State of California
THE RESOURCES AGENCY
Department of Fish and Game

EFFECTS OF AGRICULTURAL DEVELOPMENT IN KERN COUNTY, CALIFORNIA, ON THE SAN JOAQUIN KIT FOX IN 1977[1/]

by

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ABSTRACT

On land being developed for agriculture in Kern County, California, movements of 13 San Joaquin kit foxes (*Vulpes macrotis mutica*) were studied from February 5, 1977, to January 31, 1978. Radio-tracking of these kit foxes showed an average minimum home range of 251.6 ha (621.4 ac) and evidence that the home ranges of kit foxes overlap. Over the 8.5-month monitoring period, 15 dens were found for 10 of the 13 radio-collared foxes. The maximum number of dens per fox was three. The use of artificial dens by two of the 13 foxes was observed. This study showed that at least three San Joaquin kit foxes found to be denning on areas undergoing land conversion operations were buried and died in their dens. Because of such evidence of kit fox mortality, 12 of 38 captured kit foxes were relocated from areas of development surrounded by agriculture to areas selected by the Region 4 Office of the Department of Fish and Game. After relocation these foxes were not studied. Analysis of 47 kit fox scats indicated that the desert cottontail (*Sylvilagus audubonii*) was the main food item of the San Joaquin kit fox in areas of agricultural development. Kit fox activity in intensive agriculture in Kern County indicated that the kit fox was in a wide range of agricultural situations. A 1,340 ha (3,410 ac)-area of native vegetation in the flood plain of the Kern River, near Tupman in Kern County, was studied as a potential site for an ecological reserve. It was concluded that, although land conversion operations cause direct kit fox mortality, habitat loss is the major threat to the survival of the San Joaquin kit fox.

1/ Supported by Endangered Species Act grant-in-aid program, Nongame Wildlife Investigations Final Report, Project E-1-1, Job V-1.21 (July, 1978).

RECOMMENDATIONS

Based on the findings of this study it is recommended that the California Department of Fish and Game:

1. Conduct a more detailed study of the Kern River site, the Buttonwillow Area, and the two other areas suggested in this study as San Joaquin kit fox and blunt-nosed leopard lizard critical habitat. (Resubmit these areas to the U. S. Fish and Wildlife Service for declaration as critical habitat, and/or initiate efforts for acquisition of the areas as ecological reserves by the State of California.) Preserve one of these few remaining areas of native vegetation in the San Joaquin Valley which are essential to the survival of the San Joaquin kit fox.

2. Support the City of Bakersfield in its efforts to maintain a natural area of native vegetation along the Kern River in the Tupman Essential Habitat Area.

3. Continue the present study through the crop planting phase, and determine kit fox adaptability in intensively farmed areas. Determine dispersal of juvenile San Joaquin kit foxes through all agricultural development phases and in intensively farmed areas with radio-telemetry techniques.

4. Determine the adaptability of relocated kit foxes to their new environment by intensive radio-tracking techniques. Efforts should be made to determine the status of the foxes that were relocated during the course of this study.

5. Determine the availability and type of prey taken by kit foxes in native vegetation, during agricultural development, and in intensive agriculture.

6. Pursue interagency cooperation to review and update kit fox management techniques through action of the San Joaquin Kit Fox Recovery Team.

INTRODUCTION

BACKGROUND

Status of Kit Fox

The California State Water Project has provided irrigation water for the western San Joaquin Valley, California. This delivery of water, together with groundwater development, has accelerated the conversion of native valley vegetation to cropland to meet the increasing world demand for agricultural products. Most of the converted native vegetation was the alkali-sink plant community type (Twisselmann, 1967), the natural habitat of the San Joaquin kit fox (*Vulpes macrotis mutica*). From 1959 to 1969 there was an estimated 34% reduction in native vegetation in the range of the San Joaquin kit fox (Laughrin, 1970). Laughrin (1970) noted that vegetation on the southern San Joaquin Valley floor supported the densest population of San Joaquin kit foxes within their range.

Kit fox population reduction caused by the combination of loss of habitat and indiscriminate shooting prompted the California Fish and Game Commission to give the kit fox protected furbearer status in 1965 (Laughrin, 1970). The Secretary of the Interior, under the Endangered Species Preservation Act of 1966, listed the San Joaquin kit fox as an endangered species in 1967. In May 1971, the California Fish and Game Commission, under the authority of the California Endangered Species Act of 1970, listed the San Joaquin kit fox as rare (Leach and Fisk, 1972). A San Joaquin Kit Fox Recovery Team was appointed by the Director of the U. S. Fish and Wildlife Service (USFWS) on July 1, 1975.

Previous Studies

Concern for loss of native habitat in the San Joaquin Valley has been noted from the 1960's in reports of kit fox den counts by the USFWS (Knapp, 1977a). These reports established a relative population figure for kit foxes and evaluated the effect of environmental changes caused by the increasing use of kit fox habitat for agriculture. From 1969 to 1971, 18% of the 76,893 ha (190,000 ac) previously surveyed for kit fox dens was converted to agriculture. Jensen (1972) determined that in Kern County alone from 1968 to 1971, 46,055 ha (113,800 ac) of native vegetation were converted to cropland. Land use surveys of 2,063,161 ha (5,098,000 ac) by the California Department of Water Resources showed that between 1958 and 1970 there was a loss of 198,303 ha (490,000 ac) of native vegetation on the San Joaquin Valley floor in Kern, Kings, Tulare, and Fresno counties (Morrell, 1975). The most recent studies showed that from August 1974 through April 1977, a total of 45,480 ha (112,380 ac) in the San Joaquin Valley was lost to land leveling operations (Peck and Wilson, 1977). The largest portion was 23,861 ha (48,960 ac) in Kern County. Kern County lost the greatest amount of habitat, but it also had the greatest amount, 171,617 ha (424,060 ac), of native vegetation remaining.

Distribution and Abundance of Kit Foxes.

The remaining areas of native vegetation in Kern County support the San Joaquin kit fox in the southernmost portion of its range. The first survey of kit fox distribution and abundance was done by Laughrin (1970). His study showed that the range of the kit fox extended from the Tehachapi Mountain foothills at the southern end of the San Joaquin Valley north along the foothills of the western San Joaquin Valley almost to the town of Los Banos. On the eastern edge of the valley, kit fox range extended north to about 32.2 km (20 mi) south of the town of Porterville. The kit fox also occurred on the Carrizo Plain in San Luis Obispo County. This range consisted of approximately 7,770 sq km (3,000 sq mi). These range distribution and abundance figures were updated by Jensen (1972). His study extended the known range of the kit fox into Monterey and Contra Costa counties. Further studies on range extension were done by Swick (1973). His investigation delineated areas inhabited by kit foxes in Contra Costa, Alameda, San Joaquin, and Tulare counties. The most recent study confirmed the presence of the San Joaquin kit fox in 14 counties of California and updated the designated range of the kit fox (Morrell, 1975). This study estimated the number of kit foxes to be between 5,066 and 14,800 adults with a mean 10,000 adults living in native and nonnative areas in Kern, Fresno, Kings, Merced, San Joaquin, Stanislaus, and Tulare counties.

OBJECTIVES OF STUDY

The present study was done from February 1977 through January 1978 to:

1. Rescue and relocate San Joaquin kit foxes threatened with immediate mortality by land leveling operations and to determine their adaptability to their new environment.

2. Determine the immediate effect of habitat loss on kit foxes in areas of active agricultural development.

3. Determine kit fox adaptability to a stable agricultural community.

4. Seek preservation of natural habitat essential to the survival of the kit fox in the San Joaquin Valley.

BIOLOGY OF THE KIT FOX

Description

One of the first studies of the San Joaquin kit fox was made by Grinnell *et al*. (1937), who described the kit fox in detail and compared it with two other subspecies of kit foxes found in California. The kit fox (*Vulpes macrotis*) is grayish-yellow in color. It has pale reddish-brown shading down the center of the back from between the ears to the base of the tail. The underparts are nearly white (Seymour, 1962). The summer coat is tan and the winter coat is silver-gray (Morrell, 1972). There are blackish spots on each side of the snout. The kit fox has a slender build and big ears (Palmer, 1954). These large ears contain a dense screen of long, fine hairs that almost fill the ears. These hairs may be a safeguard against dust damage from wind storms (Cahalane, 1947). The tail is cylindrical in shape and blackish at the tip (Palmer, 1954). The body length is 600-840 mm, the tail is 225-323 mm, the hind foot is 108-137 mm, the ear is 78-94 mm, and the skull is 105-122 mm (Ingles, 1965). A taxonomic study (Waithman and Roest, 1977) determined by stepwise discriminant analysis of nine cranial measurements (n=104) that the San Joaquin kit fox was a distinct subspecies of *Vulpes macrotis*, being larger in size than four other subspecies of kit foxes.

