitratoides is best described--by Hoffman (1974) in his M.A. thesis submitted to the California State University, Fresno.

RESULTS

Distribution Survey

Results of the search of the type locality are best illustrated on Map 1, appended. Out of 237 possible habitat areas observed, 38 of these areas

were trapped. Of the 38 areas trapped, Heermann kangaroo rats (Dipodomys heermanni) were captured at 10 locations. The Fresno kangaroo rat was captured at 4 locations of the undisturbed alkali-sink plant community.

Habitat and Population Dynamics

Plant survey results are listed in Table 1. Quadrat B, the ungrazed quadrant, had a significantly higher occurrence of dead vegetation and Hordeum hystrix than Quadrant A. The heavily grazed Quadrant D had high percentages of bare ground and Erodium; whereas, the moderately grazed area on the opposite side of the fence (Quadrant C) contained higher percentages of Festuca megalura and Bromus rigidus. Suaeda fruticosa, the dominant shrub of three of the study areas, was absent from Quadrant D.

Figures 2-4 illustrate the difference in plant composition on Quadrats A to D, Raisin City Study Area.

Figure 2. Moderately Grazed Area Which Includes Quadrat A.

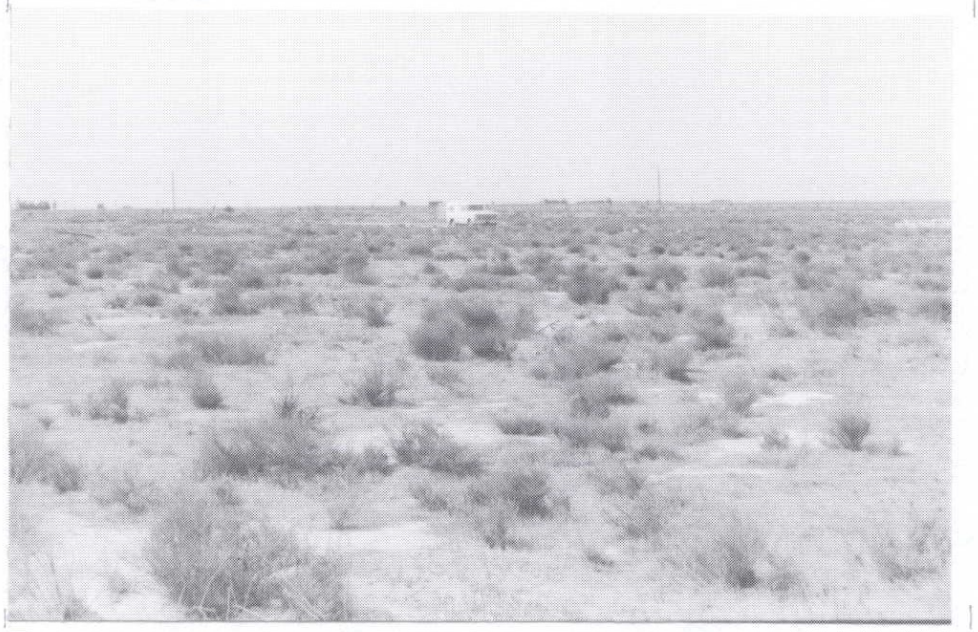


Figure 3. Nongrazed Area Which Includes Quadrat B.

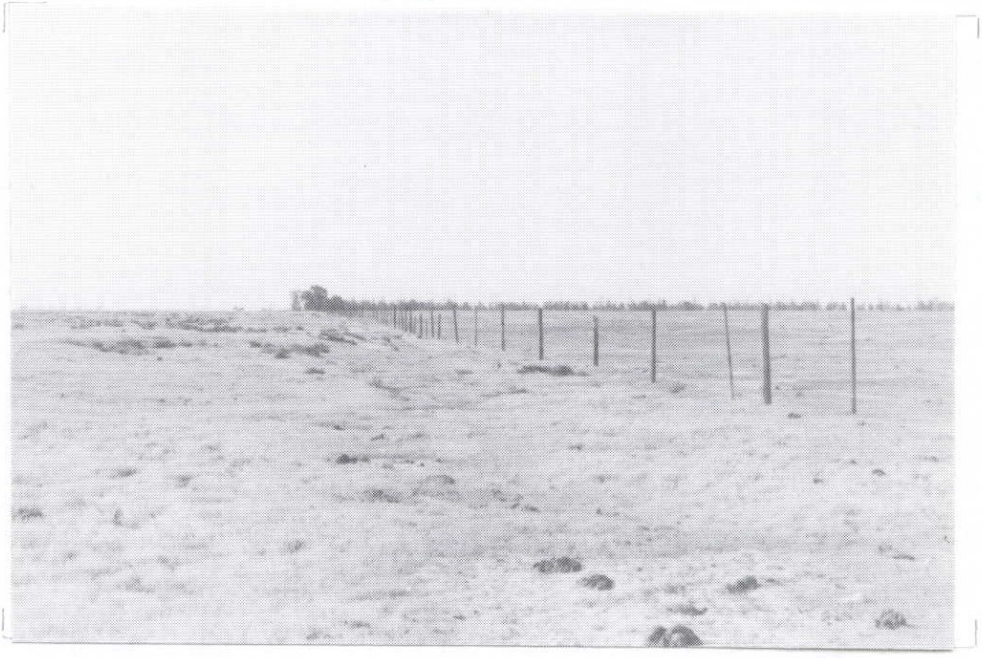


Figure 4. Severely Grazed Area Which Includes Quadrat D is to the Right of the Fence Line, Moderately Grazed Area Which Includes Quadrant C is to the Left of the Fence Line.

