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LIFE HISTORY STUDY
OF THE
SAN JOAQUIN KIT FOX

by

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Wildlife Management Branch 1/

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INTRODUCTION

The San Joaquin kit fox (Vulpes macrotis mutica) is classified by the California Fish and Game Commission as a protected furbearing mammal. The Secretary of the Interior has deemed it an endangered species.

A study to determine the current status of the San Joaquin kit fox was undertaken by Special Wildlife Investigations in July 1969. Results of this study have been published as a Wildlife Management Branch Administrative Report No. 70-2 "San Joaquin Kit Fox, Its Distribution and Abundance" (Laughrin, 1970).

To learn more about the habits and behavior of this endangered species, a life history study of a colony of San Joaquin kit foxes was initiated in April 1970. Primary objectives were to gather information on reproduction, survival, movements and activity, food habits and habitat requirements.

THE STUDY AREA

The study area is approximately one square mile and lies adjacent to the Elk Hills Naval Petroleum Reserve 15 miles northeast of the town of Taft, Kern County. This area in Buena Vista Valley was located by Herbert Hagen, California Department of Fish and Game and Richard Fiant, U. S. Fish and Wildlife Service in February, 1970.

The vegetation is a combination of Alkali Sink and Valley Grassland communities as described by Munz and Keck (1965). The dominant shrub is saltbush (Atriplex polycarpa). Annual grasses covering the plains and hills consist primarily of Vulpia reflexa and Bromus rubens L.

Elevation on the valley floor is approximately 1000 feet, with elevations in the immediately adjacent hills rising to 1200 feet. Nearby Elk Hills rise to over 1500 feet. The valley plain, approximately 1.3 miles wide, is broken by numerous dry washes. The soil in the entire area, including the hills, is sandy.

Animals in the area include:

Mammals

- San Joaquin kangaroo rat - Dipodomys nitratoides
- Giant kangaroo rat - D. ingens
- San Joaquin antelope ground squirrel - Ammospermophilus nelsoni
- Beechey ground squirrel - Otospermophilus beecheyi
- Deer mouse - Peromyscus maniculatus
- Southern grasshopper mouse - Onychomys torridus
- Black-tailed hare - Lepus californicus
- Audubon cottontail - Sylvilagus audubonii
- Badger - Taxidea taxus
- Coyote - Canis latrans
- Long-tailed weasel - Mustela frenata

Reptiles

- Leopard lizard - Crotaphytus wislizenii
- Desert horned lizard - Phrynosoma platyrhinos
- Gopher snake - Pituophis melanoleucus
- Western prairie rattlesnake - Crotalus viridis viridis

Birds

- Burrowing owl - Speotyto cunicularia
- Road runner - Geococcyx californianus
- Horned lark - Eremophila alpestris
- Le Conte's thrasher - Toxostoma lecontei
- Red-tailed hawk - Buteo jamaicensis
- Golden eagle - Aquila chrysaetos
- Turkey vulture - Cathartes aura

Birds - continued

Mourning dove - Zenaidura macroura
California quail - Lophortyx californicus
Mockingbird - Mimus polyglottos
Killdeer - Charadrius vociferus
Loggerhead shrike - Lanius ludovicianus

This region of the San Joaquin Valley is still in native vegetation. Although sheepherders graze their flocks here in the spring, the major use of the land is for oil production. Oil wells, storage tanks, pumping stations, and pipelines are commonly found in the area. Wildlife appears to be able to coexist with these manmade appurtenances. Indeed, large land reserves, such as the Elk Hills Naval Petroleum Reserve, may be the last hope for the San Joaquin kit fox and other species dependent upon the native vegetation of this region. There are no producing wells in our primary study area. Gas and water pipelines pass through the northeast portion of the section.

This area of the San Joaquin Valley has a desert climate. Temperatures in summer range from 70°F at night to 115°F on the hottest days. Winter temperatures range from 30°F to 65°F. The normal annual rainfall is approximately 6 inches, deposited almost entirely in winter.