The life history of the San Joaquin kit fox was studied by Morrell (1972), utilizing radio-telemetry techniques. Data were gathered on denning, food habits, reproduction, and behavior. His study suggested that illegal shooting, largely at night, was a short-term threat to the survival of the San Joaquin kit fox, with habitat conversion as a long-term threat to its survival. As a result of this study, the California Fish and Game Commission closed areas in the range of the San Joaquin kit fox to night hunting.

Food Habits

A San Joaquin kit fox food habits analysis showed a varied diet of kangaroo rats (Dipodomys spp.) and grasshoppers (Oedaleonotus enigma) (Hawbecker, 1943). Other species of insects eaten were little bear (Pocalta ursinus), a beetle (Coniontis spp.), and crickets (Stenopelmatus spp.). Grass (Bromus spp.) was present in all 74 scat samples.

Similar food habits were found by Morrell (1972). Kangaroo rats were the staple item of diet, occurring in 80.7% of 52 scats. Lagomorphs, mostly cottontails (Sylvilagus audubonii), occurred in 46.2% of the scats. Invertebrates such as scorpions (17.3%), Jerusalem crickets (Stenopelmatus longispinus) (13.5%), and insect larvae (11.5%) were found. Red-stemmed filaree (Erodium cicutarium), cheatgrass (Bromus tectorum), and peppergrass (Lepidium spp.) occurred frequently in the scats, but probably were ingested accidently.

STUDY AREAS

Location

The floor of the southwestern San Joaquin Valley in Kern County, California, was chosen for this study. Previous reports designated this area as the southern end of kit fox range (Laughrin, 1970; Morrell, 1975). The four basic land use practices identified in Kern County were: 1) grazing of otherwise undisturbed native valley floor vegetation; 2) agricultural development through conversion of native vegetation; 3) intensively farmed, stable agriculture; and 4) oil production. At the initiation of the study, land conversion was being done in western Kern County on land owned by Tenneco West, Inc. Two conversion areas selected as study areas were the Tupman Essential Habitat Area and the 7th Standard Area (Fig. 1). The Tupman Essential Habitat Area (Fig. 2) is bisected northwest to southeast by Interstate 5 and east to west by Taft Highway 119. The 7th Standard Area (Fig. 3), is bisected east to west by 7th Standard Road, with Highway 58 being its southern boundary. On February 28, 1977, the San Joaquin Kit Fox Recovery Team petitioned the USFWS to establish the Tupman Essential Habitat Area and three other areas as Critical Habitat for the San Joaquin kit fox.

The Tupman Essential Habitat Area (Fig. 2) consists of 9,227 ha (22,800 ac). It is representative of the alkali-sink plant association. The Kern River, which bisects the area from northeast to southwest, exhibits the streambank plant association along its banks. The area is utilized for oil production; it has oil pumps and two oil refineries within its boundaries. In 1977, 1,497 ha (3,700 ac) were proposed for agricultural development.

The 7th Standard Area (Fig. 3) consists of 1,408 ha (3,480 ac). It is representative of the alkali-sink plant association. This natural area was used for

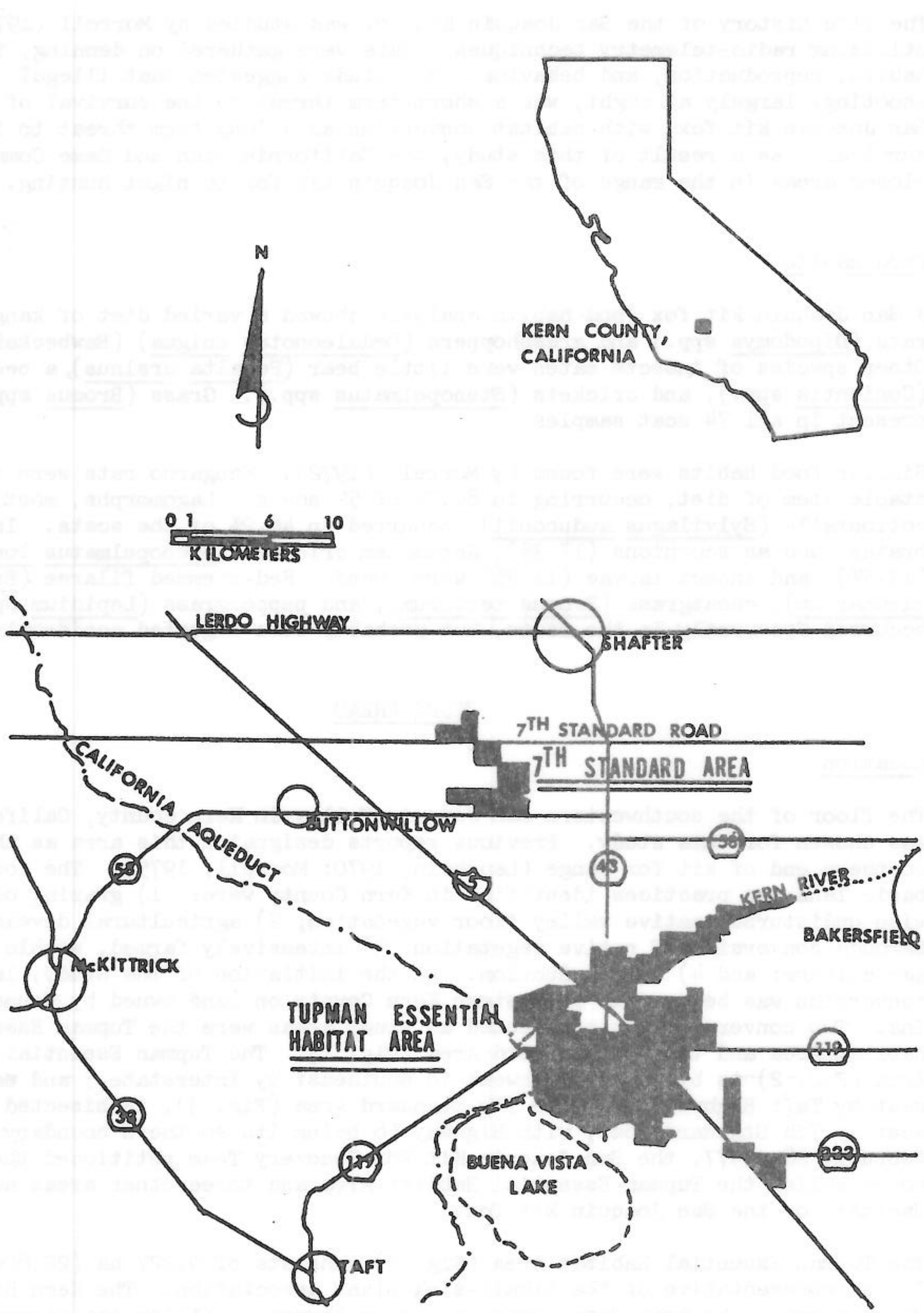

Fig. 1. Locations of San Joaquin kit fox study areas, Kern County, California.