Table 1

Plant Composition of Quadrats

	Quadrat A	Relative Quadrat B	Percent Cover Quadrat C	Quadrat D
Bare ground	45.8	36.6	32.7	53.2
Dead vegetation	2.0	14.6	2.9	2.0
Erodium circutarium	10.2	6.8	1.4	3.4
Erodium[1/]	5.4	.5	22.6	24.9
Suaeda fruticosa	7.3	6.8	4.8	---
Festuca megalura	10.7	5.0	11.1	3.9
Bromus rigidus	.5	5.0	12.5	3.4
Hordeum hystrix	.5	10.5	1.0	---
Hordeum leporinum	---	---	4.3	---
Bromus mollis	---	1.4	---	---
Distichlis spicata	1.0	.5	---	---
Lepidium nitidum	12.7	6.8	---	2.9
Lasthenia chrysostoma	1.5	.5	---	.5
Hemizonia pungens	---	1.8	.5	1.0
Gilia sp.	---	---	1.0	.5
Amsinckia sp.	---	.5	---	---
Other, too small to tell	2.4	2.7	5.3	4.4
Trash	---	---	---	---

1/ *Erodium* sp. other than *Erodium circutarium*.

Trapping results are summarized in Tables 2 and 3. Figures 5-9 graphically depict trapping results in the quadrats established on the Raisin City Study Area. The main points to note are: (1) the relatively high densities of rats in May shown in Figure 5; (2) the low rate of recapture of individuals in different trapping periods shown in Table 3; and, (3) the low number of individuals caught in the ungrazed Quadrat B shown in Figure 6.

The number of kangaroo rats per acre appears to fluctuate monthly (April through December) between 6.8 and 10.1 individuals. The total population in the 2 square mile habitat area appears to vary from 10,000 to 13,000 individuals.

To determine reproductive cycle the museum specimens were examined and grouped into the 3 age categories. These are shown in Figure 10. Adults appear to be the most numerous, especially in winter months. Juveniles show their greatest abundance in the spring and early fall and young adults appear most abundant in the fall. Females with embryos were found in all months except June, August, and December.

DISCUSSION

The Fresno kangaroo rat is associated with the alkali-sink plant community once characteristic of western Fresno County. On the Raisin City Study Area, moderately grazed to heavily grazed areas seem to be preferred over nongrazed areas. Relatively low numbers of kangaroo rats were present in nongrazed Quadrat B whereas the moderately grazed Quadrat C on the opposite side of the fence maintained a fairly high population. This difference in rat density may be attributable to a combination of two factors. According to Bartholomew and Caswell (1951) dense vegetation may adversely affect kangaroo rat locomotion. Boolootian (1954) believed that level land was detrimental to kangaroo rat populations due to the amount of standing water in the winter. Since both of these situations occur in Quadrat B, it is difficult to tell which of the factors is most significant. It is worthy to note, however, that the greatest number of kangaroo rats in Quadrat B occurred during the wettest months of the survey. This would leave one to believe that the Bartholomew and Caswell hypothesis is supported by the results of this study.

Population structure appears to vary considerably depending on the time of year. Chew and Butterworth (1959) reported the gestation period of Merriam kangaroo rat (Dipodomys merriami) (a close relative of D. nitratoides) as being 33 ± 2 days. Newborn Fresno kangaroo rats begin to forage as early as 5 weeks (Culbertson, 1946). Using the above investigator's observations and data from Figure 10, it appears that intense reproductive activity takes place in late February, peaks in April, and continues until September. The mid-summer months of July and August exhibit low numbers of juveniles which is an indication of a slack in reproduction in the months of May and June. This "slack," however, is probably more artificial than real because there was no percentage decrease in the number of young adults in the months of September and October which would be characteristic of a decrease of

Table 2

Capture Results of Dipodomys nitratoides
in Raisin City Study Area

	Quadrats	First Two Night Captures	Second Two Night Captures	Recaptures From First Two Nights	Total Trap Nights	Total Individuals Captured
Feb. 10-13, 1972	A	5	4	4	100	5
Apr. 6-9, 1972	A	5	6	2	100	8
May 26-29, 1972	A	9	5	3	100	11
Sept. 14-17, 1972	A	5*	2	2	100	5
Dec. 28-31, 1972	A	6***	4*	2	100	9
Feb. 10-13, 1972	B	0	0	0	100	0
Apr. 6-9, 1972	B	1	2	0	100	3
May 26-29, 1972	B	1	1	0	100	2
Sept. 14-17, 1972	B	0	1	0	100	1
Dec. 28-31, 1972	B	3	2	1	100	4
Apr. 6-9, 1972	C	0	1	0	100	1
May 26-29, 1972	C	4	6	3	100	7
Sept. 14-17, 1972	C	10**	4	3	100	11
Dec. 28-31, 1972	C	6**	1	0	100	7
Apr. 6-9, 1972	D	5	6	3	100	8
May 26-29, 1972	D	7	11*	5	100	13
Sept. 14-17, 1972	D	5	5	3	100	8
Dec. 28-31, 1972	D	9*	3	3	100	9
	TOTAL	80	64	34	1,800	112

* One died in trap.
** Two died in traps.
*** Three died in traps.