SCOPE OF THE STUDY

Capture and Tagging

A close search of the study area was conducted for active kit fox dens in February by Herbert Hagen and Richard Fiant. Fresh digging, numerous scats and prey remains around den entrances indicated active dens. When found, live traps baited with sardines or pieces of jackrabbit were set near the den.

Adult foxes, upon capture, were weighed, fitted with radio transmitting collars, checked for general physical condition and sex, and released. In addition, numbered tags were attached to the ear. In May, females were tagged on the right ear and males on the left ear. Kit fox pups received identical treatment, except they were not fitted with collars until June 30. Before that date, the collars could not be attached securely without endangering the pups later as their necks grew.

Observations

After release, radio tagged foxes were located using a Johnson Messenger 350/DF radio receiver and/or a specially built portable radio receiver. A variety of both directional and nondirectional antennas were employed.

Dens in which tagged foxes were located were numbered and marked. A record was kept of den use. Foxes were observed in the evening as they left their dens, and also in the early morning before they returned to their dens. In addition, it was possible to follow tagged foxes at night with the radios.

Prey Density

A prey density sample was begun in July with the assistance of Frank Schitoskey, U. S. Fish and Wildlife Service. Two trap lines of 100 traps each were set at random locations. One trap line consisted of Museum Special traps baited with oatmeal, and the other trap line was rat traps baited with dried prunes. Both trap lines were checked twice daily, at which time caught animals were removed and identified and all sprung traps were reset and rebaited when necessary.

This sample was conducted for three consecutive days and the entire procedure will be repeated every two months.

GENERAL BEHAVIOR

Activity

San Joaquin kit foxes spend most of the daylight hours in dens excavated in the sandy soil. Young pups may frequently be seen playing very close to their den in late afternoon. Occasionally adults are seen resting in the shade of bushes near dens prior to sunset, but the usual behavior is to remain in the den until sunset. Pups begin to forage for themselves at 3-4 months of age. While learning to hunt, these pups leave their dens several hours before sunset and return to their dens in the morning after the adults. Adult kit foxes return to their dens 2-3 hours after sunrise (probably earlier in winter months).

Rather than digging to catch their prey, kit foxes rely on speed and agility. The senses of smell and hearing are developed to a high degree. Sandy washes and the areas around large bushes are favored hunting grounds. Foxes from different family groups have been observed hunting in the same area. Observations to date indicate that kit foxes do not maintain or defend specific hunting grounds.

Dens, unlike hunting areas, appear to belong to specific family groups. In more than five months of extensive observation and monitoring radio signals from transmitters attached to the foxes, a fox from one family has never been found to occupy a den previously inhabited by a member of another family. On one occasion, an adult female kit fox aware of the observer's presence and obviously seeking shelter was seen to pass two unoccupied dens used by another family in the past. She stopped long enough to smell the entrance to one den, and then ran approximately one-half mile to her own den.

Fox #1 tagged and released on August 23, was found that afternoon in a den previously occupied by fox #30. Fox #1 has since been found only in another den of his own. His family background is unknown, but it is suspected that he may be a pup of fox #30 and a female from previous years.

Denning

As of August 31, 28 different dens have definitely been occupied by one or more members of one family. This family consisted of two adults (foxes #22 and #30) and their four pups. Members of another family of the same size

(foxes #34 and #54 and their pups) have occupied at least 12 different dens. A third family, consisting of two young adults (foxes #42 and #50) of opposite sex, have occupied at least six different dens. Thusly, 52 kit fox dens have been located in the study area (through August 31), 47 of which have been occupied at various times since the study began. Description of the dens is to be found in Table I.