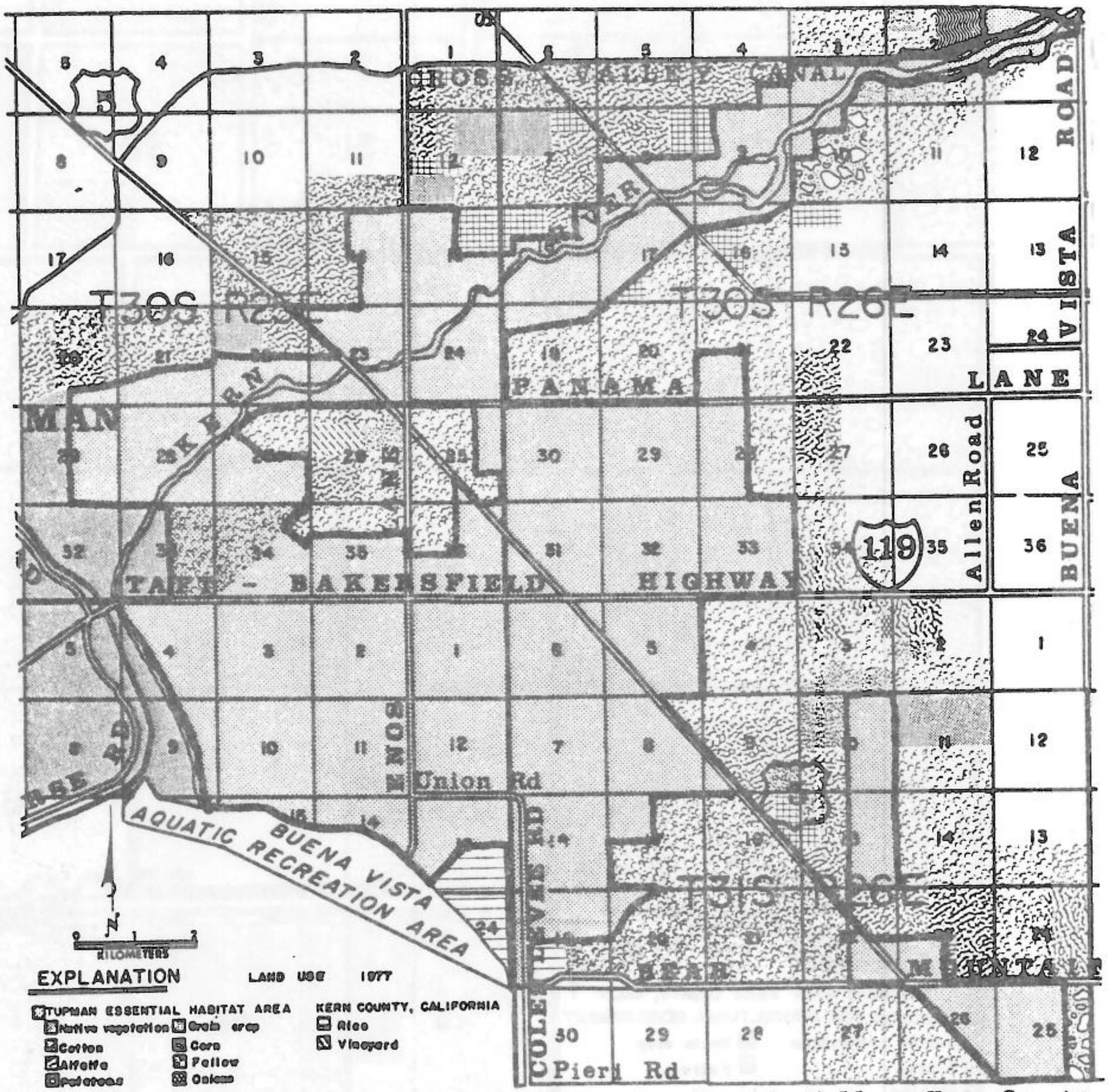

Fig. 2. Tupman Essential Habitat Area, San Joaquin Valley, Kern County, California.

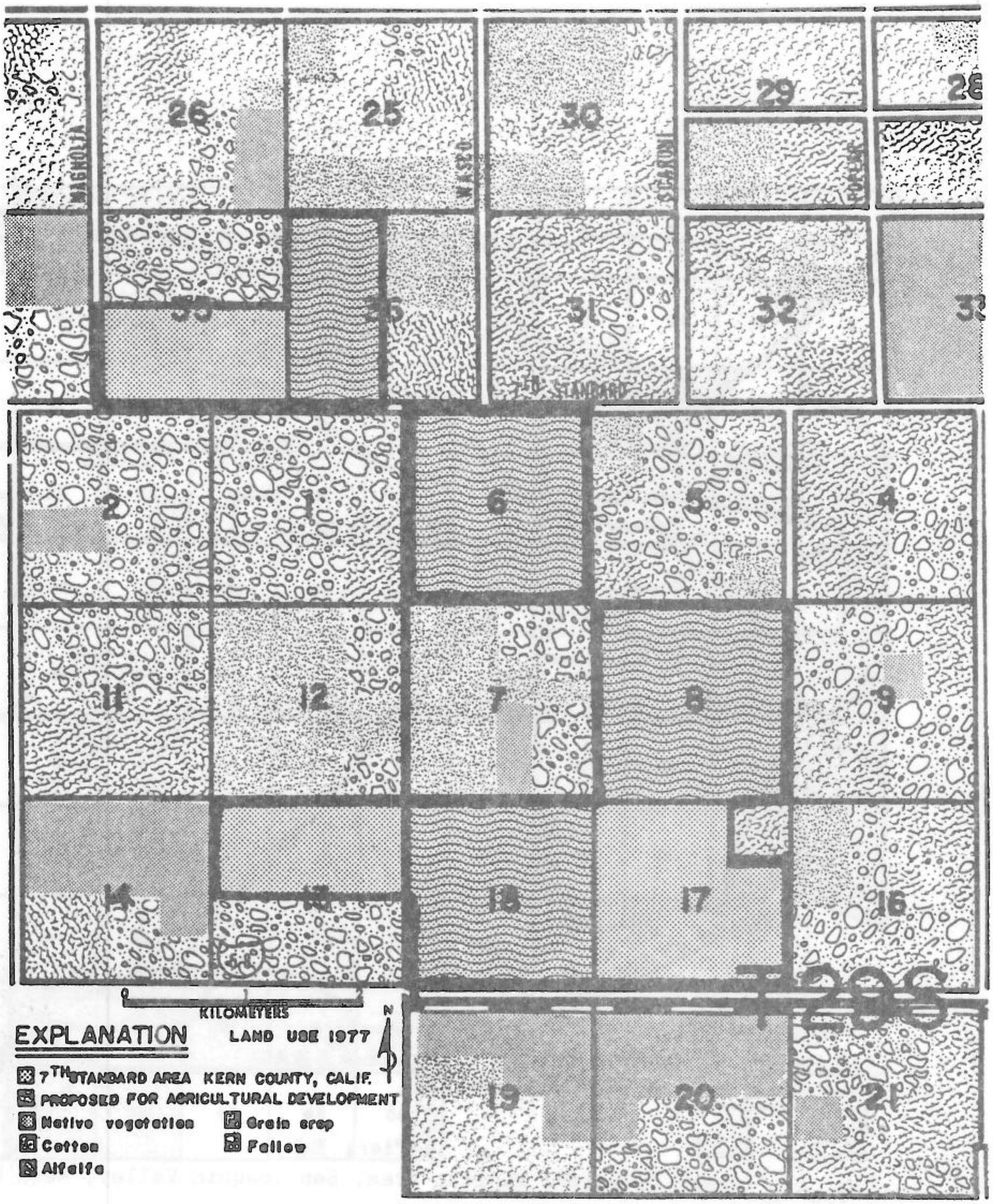

Fig. 3. 7th Standard Area, San Joaquin Valley, Kern County, California.

grazing sheep in past years. In 1977, 907 ha (2,240 ac) were proposed for agricultural development. The 7th Standard Area, like the Tupman Essential Habitat Area, is surrounded by agriculture.

These study areas on the southwestern San Joaquin Valley floor are on alluvial flood plains that moderately slope from 109.7 m (360 ft) in the east to 86.9 m (285 ft) in the west where the plain is abruptly terminated by Elk Hills. The major geographic feature of the area is the Kern River. Originally the entire area was a flood plain characterized by shallow lakes, sloughs, and marshes of Kern Lake, Buena Vista Lake, and Tulare Lake. Construction of Isabella Dam on the Kern River and Pine Flat Dam on the Kings River, and damming of the Kaweah and Tule rivers, has resulted in the destruction of the natural water courses in the Tulare Lake Basin.