Table 3

Length of Occupation of *Dipodomys nitratoides* in the Quadrats

	Individuals Captured in One Trapping Period Only	Individuals Captured in Two Trapping Periods Only	Individuals Captured in Three Trapping Periods Only	Individuals Captured in Four Trapping Periods Only
Quadrat A	25***	5*	1	0
Quadrat B	5	2	0	0
Quadrat C	7*	6***	1	1
Quadrat D	10	9**	2	1****
TOTAL	47	22	4	2

* One died in trap.
** Two died in traps.
*** Three died in traps.
**** Originally trapped in Quadrat B.

Figure 5. Quadrat A Capture Results

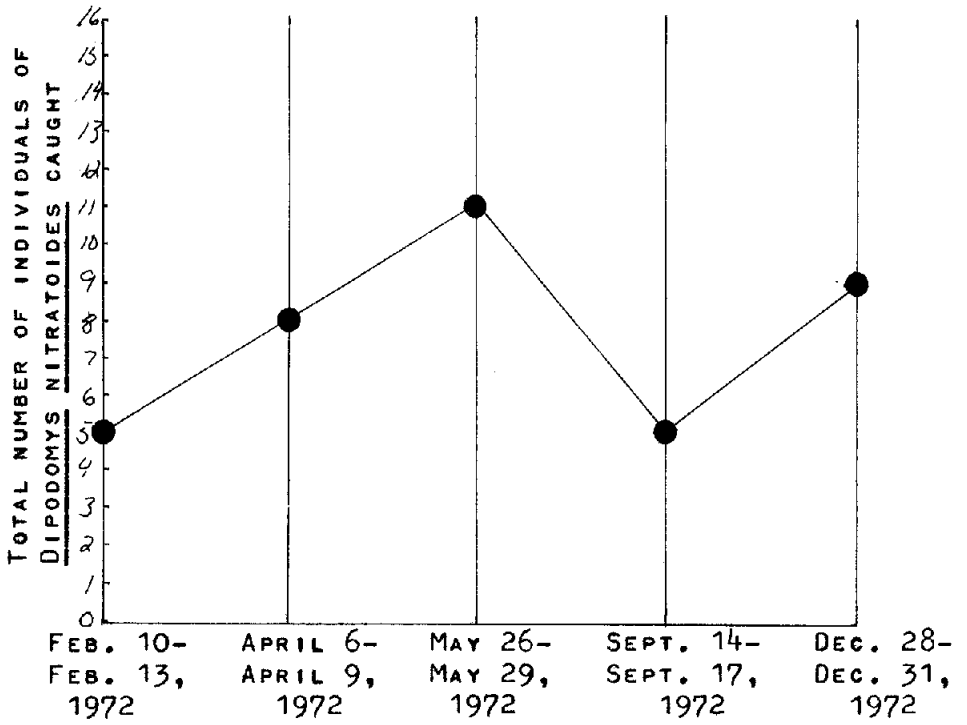


Figure 6. Quadrat B Capture Results

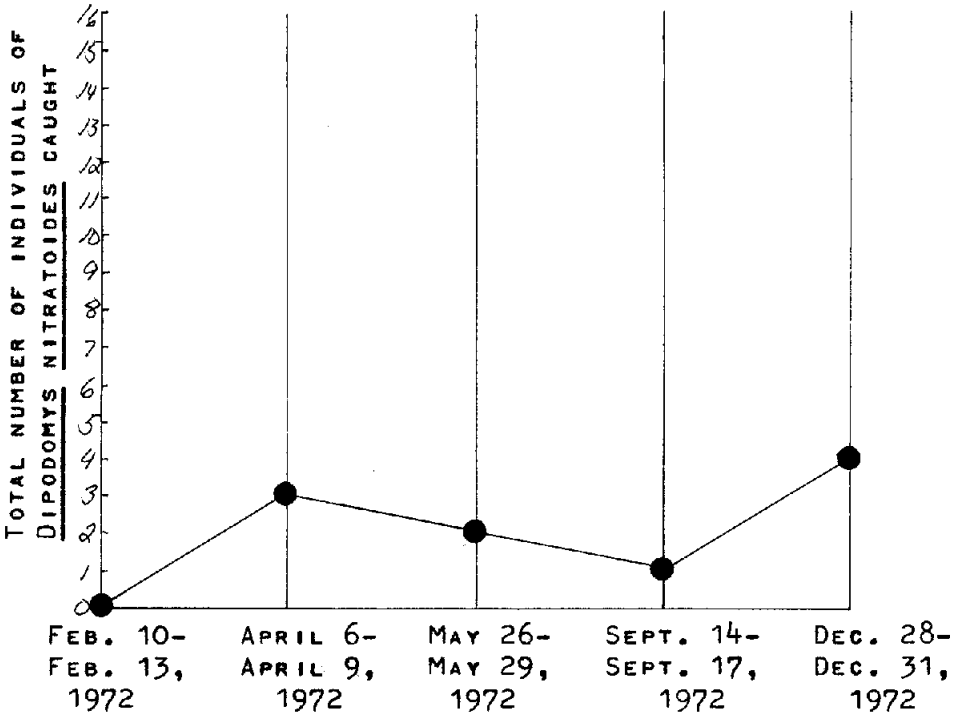