TABLE I

Description of Kit Fox Dens

Den Number	Entrances*	Cover and Terrain (30 foot radius around den)
1	9	Flat; open, with short grass to west and scattered brush to north, east, and south.
2	2	Flat; open, with short grass.
3**	4	Flat; open, with short grass; heavy overgrazing by sheep.
4	2	Gentle slope toward wash; open with sparse brush and short grass.
5	2	Den not in primary study area.
6	3	Flat; scattered brush and short grass.
7	2	Flat; open, with short grass.
8	3	Slight slope; open, with short grass; in large mound.
9	6	Slight slope; open, with short grass.
10	6	Flat; open, with short grass.
11	10	Flat; open, with short grass.
12	3	Flat; open, with short grass
13**	2	Slightly rolling (gullies); scattered brush and short grass.
14**	5	Flat; open, with short grass and sparse brush.
15	2	Flat; open, with short grass.
16	7	Flat; open, with short grass.
17	2	Flat; open, with short grass.

Den Number	Entrances*	Cover and Terrain (30 foot radius around den)
18	3	On flat adjacent to dry wash, one entrance in wash; open, with short grass and scattered brush.
19	4	Flat; open, with short grass.
20	5	Slight slope; short grass and scattered brush.
21	2	Flat; common brush with short grass.
22**	8	Flat; open, with short grass.
23	8	On moderate slope in a wash in hills; short grass and common brush.
24	4	On fairly steep slope in wash east of den #23; short grass and common brush.
25**	3	Slight slope; open, with short grass.
26	1	Slight slope, near large wash; open, with short grass and one bush.
27	6 (only 2 in use)	Flat; open, with short grass.
28	2	Flat; open, with short grass.
29	4	Slight slope; near gully; open, with short grass.
30	9	Slight slope; open, with short grass.
31	2	Steep; thick brush with grass; in same gully as den #24.
32	1	In bank of small wash; scattered brush and short grass; den entrance at base of large <u>Atriplex</u> .
33	6 (only 3 in use)	Flat; open, with short grass.
34	1	Slight slope; open, with short grass and 1 bush.
35	5	Steep, eroded gullies below road; thick brush.
36	1	Flat; open, with scattered small brush and short grass.
37	4 (1 caved in)	Flat; open, with short grass and 1 bush; near fence.
38	1	Steep slope near ridge top; common brush.

Den Number	Entrances*	Cover and Terrain (30 foot radius around den)
39	1	Slight slope; open, with short grass.
40	2	In bank of wash; very sandy with common small brush on flat above den.
41	2	Steep slope in hills; open, with short grass and scattered brush.
42	1	In bank of wash; common brush and short grass; entrance at base of large <u>Atriplex</u> .
43	1	Steep slope with numerous other abandoned dens; open, with short grass and small brush.
44	1	In bank of wash; very thick brush; at base of large <u>Atriplex</u> ; flats above scattered short brush and grass.
45	1	Flat; open, with short grass and scattered small brush.
46	1	Flat; open, with short grass; entrance smaller and more elliptical than usual.
47	1	In bank of wash; scattered brush and short grass.
48	2 (1 caved in)	Flat; open, with short grass.
49	4 (2 caved in)	Flat; open, with scattered brush and short grass.
50	4	Flat; open with short grass.
51	2	Flat; common brush in loose, sandy soil in wash in hills.
52	4	Flat; open, with short grass.
53	2	Very steep on side of hill; open, with grass and common brush.

* Most den entrances are 8-9 inches in diameter and circular in shape.

** Den never definitely occupied by a tagged fox from beginning of study to June 30, 1970.

Evidence to date in this study indicates that dens may be occupied for as short a period as one day. However, occupied dens have been monitored for as long as 10 consecutive days, and two foxes have probably occupied one den for over 30 consecutive days. Dens are most frequently occupied for long periods of time when pups are very young.

Once the pups are on their own, the family group breaks up. The parents usually occupy separate dens, although they may infrequently be found in a den together. The pups may den and hunt together or separately. Occasionally a pup may be found in a den with one of its parents.

FOOD HABITS

Feeding

It appears that kit foxes will take any meat offered them, even if it is several days old and in a state of decay. A kit fox was known to eat a dead rattlesnake as well as road-killed animals. Kit foxes have been trapped using sardines for bait.