Climate and Soils

The climate of the area is arid. The rainy season is from November through April, with an average rainfall in the southern San Joaquin Valley of 2.5-7.6 cm (1-3 in) in dry years and 20.3-30.5 cm (8-12 in) in wet years. The average growing season is 250 days. The annual mean temperature is 18.3°C (65.0°F). The summers have a maximum temperature of 47.7°C (118.0°F) and a minimum of 3.3°C (38.0°F). The winters have a maximum temperature of 31.1°C (88.8°F) and a minimum of -10.5°C (13.0°F) (Elford and McDonough, 1964).

A greater portion of the valley floor consists of deep alluvial fan and flood plain soils. When cultivated and irrigated, these calcareous soils produce crops such as cotton (Gossypium spp.), alfalfa (Medicago sativa), and flax (Linum spp.). The second most abundant soil class is the alkaline and saline types. These contain a moderate to high content of soluble salts. In an uncultivated state, such soils are suitable for saltgrass (Distichlis spicata) pasture. When these soils are intensively farmed, they produce such salt-tolerant crops as barley (Hordeum spp.), rice (Oryza sativa), and flax. Dry farming produces wheat (Triticum spp.) or barley. Uncultivated areas may yield permanent or irrigated native pasture (Storie, 1953). Much of the flood plain is classified as imperfectly drained soils. The plain has a high water table and is subject to overflow in wet years.

Vegetation

The arid climate and soils support native plants that have adapted to arid conditions in the summer and flood conditions in the winter. Annual flowering plants and grasses grow during the wet season and perennial plants and shrubs have a drought-resistant morphology in order to survive during the dry season. (Therkelsen, 1973). The plant communities best described by Twisselmann (1967) as the Alkali-sink Plant Association and the Streambank Association characterize the study areas. The latter association occurs along the Kern River in the Tupman Essential Habitat Area. The Alkali-sink Plant Association is characterized by a microrelief of poorly drained flats and playas interrupted by hummocks 0.5-1.0 m (1.6-3.3 ft) above the surface of the playas (Fig. 4). All vegetation, including grasses, grows on the hummocks. The dominant plant species in this association are saltbush, quailbush, iodine bush, seepweed, and mesquite. Other plants characteristic of the association are listed in Appendix I.

The streambank association (Fig. 5) is dominated by willow and Fremont cottonwood. Mesquite is also found along the streambanks. Many of the plants are

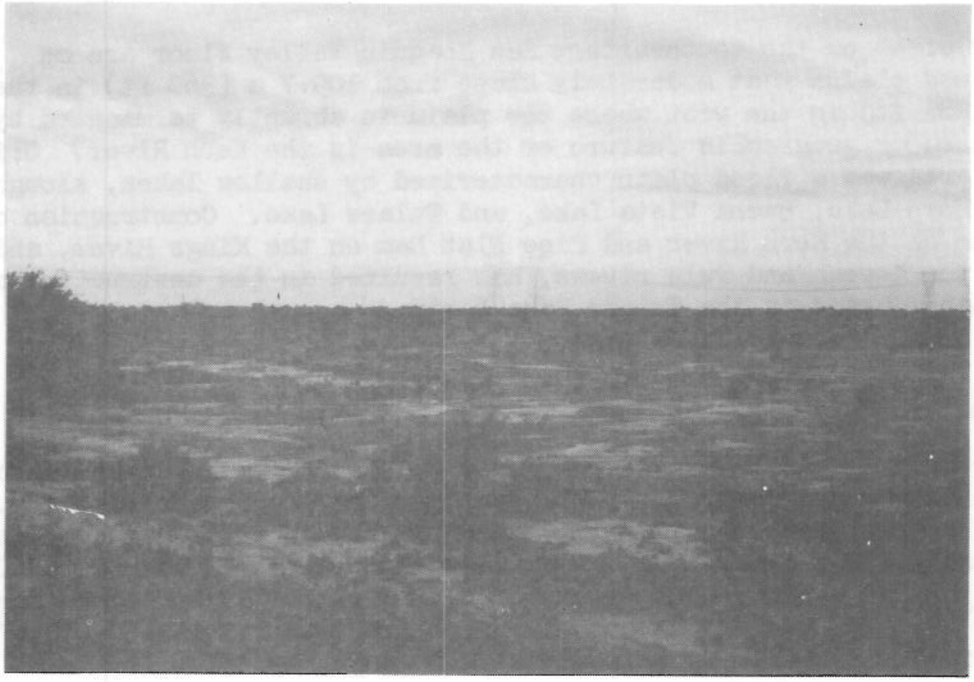

Fig. 4. Alkali-sink Plant Association, San Joaquin Valley, Kern County, California, 25 May 1977.

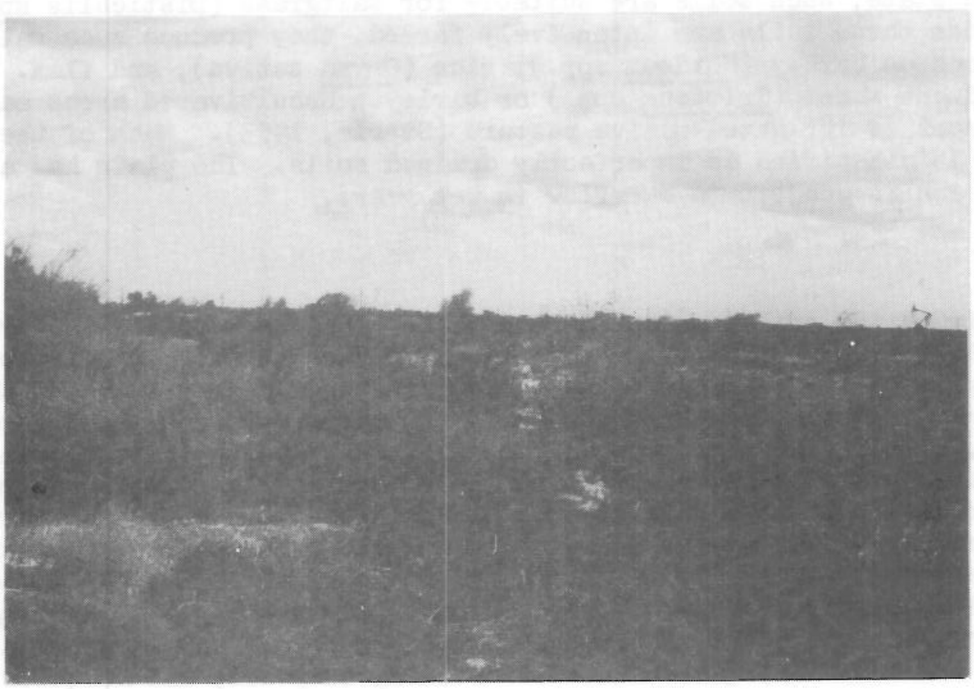

Fig. 5. Streambank Plant Association, San Joaquin Valley, Kern County, California, 26 August 1977.

dying because of the lowering of the groundwater table due to groundwater pumping and diversion of the Kern River (Therkelsen, 1973). These and other streambank plant species (Appendix I) are supported along the banks of the river all year and in the sandy river bottom during the late dry season (Twisselmann, 1967).

Wildlife

Wildlife in the southwestern San Joaquin Valley has adapted to arid conditions. Terrestrial vertebrates that have geographic ranges which include the study areas are listed in Appendix II. These species include the endangered San Joaquin kit fox and blunt-nosed leopard lizard. The most abundant large mammals are the coyote; badger; western spotted and striped skunks; and bobcat. Small mammals such as desert cottontails, black-tailed jack rabbits, Nelson's antelope squirrels, California ground squirrels, kangaroo rats, deer mice, and house mice are numerous. Because the San Joaquin Valley is in the Pacific flyway, migratory waterfowl and shorebirds (Appendix II) are found in the area in the fall and spring. In agricultural areas in which irrigation water is standing, shorebirds are present all year.