Figure 7. Quadrat C Capture Results

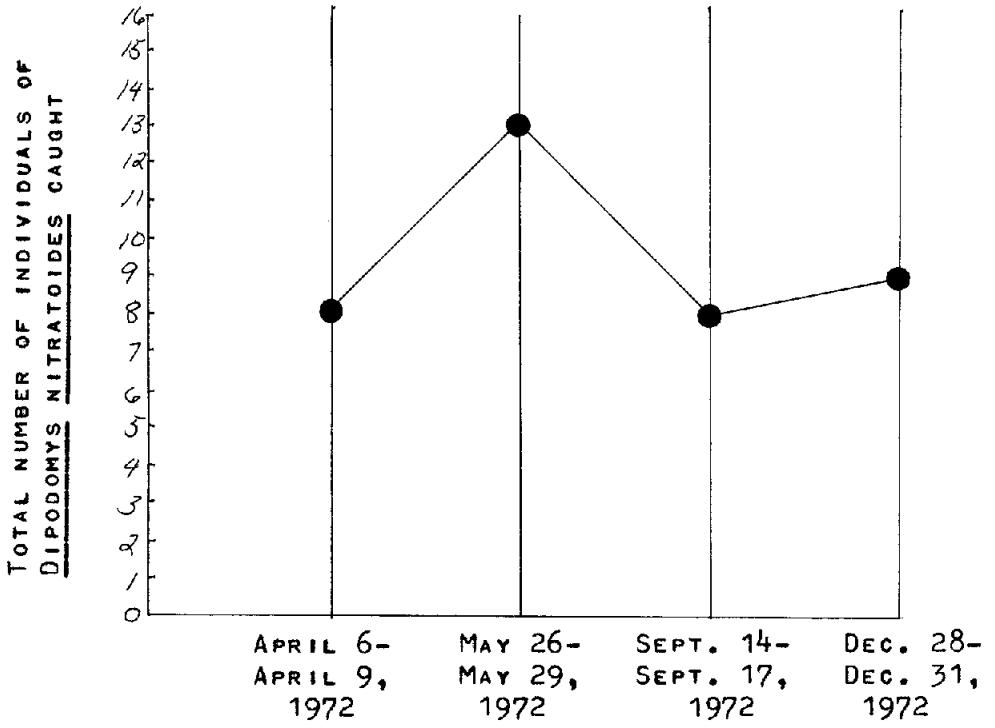


Figure 8. Quadrat D Capture Results

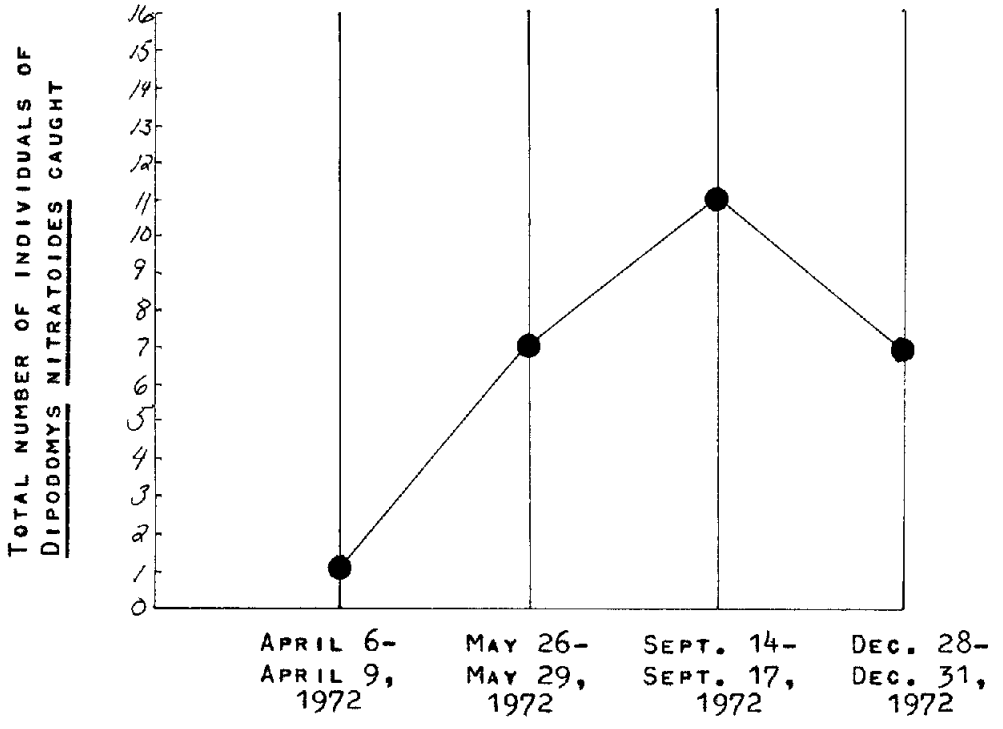


Figure 9. Capture Results For All Quadrats

Cumulative Scores of Quadrats A, B, C, and D

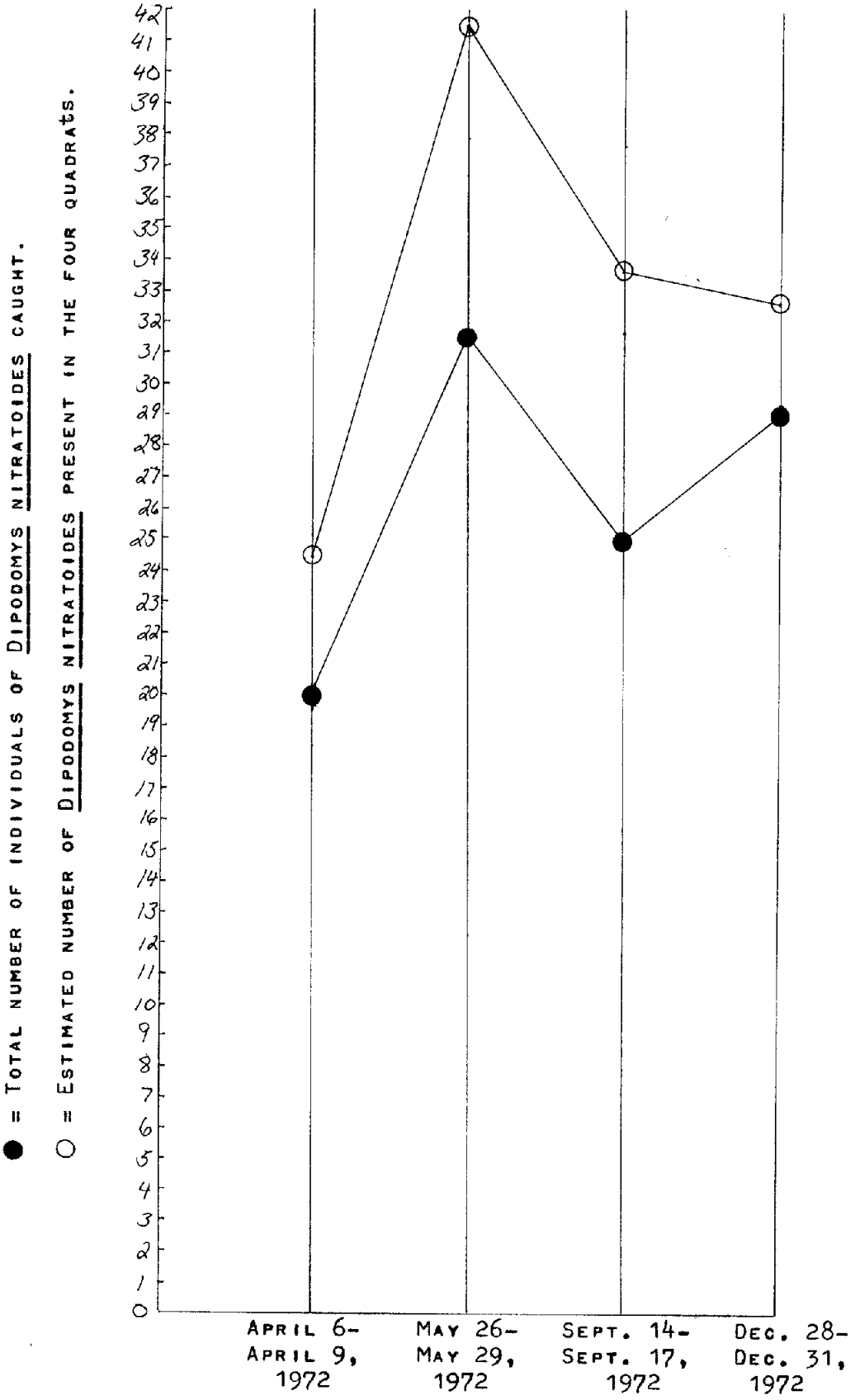
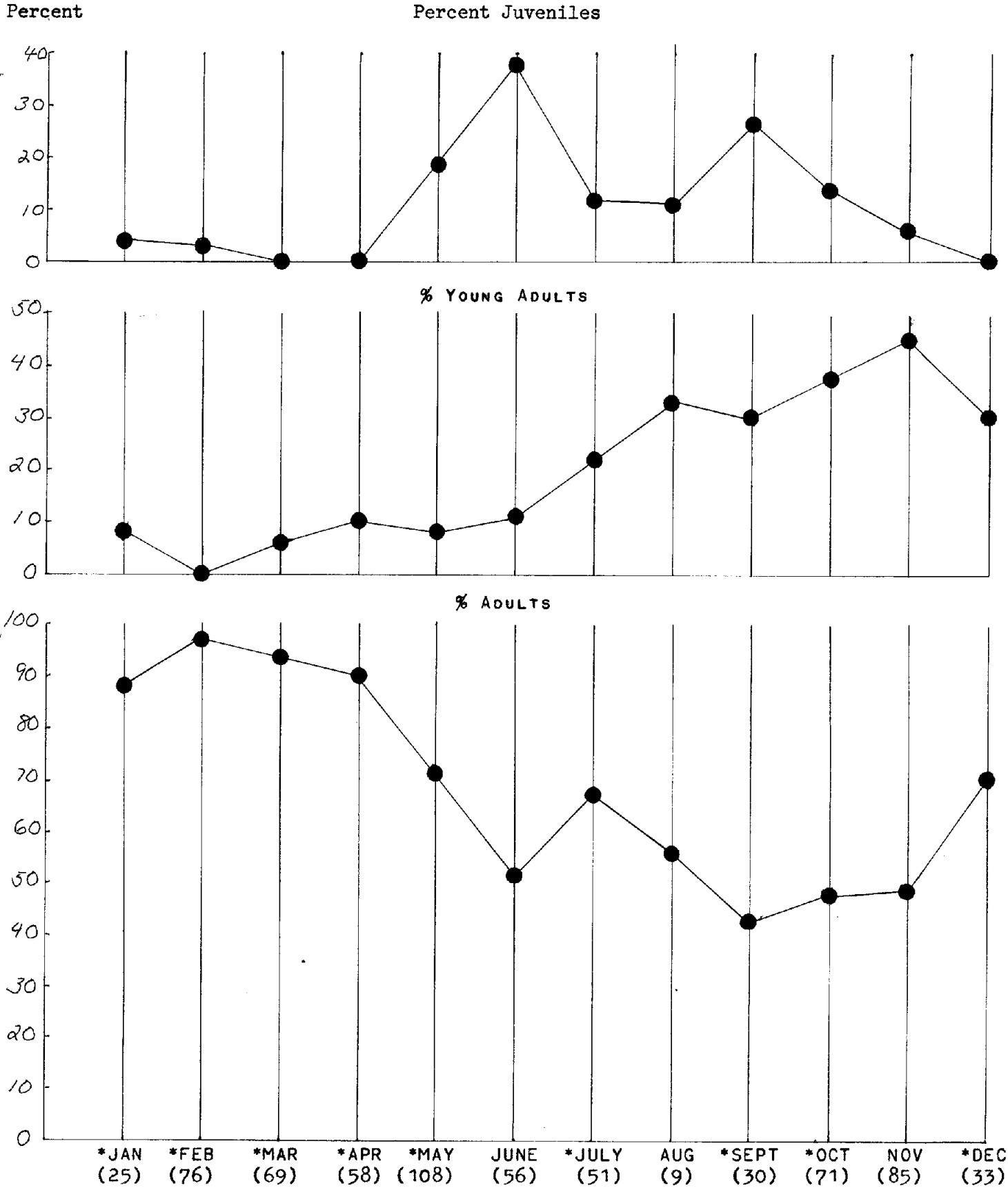