Food is frequently brought back to the den to be consumed. Numerous prey remains, mostly rodent feet and tails and occasional feathers, are found scattered about den entrances. Whole prey animals, such as kangaroo rats, are infrequently placed by foxes in ground squirrel or kangaroo rat holes near their dens. Although presumably being "stored" for later consumption, these animals are often not recovered by the kit foxes.

Kit foxes have never been observed hunting in groups larger than two and it is believed that most hunting is done by solitary animals.

Scat Analysis

Scats and prey remains are collected around kit fox dens every month to determine kit fox diets and seasonal fluctuations in the diet. These scats and prey remains are analyzed in Sacramento by Bruce Browning, California Department of Fish and Game, Food Habits Laboratory.

Results to date indicate rabbits and kangaroo rats are the dominant prey items in this area. A complete list of items found in the scats may be found in Table II.

TABLE II
Scat Analysis Results

<u>Mammals</u>	<u>Frequency in Numbers</u>	<u>Frequency Percent</u>
Kangaroo rat (<u>Dipodomys</u> sp.)	15	93.8
Rabbit (<u>Leporidae</u>)	8	50.0
Pocket mouse (<u>Perognathus</u> sp.)	1	6.3
Squirrel (<u>Sciuridae</u>)	1	6.3
<u>Birds</u>		
Unidentified fragments and/or feathers	4	25.0
<u>Insects</u>		
Unidentified adult insects	7	43.8
Scorpion (<u>Scorpionidae</u>)	3	18.8
Ants (<u>Formicidae</u>)	1	6.3
Grasshopper (<u>Locustidae</u>)	1	6.3
Jerusalem cricket (<u>Stenopelmatus longispina</u>)	1	6.3
Larva (<u>Lepidoptera</u>)	1	6.3
Unidentified insect larva	1	6.3
<u>Vegetable</u>		
Grass leafage and stems (<u>Gramineae</u>)	8	50.0
Filaree seeds (<u>Erodium cicutarium</u>)	7	43.8
Cheatgrass seeds (<u>Bromus tectorum</u>)	4	25.0
Pepper-grass seeds (<u>Lepidium</u> sp.)	4	25.0
Unidentified forbs	1	6.3

NOTE: Scat groups collected from March through July 1970.
Analyzed were 16 groups of scats of varying numbers. Scats collected from individual den sites were grouped together for analysis.

GROWTH AND DEVELOPMENT

A kit fox pup develops the characteristic black tip on its tail at about 2-3 months, and puppy fur is replaced by adult fur at 4-5 months. The pups which were trapped repeatedly showed a weight gain of approximately a pound per month. At this rate pups should reach adult weight in July or August (at about 5 months). Records of kit fox weights for both adults and pups may be found in Table III.

TABLE III

SAN JOAQUIN KIT FOX WEIGHTS

FOX	COLLAR NUMBER	EAR TAG NUMBER	DATE AND WEIGHT (LBS.)											
			4/8	4/9	4/10	5/2	5/3	5/4	6/30	7/2	8/23	8/24	8/25	
ADULT, M	42	-	5.1	-	-	-	-	-	-	-	-	-	-	-
ADULT, F	50	628	4.8	-	-	-	-	-	-	-	-	4.6	-	-
ADULT, F	22	500	4.7	-	-	4.5	-	-	-	4.8	-	-	5.1	-
ADULT, F	54	498	4.4	-	-	-	-	-	-	-	5.1	-	-	4.5
ADULT, M	34	478	5.9	-	-	-	-	-	5.7	-	-	-	-	6.2
PUP, M 1/	-	-	-	2.4	-	-	-	-	-	-	-	-	-	-
PUP, M 2/	-	491	-	1.5	1.6	-	2.6	-	-	-	-	-	-	-
PUP, F 2/	18	488	-	-	2.2	-	3.0	-	-	3.9	-	-	-	-
PUP, M 2/	46	499	-	-	2.2	-	3.0	-	-	3.6	-	-	-	-
PUP, M 2/	-	480	-	-	2.0	-	2.9	-	-	-	-	-	-	-
ADULT, M	30	481	-	-	-	5.0	-	-	-	-	-	-	4.7	-
PUP, M 1/	-	485	-	-	-	-	-	-	3.3	-	-	-	-	-
ADULT, F 3/	-	494	-	-	-	-	-	-	4.3	-	-	-	-	-
ADULT, M (Fox #1) 34	34	495	-	-	-	-	-	-	-	-	-	4.1	-	-