Conversion

With delivery of irrigation water from the Central Valley Project since the early 1950's, intensive agriculture has become the major land use practice in Kern County. Of 393,266 ha (971,748 ac) harvested in 1976, the greatest portion (31.3%) was 123,029 ha (304,000 ac) of cotton. The next highest harvested protion was 49,373 ha (122,000 ac) of alfalfa (12.6%) and 31,929 ha (78,895 ac) of grapes (8.1%) (Edwards, 1977). Oil production is 3.9% of Kern County's land use practices. Oilfields cover a production surface of 61,110 ha (151,000 ac) and an administrative surface of approximately 204,778 ha (506,000 ac). In 1973, these oilfields produced more than one-third of the oil of California (Therkelsen, 1973). The largest portion (49.3%) of land, 1,030,164 ha (2,545,500 ac), is irrigated and nonirrigated pasture and range land. This rangeland includes the valley Alkali-sink Plant Association and surrounding foothills, which are largely dominated by annual grasses. The two study areas are examples of native vegetation and oilfields that are being actively developed for agricultural purposes.

METHODS

Land Conversion Procedures

Tenneco West, Inc., granted permission to the Department of Fish and Game (DFG) to conduct this study on its land in western Kern County that was being readied to lease for agricultural production. Tenneco had contracted with private companies to develop the study areas for agricultural use. Development plans were obtained from Tenneco for the Tupman Essential Habitat Area (Johns, 1976). A map of the proposed development was used as a basis for field work in the Tupman Essential Habitat Area (Fig. 6). The areas designated as "Proposed for agricultural development 1977" were considered to be areas of immediate threat of displacement of kit foxes. Plans for the 7th Standard Area were obtained later in the study. Development schedules were intermittently acquired from Tenneco personnel within two weeks before the development of a specific area. Most development information was obtained by searching for signs of the first phase of development.

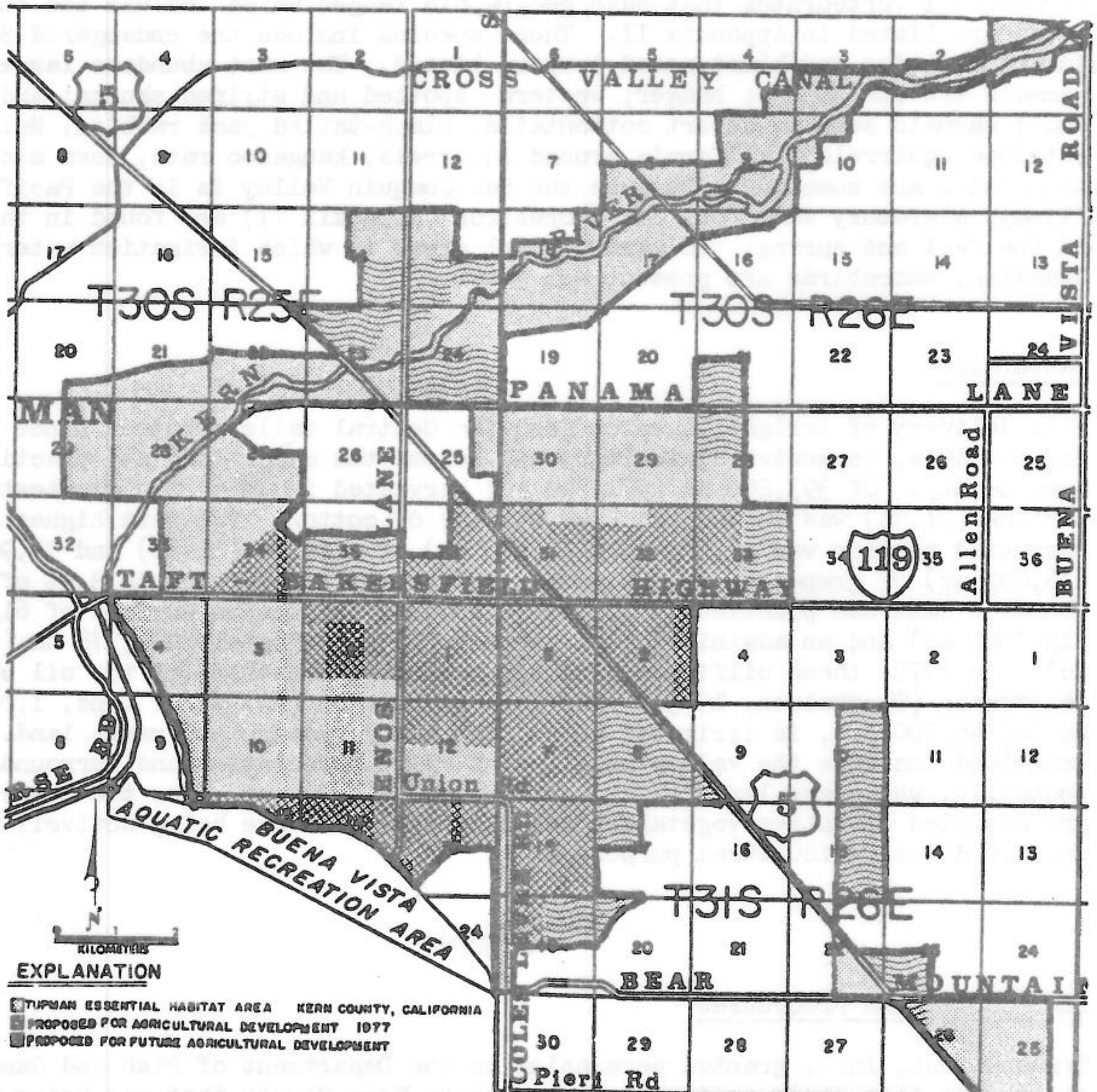

Fig. 6. Areas proposed for agricultural development, Tupman Essential Habitat Area, San Joaquin Valley, Kern County, California, 1977.

Eight development phases for these lands were documented (Table 1). These phases are shown in Figs. 7-13. Survey markers set out by developers in the first phase served to identify areas to be developed. Trees cleared during commercial wood operations were mostly mesquite, a plant that is disappearing from the San Joaquin Valley floor due to clearing and the overdraft of groundwater. During the brushing phase, old canals and gullies were filled with excess soil from higher leveled areas. Racking was done when the brush was completely dry. Burning required a permit and was limited to a designated burn day. During leveling, water delivery was initiated by drilling a well. Underground irrigation pipes were installed when leveling was complete. Crop planting was done by the persons who had leased the land from Tenneco. Because commercial wood operations, brushing, racking, and burning occurred simultaneously on a section of land, these phases were combined into one brushing phase. Water delivery was considered to be in the leveling phase. The adaptation of San Joaquin kit foxes to surveying, brushing, and leveling operations was covered in this study. Adaptation to crop planting was not studied.

* * *

Table 1. Development phases for agricultural production in the San Joaquin Valley, Kern County, California.+

Phase Number	Phase Name	Type of Development
1	Surveying	Identified boundaries. Grid marked areas to be filled and leveled.
2	Commercial Wood Operations	Cleared large trees and utilized for firewood.
3	Brushing	Cleared and dried remaining trees, large bushes, and dense brush.
4	Racking	Concentrated dry debris into large piles.
5	Burning	Burned large piles of dry debris.
6	Leveling	Scraped high areas and filled low areas making cleared lands level.
7	Water Delivery	Drilled a well. Installed underground irrigation pipes.
8	Crop Planting	Treated soil, irrigated, and seeded

+After Johns (1977).

* * *

Fig. 7. Surveying phase of agricultural development, San Joaquin Valley, Kern County, California, 12 October

Fig 8. Commercial wood operations phase of agricultural development, San Joaquin Valley, Kern County, California, 15 April 1977.