Figure 10. Age Structure of Museum Specimens



GRAPHS OF POPULATION STRUCTURE SHOWING THE MONTHLY CHANGES IN MEAN PERCENTAGES OF JUVENILE, YOUNG ADULT, AND ADULT SPECIMENS OF D. NITRATOIDES. THE 671 SPECIMENS ARE FROM 79 DIFFERENT LOCALITIES. THE NUMBER IN PARENTHESES IS THE NUMBER OF SPECIMENS THAT WERE EXAMINED FOR THE MONTH IN QUESTION. MONTHS WITH * INDICATE FEMALE(S) WITH EMBRYO(S) FOUND.

reproductive activity in the months of July and August. The above conclusions regarding population structure should be viewed somewhat cautiously since the forage time of 5 weeks was based on Culbertson's observation of one kangaroo rat. Obviously, there is need for a more intense life history study before logical conclusions can be made.

Rodent population density estimates based on one year's data are notoriously unreliable due to a combination of different factors, the most common of which is rainfall. Therefore, the figures of 6.8 to 10.1 kangaroo rats per acre should be regarded as a tentative estimate at best. The reason for the substantial increase in density in late May is probably due to the influx of spring-born young. The density then begins to taper off in the fall. Perhaps this is due to the elimination of some of the unfit juveniles and older adults.

What specifically is the controlling factor in population density fluctuations? This remains the unanswered question. The time of grazing and amount of grazing are obviously involved. Reynolds (1958) found that the direct and indirect effects of percipitation seemed to be the most potent factors determining the Merriam kangaroo rat numbers. This may also be a major factor in the Fresno kangaroo rat's density; however, with just 1 year's data no speculations can be made.

Table 3 indicates a relatively short life span for the Fresno kangaroo rat. This conclusion should be rendered cautiously. It is possible that many of the marked individuals moved out of the quadrant area. One individual not only moved out of Quadrat B, but moved 1,600 feet into Quadrat D.

The distribution of the Fresno kangaroo rat within the Fresno area has been decreased dramatically. At the 16 sites[4/] reported, no Fresno kangaroo rats were found. Of these sites only one was not under cultivation.

Without doubt the main factor leading to the extinction of the Fresno kangaroo rat is the conversion of native habitat to agriculture. There were no instances where rat populations were found to inhabit crop land or fallow fields.

Although both the Heermann kangaroo rat and Fresno kangaroo rat historically inhabited much of the same terrain, the Heermann kangaroo rat appears to be more flexible. It was found in a wide variety of marginal habitats such as old field vegetation, ungrazed areas, and severely grazed areas not occupied by the Fresno kangaroo rat.

4/ The museum specimens supplied the number of sites, location of the sites, and last date of capture of D. nitratoides from the sites represented on Map 1.

Taxonomic Conclusion

This study supports Grinnell's (1922) thesis that there is a Fresno kangaroo rat Dipodomys nitratoides exilis. Its current distribution is east of the Fresno Slough and north of the Kings River. Figure 11 summarizes the distribution of the three subspecies of Dipodomys nitratoides. Evidence supporting these findings are found in Hoffman (1974).