NOTE: EAR TAGS WERE NOT PLACED ON PUPS UNTIL 5/3, SO THE ASSIGNMENT OF WEIGHTS FOR 4/9 AND 4/10 IS ONLY AN EDUCATED GUESS.

- 1/ PUP OF FOXES 34 AND 54.
- 2/ PUP OF FOXES 22 AND 30.
- 3/ NOT IN PRIMARY STUDY AREA.

The San Joaquin kit fox may not reach sexual maturity until the second year. This statement is based solely on the fact that one pair of young adults (foxes #42 and #50) were estimated to be one year old and they had no pups. Age at sexual maturity is one question to be answered this winter.

VOICES AND CALLS

Kit foxes have been observed to make only three different sounds. These are classed as a perk, a growl and a bark. The perk is a bubbling noise closely resembling that made by a perking coffee pot. This sound is made by almost every kit fox trapped, whether caught alone or when other trapped foxes were nearby. The fox is usually lying calmly on the floor of the cage when making this noise. The growl is a soft sound, frequently uttered when trapped foxes are approached. This sound may precede the bark which is highly pitched and

often rapidly repeated. This bark resembles that made by a small dog. It may occur separately or following the growling noise. Trapped kit foxes have occasionally tried to snap at us through the wire cages while making this barking noise.

POPULATION DYNAMICS

Number

In April, 14 kit foxes (6 adults and 8 pups) occupied this area of approximately 640 acres. A fifteenth fox, a young adult male, was tagged in August and he resides on the northwest edge of the study area. This area is a very productive portion of the total San Joaquin kit fox range. It has a high rodent population, which may account for the large number of kit foxes. It is not believed that this high density for kit foxes is typical of range.

Breeding and Care of Young

In December the study area was occupied by three pairs of kit foxes. Two pairs later had pups and one pair of young adults failed to reproduce. Breeding begins in December and ends in January or February. Young are usually born in February or March, although some litters may possibly appear as late as April. Of the two litters observed, one was probably born in February and the other in March, judging from the weights of trapped pups.

Both litters consisted of four pups each. Reports of litters as large as seven have been made, but three to five seems to be the average size.

From personal observation, it appears that both parents help raise the young, although the father may occasionally leave for several days at a time. During these short "vacations," the male usually occupies a den within a few hundred yards of the den containing mother and pups. It is probable that he still assists in hunting food for the pups.

Food for the young pups is brought back to the den, resulting in prey remains being scattered about the den entrances. At the age of one month, pups play about the den entrances during late afternoon and, presumably, through the night. Pups three to four months old begin to forage for themselves. At this time the family group dissolves.

It is unanimously accepted that kit foxes are monogamous. Egoscue (1962) feels that kit foxes mate for life. One experience from the present study is worth relating.

On February 4, Herb Hagen, Frank Schitoskey and Dick Fiant live-trapped two kit foxes, one male and one female, at a den in the study area. The female aborted two pups while in the trap and died under anesthetic. Since then the practice of anesthetizing foxes while attaching or removing collars has been discontinued. The male was tagged with collar #30 and released. On April 8, five additional adult kit foxes were trapped and radio tagged in the study area. Included was one lactating female (#22). On April 10,

foxes #30 and #22 were located in den #10, and four pups were trapped near entrances to den #10. When released, all of the pups entered den #10. The pups were estimated to be one month old. Since April 10, fox #30 has frequently been located with fox #22 and the four pups, and every indication is that he is the father of the pups.