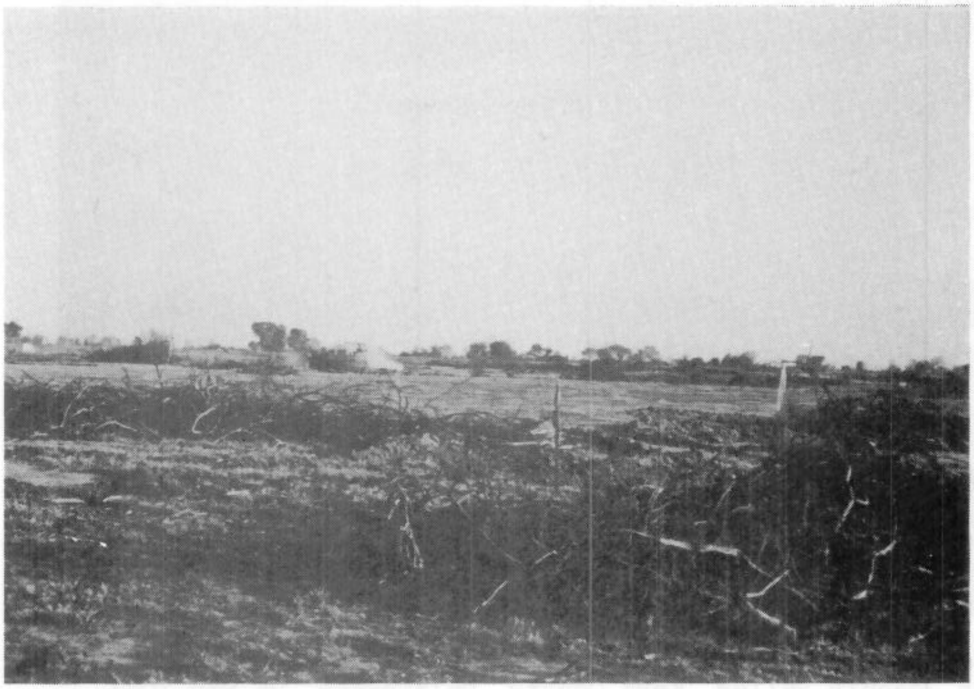

Fig. 9. Brushing phase of agricultural development, San Joaquin Valley, Kern County, California, 19 April 1977.

Fig. 10. Racking phase of agricultural development, San Joaquin Valley, Kern County, California, 17 June 1977.

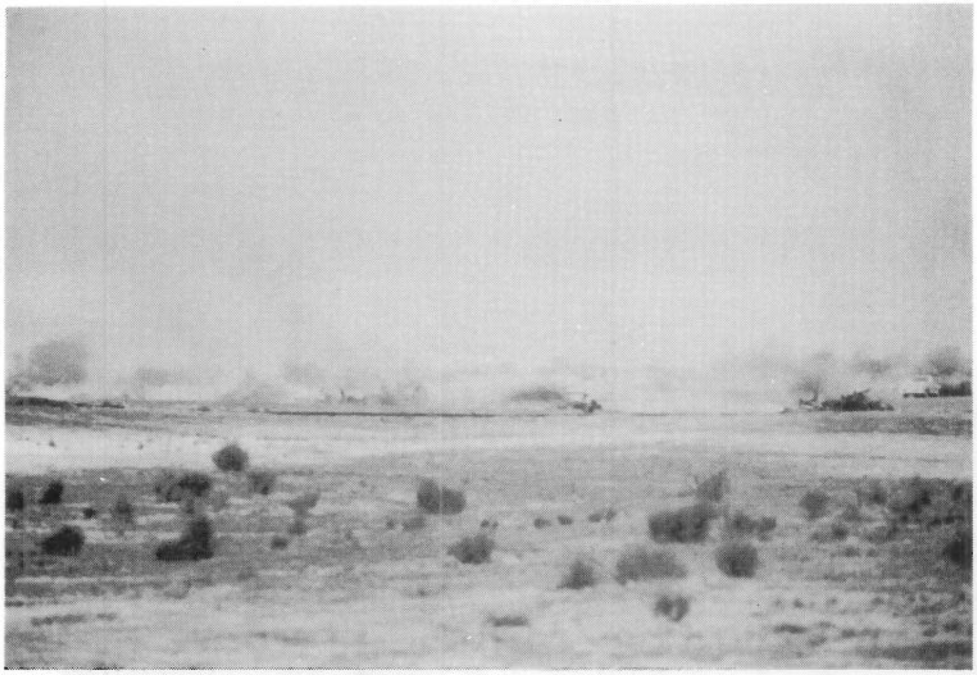

Fig. 11. Burning phase of agricultural development, San Joaquin Valley, Kern County, California, 25 May 1977.

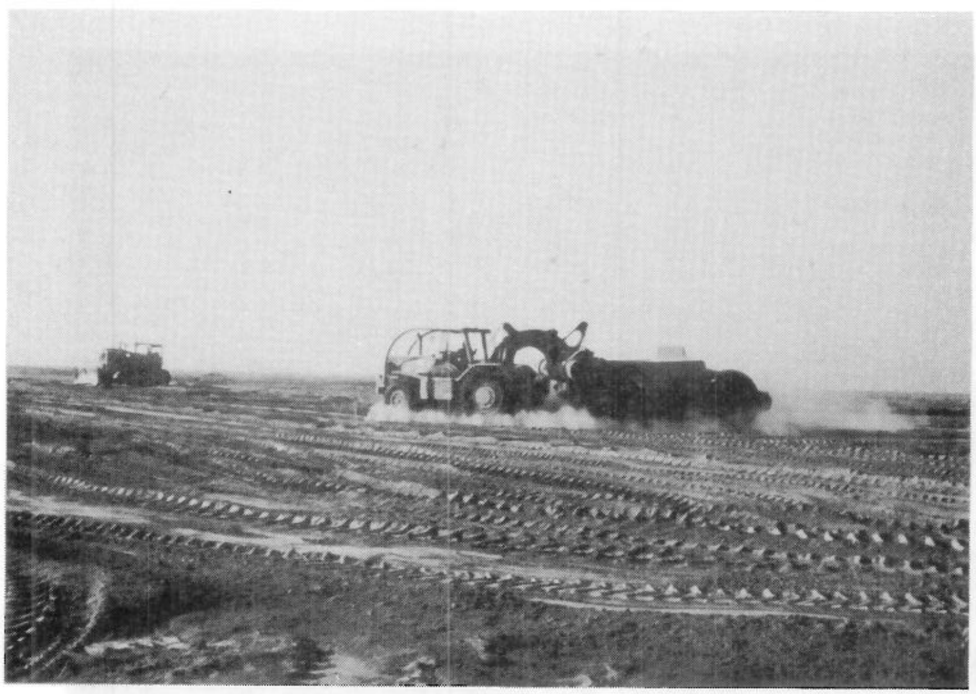

Fig. 12. Leveling phase of agricultural development, San Joaquin Valley, Kern County, California, 14 December 1977.

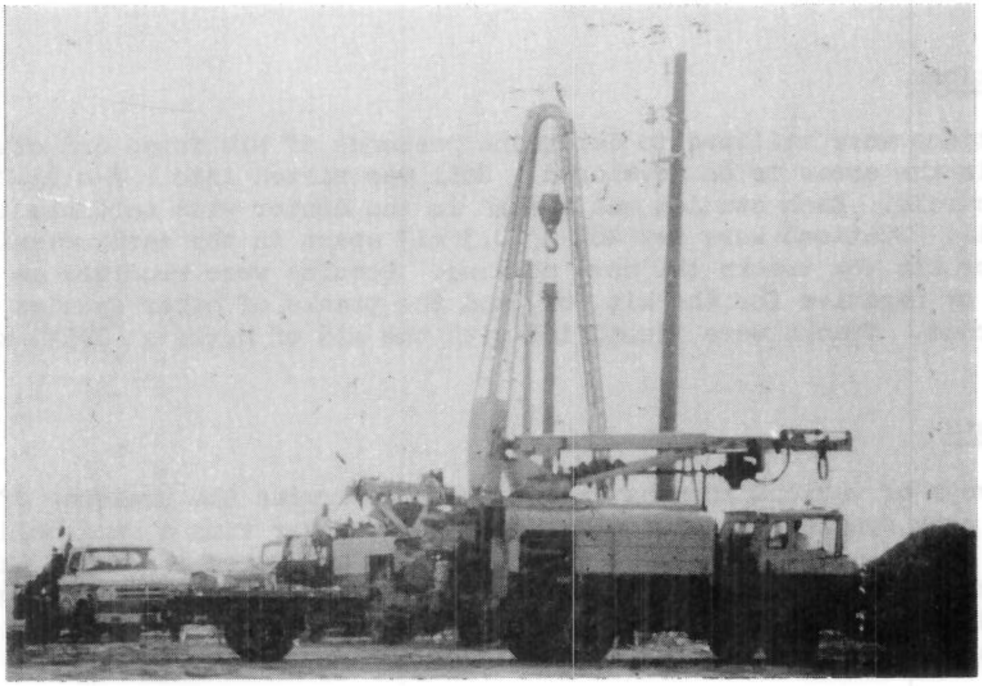

Fig. 13. Water delivery phase of agricultural development, San Joaquin Valley, Kern County, California, 14 December, 1977.