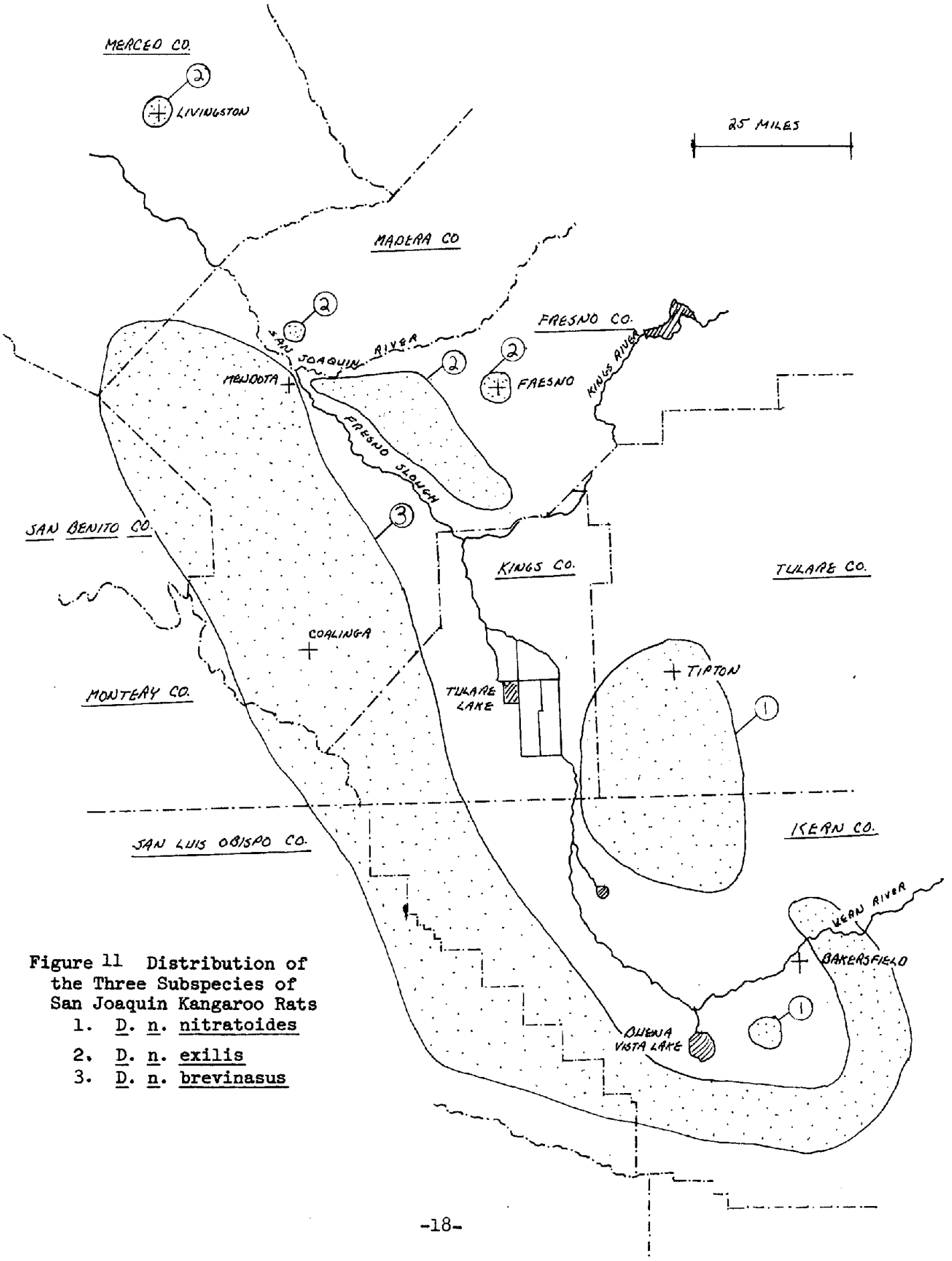


Figure 11 Distribution of the Three Subspecies of San Joaquin Kangaroo Rats

1. D. n. nitratoides
2. D. n. exilis
3. D. n. brevinasus

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RAISIN CITY STUDY AREA

Location: The study area is located two and one-half miles northwest of Raisin City, Fresno County, California.

Description: The study area does not fit rigidly into either the valley grassland or alkali-sink plant communities described by Munz (1968). The dominant plant of the area is the perennial shrub Suaeda fruticosa. This is, however, noticeably less abundant in the several grazed areas. Winter annuals such as Erodium sp., Festuca megalura, and Bromus rigidus form the majority of the smaller herbs. The soil in the habitat area is predominantly Fresno fine, sandy loam.

If the quadrat were to be classified according to grazing pressure, Quadrat B would be ranked nongrazed, Quadrats A and C would be ranked as moderately grazed, and Quadrat D would be ranked as severely grazed. To facilitate a perception of the grazing areas of which each quadrant is a part, the fence lines have been included in Map 2 and pictures of the respective grazing areas which include the quadrats are included in Figures 7, 8, and 9.

The plant composition of each of the four quadrats adequately presented in Table 1 and need not be repeated here. The physical features and grazing history of the respective quadrats is, therefore, given below.

Quadrat A has slightly rolling terrain with elevation variations from 1 to 4 feet. **This area is under absentee land ownership; therefore, knowledge** of past grazing practices is limited. According to Mr. Morris, landowner, 70 head of cattle were taken off the land in July, 1971. At present only two horses graze the fenced area (approximately 550 acres)--of which Quadrat A is a part.

Quadrat B is flat and has not been subjected to grazing for 10 to 12 years.

Quadrat C's terrain is slightly rolling with elevation variations from 1 to 4 feet. Quadrat C's area is also owned by Mr. Morris. According to Mr. Morris, 70 head of cattle were taken off the approximately 300 acre fenced region (of which Quadrat C is a part) in November or September, 1971. No domestic animals presently graze the area.

Quadrat D, like Quadrat A and C, is in slightly rolling terrain with elevation variations from 1 to 4 feet. Quadrant D's area has been severely grazed by cattle since the 1940's. Forty head of cattle were put on Quadrat D's area on September, 1971 and were taken off approximately one year later. At present no domestic animals graze the area.