The four pups were probably born in early March, which means (assuming a gestation period for kit foxes of approximately 50-55 days) that fox #30 and fox #22 mated in January. If kit foxes are truly monogamous, it seems highly unlikely that fox #30 would have been hunting and/or denning with the female fox which died on February 4. It is strongly believed that this male was also the father of the two pups stillborn in the trap.

At this time, it is felt that kit foxes are usually monogamous, but they may occasionally be polygamous. This could be an important factor in kit fox management and relocation projects. A great deal is hoped to be learned about kit fox breeding behavior this winter.

MORTALITY

Three kit foxes (two pups, one adult) were definitely lost by July from the original population of 14 foxes. An adult (#34) and two pups were apparently killed by varmint hunters. This was evidenced by removal of ears and tail. The indiscriminate and illegal shooting of kit foxes, particularly at night, by varmint hunters appears to be the most significant mortality factor affecting this kit fox population.

Golden eagles and red-tailed hawks frequent the area. Conceivably they could take kit foxes, especially pups playing in the open during daylight hours. However, to date, there is no evidence of kit fox loss to these birds.

Starvation, especially in pups learning to hunt, is almost certainly an important factor in limiting the size of the kit fox population. The total population very likely declines in years of poor rodent yields.

RECOMMENDATIONS

The following are recommendations resulting from this study:

1. Continue this life history study of the San Joaquin kit fox for at least one more full year (through June 1971).
2. Place radio collars on all of the kit foxes in the study area.
3. Determine the minimum size, and possible locations of reserves necessary to maintain kit fox populations.

BIBLIOGRAPHY

- Anderson, S., and S. Hadary. 1965. Kit fox from southern Zacatecas. *Journal of Mammalogy* 46:343.
- Burns, R. D. 1960. Stomach contents of a kit fox. *Ecology* 41:365.
- Cutter, W. 1958. Denning of the swift fox in northern Texas. *Journal of Mammalogy* 39:70-74.
- _____ 1958. Food habits of the swift fox in northern Texas. *Journal of Mammalogy* 39:527-532.
- Davis, W. B., and J. L. Robertson, Jr. 1944. The mammals of Culberson County, Texas. *Journal of Mammalogy* 25:254-273.
- Egoscue, H. 1956. Preliminary studies of the kit fox in Utah. *Journal of Mammalogy* 37:351-357.
- _____ 1962. Ecology and life history of the kit fox in Toole County, Utah. *Ecology* 43:481-497.
- Grinnell, J., J. S. Dixon and J. M. Linsdale. 1937. Furbearing Mammals of California, Volume II. University of California Press, Berkeley, California.
- Hall, E. R. 1927. An outbreak of house mice in Kern County, California. *University of California Publications in Zoology* 30(7):189-203.
- _____, and K. R. Kelson. 1959. Mammals of North America. Ronald Press, New York, New York.
- Hawbecker, A. 1943. Food of the San Joaquin kit fox. *Journal of Mammalogy* 24:499.
- Ingles, L. 1967. Mammals of the Pacific States. Stanford University Press, Stanford, California.
- Laughrin, L. 1970. San Joaquin kit fox: its distribution and abundance. California Department of Fish and Game, Wildlife Management Administrative Report No. 70-2.
- Miller, P., and C. McCoy. 1965. Kit fox in Colorado. *Journal of Mammalogy* 46:342-343.
- Munz, P., and D. Keck. 1965. A California Flora. University of California Press, Berkeley, California.
- Robbins, C. S., B. Bruun, and H. S. Zim. 1966. Birds of North America. Golden Press, New York, New York.
- Stebbins, R. C. 1966. A Field Guide to Western Reptiles and Amphibians. The Riverside Press, Cambridge, Mass.

Taylor, W. P., and C. T. Vorhies. 1923. Kangaroo rats and scorpion mice on the Santa Rita Reserve, Arizona. *Journal of Mammalogy* 4:255.

Wauer, R. 1961. Peculiar actions of coyote and kit fox. *Journal of Mammalogy* 42:109.