Ground Searches

Ground searches were done in areas proposed for development to determine location and numbers of active and inactive kit fox dens. In this study, a den was considered to be the lair of an animal not limited to the reproductive season. Searches were done by two people walking or riding small motorcycles on a straight line transect not more than 23 m (25 yd) apart. Locations of kit fox dens were recorded on photocopies of the topographic map of the particular land section. Data on the field maps were transferred to a master topographic map for the entire Tupman Essential Habitat Area. The numbers of active, possibly active, and inactive kit fox dens were totaled for each section of land. Dens of other carnivores were also noted.

Scent Stations

Scent stations were utilized to determine presence of kit foxes and other wildlife in the areas to be developed. Soil was sifted into a 1-m (3.2-ft) diameter circle. Each station was baited in the center with sardines in soybean oil. Stations were set 488 m (0.3 mi) apart in the early evening and checked for kit fox tracks the next morning. Results were recorded as positive, possible, or negative for the kit fox, and the tracks of other species were also recorded. Tracks were identified with the aid of Murie's (1954) text.

Night Counts

Night surveys of various lengths were done to determine the presence of kit foxes and prey species in critical areas. An observer with a hand-held spotlight sat on each side of the vehicle as it was driven 16-24 kph (10-15 mph). When eyeshine was seen, the vehicle was stopped and the animal was identified. Route location, weather, phase of the moon, time, mileage, and location and identity of the animal were recorded for each sighting.

Trapping

Trapping for kit foxes was initiated where foxes were present on areas of immediate development. Kit foxes were trapped in wire cage National live traps 0.8 x 0.3 x 0.4 m (32 x 12 x 16 in). Two traps were set at each station in areas of kit fox activity. Brush was put around the baited end of the trap to minimize digging activity to acquire bait.

Sardines in soybean oil, Velveeta cheese, and raisins were used as bait. Captured species other than kit fox were released. Kit foxes were removed from the trap, tagged, weighed, and sexed. If present, scats were collected. Some of the captured foxes were relocated to sites specified by the Region 4 Office of the DFG, if the foxes were judged to be in immediate danger due to land conversion operations.

Radio-collaring

To study the impact of agricultural development on the San Joaquin kit fox, 13 captured kit foxes were not relocated but were equipped with 159 MHz Telonics radio collars and were released at the capture site. The transmitters and instructions for use were obtained from Herb Hagen at the DFG Field Station in Sacramento. Each transmitter was attached to a leather dog collar, which was strapped around the neck of the fox. The collar transmitted up to 1.6 km (1 mi) when the fox was above ground and 91.4 m (100 yd) when the fox was in its den. Radio collar transmission was interpreted on a Telonics multi-frequency radio receiver as a constant series of beeps which become amplified as the fox was approached.

Monitoring

Foxes equipped with radio collars were monitored three times per week. Most monitoring was done at night during the normal activity period of this nocturnal species. When the radio signal was strong using the vehicle whip antenna, efforts were made to gain signal directions with smaller hand-held yagi antennas. Observation of the fox with the aid of a spotlight confirmed the location. The date, time, land use, location, phase of the moon, and weather conditions were recorded for each observation.

Den Locations

Den locations were determined by following the foxes at dawn as they returned to their dens. Active dens were also found by searching areas for den sites and testing these sites for a radio signal to indicate fox presence. An active den was one used by the fox three or more times.

Home Range

Minimum home range for an individual fox was determined by planimetry analysis of three or more mapped sightings. Minimum home range figures were determined for the final total range of the kit fox and for the range of the fox during applicable development phases.

Aerial Search

Two combined aerial and ground searches were made to determine the location of radio-collared foxes. The pilot and one project member flew over the study areas in a receiver-equipped fixed-wing aircraft at an altitude of approximately 152 m (500 ft) and a speed of 145 kph (90 mph). The plane could provide a general signal direction and could cover areas inaccessible by vehicle. When a signal was heard by plane personnel, the ground crew in a vehicle would be directed by two-way radio to a location at which the vehicle receiver was in range of the radio-collar transmitter.

Holding Foxes

Facilities were provided by Dr. Ted Murphy at California State College, Bakersfield, for holding captured foxes and raising fox pups. A cage provided by DFG was installed at the Facility for Animal Care and Treatment (FACT) at the college. Three San Joaquin kit fox pups were raised during the study. The foxes were fed a diet of American coots (Fulica americana) and Norway rats (Rattus norvegicus). One fox died at the facility. At an approximate age of six months, two foxes were tagged and released in the Tupman Essential Habitat Area. One of the two kit foxes was radio-collared and monitored to determine its adaptability to a new environment.

Prey Diversity

Small mammal trapping to determine diversity of potential kit fox prey was done in conjunction with kit fox trapping. Folding Sherman live traps 0.23 x 0.08 x 0.09 m (9.0 x 3.0 x 3.5 in) were utilized. Two traps were set at each fox-trapping station at a site of an active rodent burrow or dust bath. Bait consisted of crushed milo, corn, wheat, barley, and oats. Captured small mammals were identified, using keys from Ingles' (1965) text, and released at the capture site or collected as specimens and stored at California State College, Bakersfield. Diversity of prey species was also determined by collection of known age kit fox scats in conjunction with fox trapping. Scats left by the captured fox were put into paper bags with mothballs and labeled with the date, kit fox tag and radio collar numbers, and exact location by range, township, and section. The type of bait used for trapping was also recorded. The samples were sent for analysis to Bill Grenfell at the DFG Field Station.

Kit Fox Activity in Intensive Agriculture

To determine adaptations of the San Joaquin kit fox to intensively farmed areas, evidence of kit fox activity was searched for in established agricultural areas. Active dens, fresh scats, and tracks were considered positive signs of kit fox activity. Brief ground surveys were conducted in conjunction with the USFWS to find areas of current kit fox activity. Portions of the California aqueduct adjacent to agriculture were also searched. Landowners and county, state, and federal personnel were interviewed regarding kit fox activity in agricultural areas. Attempts to observe kit foxes in areas of positive sign were not made, due to time requirements for other parts of this study.

Potential Ecological Reserve Sites

Areas of native vegetation on the San Joaquin Valley floor suitable for habitation by the San Joaquin kit fox and not immediately proposed for agricultural development were considered for preservation as ecological reserve sites. Undisturbed areas of at least 2.6-5.2 sq km (1-2 sq mi) of the Alkali-sink Plant Association were regarded as suitable areas for kit fox habitation. The areas were examined for the presence of rodents and larger prey species. Presence of active and potential den sites of kit foxes and other carnivores was utilized as a criterion for possible kit fox habitation. A high index of carnivore activity may limit the possibility of relocation of San Joaquin kit foxes to potential ecological reserve sites. Suggestions for potential sites were given by USFWS and DFG personnel. All of the suggested areas were evaluated on the basis of their plant and wildlife diversity, the presence of rare and endangered flora and fauna, and unique geographic features. Importance of the area at the federal, state, and local levels, owner cooperation, recreation values, access, and management potential were also deciding factors in the selection of a site.

RESULTS

Land Conversion and Ground Searches

Of the 1,497 ha (3,700 ac) proposed for development in the Tupman Essential Habitat Area, 979 ha (2,420 ac) had been developed by the end of this study. In the 7th Standard Area, 1,149 ha (2,840 ac) of the proposed 1,408 ha (3,480 ac) were developed. Results of ground searches in areas proposed for development are summarized in Table 2. Section 14, T30S, R25E, and section 10, T30S, R26E, were also searched. These sections were developed concurrently with the original proposed areas. Six of the seven active dens which were found were in areas to be developed immediately.

* * *

Table 2. Results of ground searches for San Joaquin kit fox dens, western Kern County, California, 1977.