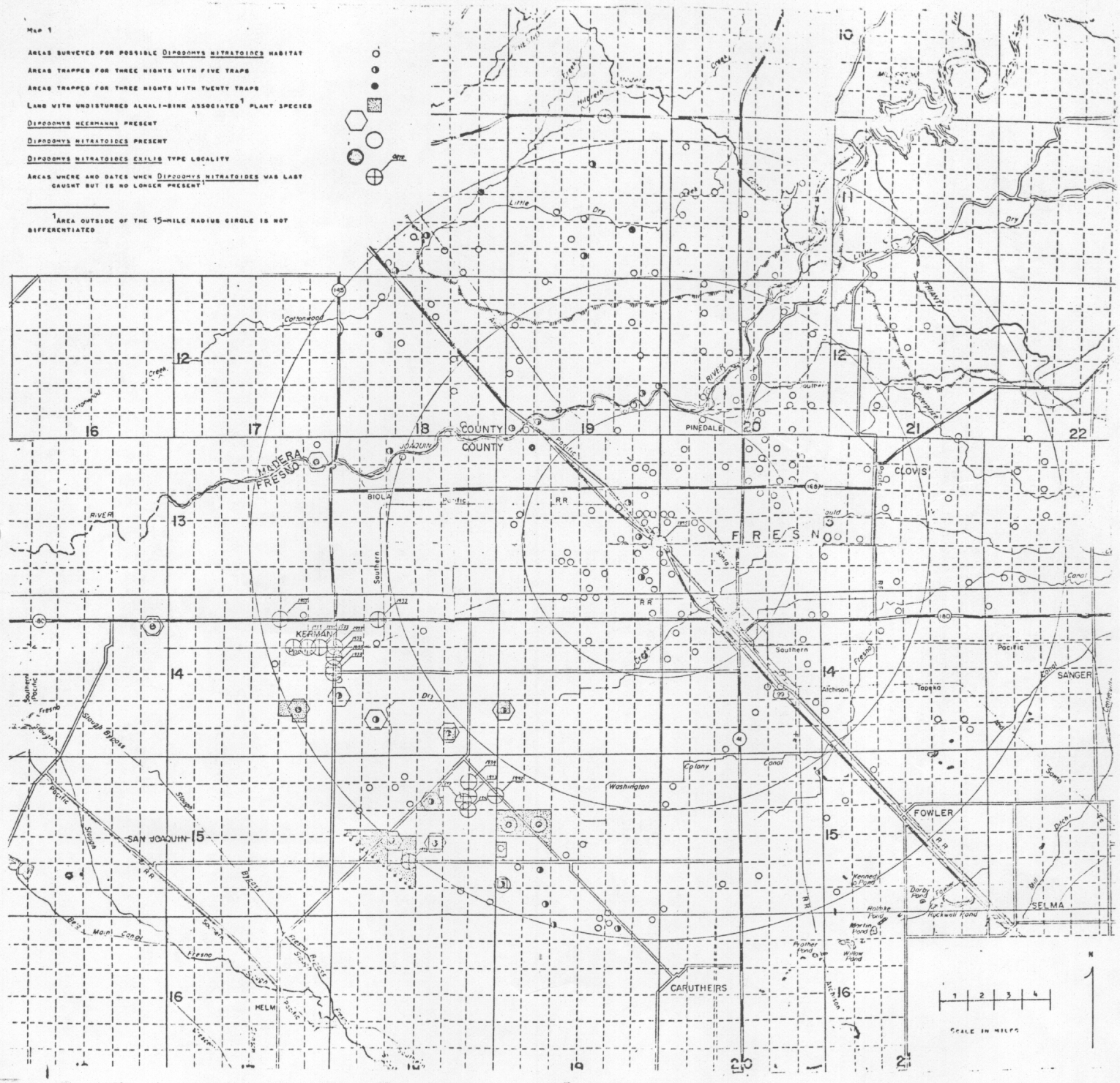
Quadrat Location: The exact quadrat locations are best found with respect to a reference point. The reference point (on May 2) is where Section 18 and Section 17 intersect Henderson Avenue. A barbed wire fence runs due north and due south from this point.

The center of Quadrat A is 1,200 feet north and 200 feet east of the reference point.

The center of Quadrat B is 1,200 feet north and 150 feet west of the reference point.

The center of Quadrat C is 400 feet south and 200 feet east of the reference point.

The center of Quadrat D is 400 feet south and 200 feet east of the reference point.


Map 1
Areas surveyed for possible Dipodomys nitratoides habitat
Areas trapped for three nights with five traps
Areas trapped for three nights with twenty traps
Land with undisturbed alkali-sink associated[1] plant species
Dipodomys heermanni present
Dipodomys nitratoides present
Dipodomys nitratoides exilis type locality
Areas where and dates when Dipodomys nitratoides was last caught but is no longer present[1]
[1] Area outside of the 15-mile radius circle is not differentiated
one
COUNTY
MADERA
FRESNO
PINEDALE
CLOVIS
FRESNO
BIOLA
KERMAN
SANGER
FOWLER
SELMA
CARUTHERS
SAN JOAQUIN
HELM
Cottonwood
Little Dry
Dry
Canal
Pacific
Southern
Atchison
Topeka
Santa Fe
Washington
Colony
Slough
Bypass
Main Canal
Kennedy Pond
Darby Pond
Rockwell Pond
Hoffike Pond
Martin Pond
Fischer Pond
Willow Pond
Scale in miles
N