Area	Number of Active Dens	Number of Possibly Active Dens	Number of Inactive Dens	Total Kit Fox Dens	Other Dens
Tupman Area					
T30S R25E					
Section 13	-	-	2	2	2 coyote
Section 14	-	2	-	2	-
Section 23	2	1	-	3	3 coyote
Section 24	1	6	2	9	1 coyote
Section 35	-	-	8	8	-
7th Standard Area					
T30S R26E					
Section 10	3	6	2	11	-
Section 21	-	-	3	3	-
Section 28	-	-	2	2	1 coyote
Section 33	-	1	5	6	-
Other					
T31S R26E					
Section 8	-	7	7	14	2 coyote
Section 9	-	1	-	1	-
Section 10	-	-	-	0	-
Section 15	-	-	1	1	-
Section 19	-	2	-	2	-
Section 20	1	1	4	6	-
Section 22	-	-	-	0	-
Section 23	-	-	-	0	-
Section 26	-	1	1	2	-

* * *

Scent Stations and Night Counts

The scent station index confirmed kit fox activity in areas proposed for early development (Table 3). Twelve of 141 stations (8.5%) had positive kit fox tracks. Nine night-count routes of over 65.2 km (40.5 mi) in areas proposed for early development were driven. Three kit foxes were seen, for an average of one kit fox per 21.7 km (13.5 mi). One fox was seen on each of the following night count routes: Section 24, T20S, R25E, one fox per 6.0 km (3.7 mi); Section 35, T30S, R25E, one per 6.9 km (4.3 mi); and Sections 8 and 17, T31S, R26E, one per 14.0 km (8.7 mi) (Fig. 2).

* * *

Table 3. Results of scent stations for San Joaquin kit fox presence, western Kern County, California, 1977.

Area	Number of Stations	Number (%) of Stations With Positive Kit Fox Tracks	Number (%) of Stations With Possible Kit Fox Tracks	Other Tracks
T30S R25E				
Section 13, 24	10	-	-	*Dipodomys* spp., unid. rodent.
Section 23	13	1 (7.7)	1 (7.7)	*Lepus californicus*, *Sylvilagus audubonii*.
Section 35	16	1 (6.2)	-	*L. californicus*, *S. audubonii*, Unid. rodent.
T30S R26E				
Section 10	17	-	2 (11.8)	*Dipodomys* spp., *S. audubonii*, *L. californicus*, *Canis latrans*.
Section 21	9	2 (22.2)	-	Unid. rodent.
Section 28	7	2 (28.6)	-	*Spermophilus beecheyi*, *S. audubonii*.
Section 33	11	1 (9.1)	2 (18.2)	*S. audubonii*, *L. californicus*.
T31S R26E				
Section 8, 17	14	3 (21.4)	-	*S. audubonii*, *L. californicus*, *Dipodomys* spp., Unid. lizard, Unid. rodent.
Section 10, 15	20	1 (5.0)	1 (5.0)	*S. audubonii*, *C. latrans*, *Dipodomys* spp., Unid. rodent.
Section 19, 20	11	-	-	*C. latrans*, *Dipodomys* spp., Sheep, Unid. bird.
Section 22, 23, 26	13	1 (7.7)	1 (7.7)	*S. audubonii*, *Dipodomys* spp.

* * *

Disposition of Kit Foxes

Forty-one San Joaquin kit foxes were acquired during this study (Appendix V). Thirty-eight individual foxes were captured, with 36 recaptures (Table 4), resulting in 74 captures in 1,036 trap nights (7.1%). Two foxes were acquired from DFG wardens and one fox was captured on the campus of California State College, Bakersfield. These three foxes were cared for at the college. All 41 foxes were tagged and 15 of the 41 were equipped with radio collars.

* * *

Table 4. Results of trapping for San Joaquin kit foxes, western Kern County, California, 1977.

Area	Number (%) of Kit Foxes	Number of Recaptures	Number of Trap Nights	Other Species
Tupman Essential Habitat Area				
T30S R26E				
Section 10	-	-	14	-
T30S R26E				
Section 13	-	-	15	-
Section 14	-	-	2	Roadrunner
Section 23	-	-	37	-
Section 24	6 (6.6)	2	90	Striped skunk
Section 35	14 (10.3)	7	136	-
T31S R26E				
Section 8, 9, 17	4 (2.4)	2	169	-
Section 10, 15	2 (2.2)	1	93	-
Section 22, 23, 26	1 (1.4)	-	73	-
7th Standard Area				
T28S R24E				
Section 36	9 (19.6)	-	46	-
T29S R25E				
Section 6	8 (7.6)	3	105	Dog
Section 8	20 (10.2)	16	197	Cat
Section 18	10 (16.9)	5	59	-

* * *

Twelve of the 38 captured foxes were relocated to areas selected by the DFG Region 4 Office because these foxes were judged to be in immediate danger due to land conversion operations. Due to time limitations, this study did not include assessing the adaptations of these 12 foxes to their new environment. However, two radio-collared and three tagged foxes were relocated to the Mendota Wildlife Area in Fresno County, and radio tracking of the collared foxes was done by the refuge staff. Of the five Mendota foxes, radio-collared fox 1A was not found after release. An aerial search for a radio signal on August 3, 1977, was negative. Kit fox 2B (radio-collared) was found dead. Fox 588 (tagged only) was killed by a coyote. The fate of foxes 556 and 571 is not known. Six foxes threatened with immediate mortality were tagged and relocated to the Elk Hills Naval Petroleum Reserve in Kern County. The status of these foxes is unknown. One fox was tagged and relocated to the Los Banos Wildlife Area in Merced County. The status of this fox is unknown. Two of the three raised foxes, one equipped with a radio collar, were relocated to the Tupman Essential Habitat Area on property along the Kern River owned by the City of Bakersfield, in Section 9, T30S R26E (Fig. 2). The movements of the radio-collared fox were recorded during this study, but the fate of the tagged fox is unknown.

Monitoring

Thirteen of the 41 foxes were monitored in this study as follows: 10 in the Tupman Essential Habitat Area and three in the 7th Standard Area. One hundred and ninety three sightings were made for 13 foxes from April 19 to December 30, 1977 (Fig. 14). The number of sightings per fox ranged from three to 50 with an average of 14.8. Radio-collared fox 1A was captured during the brushing phase on Section 24 in the Tupman Essential Habitat Area (Fig. 15), and was monitored from April 19 to May 4, 1977. Five sightings during the brushing phase were made. Total minimum range for this fox was 112.8 ha (278.7 ac). This fox utilized the brushed area for foraging, but a den search of the area was negative. The fox remained in the area until an aerial search confirmed its death 16 days after capture. The carcass was found on an adjacent area of native vegetation (Fig. 15). Cause of death for the fox was unknown.

Fox 2A was captured during the brushing phase on Section 24 (Fig. 16), and was monitored from April 19 to November 19, 1977. This fox was sighted six times during the brushing phase and 15 times after development was completed. Minimum home range during the brushing phase was 130.6 ha (322.6 ac). After development it increased to 173.8 ha (429.5 ac). The total minimum home range for the monitoring period was 749.2 ha (1,851 ac). Fox 2A used the brushed area for foraging. During the brushing phase, a 3-m (10-ft) oil pipe on an adjacent area of native vegetation was used as a den for a minimum of 30 days. The oil pipe was 1.6 km (1 mi) from the brushing activities. After the leveling phase was completed, fox 2A moved 3.2 km (2 mi) southwest of the graded area to native vegetation in Section 35 (Fig. 16). Fox 2A used a den on Section 35 for a minimum of 14 days and utilized adjoining sections of native vegetation. It was found dead in a neighboring cotton field. Its death was possibly due to injuries received from a collision with mechanical farming equipment.

During the brushing phase, fox 3 was captured on Section 24 (Fig. 17), and was monitored from May 5 to June 8, 1977. Fox 3 had a total of nine sightings as follows: 2 in the brushing phase, three in the leveling phase, and four after completion of the development. Minimum home range was 127.7 ha (315.3 ac). After completion of development, the four sightings show a minimum home range of 24.1 ha (59.6 ac). This fox was found on the developed area during the brushing and leveling phases. During those two phases fox 3 used one den in adjacent native vegetation for a minimum of 13 days. Contact with this fox was lost 35 days after capture. An aerial search for a radio signal was negative.

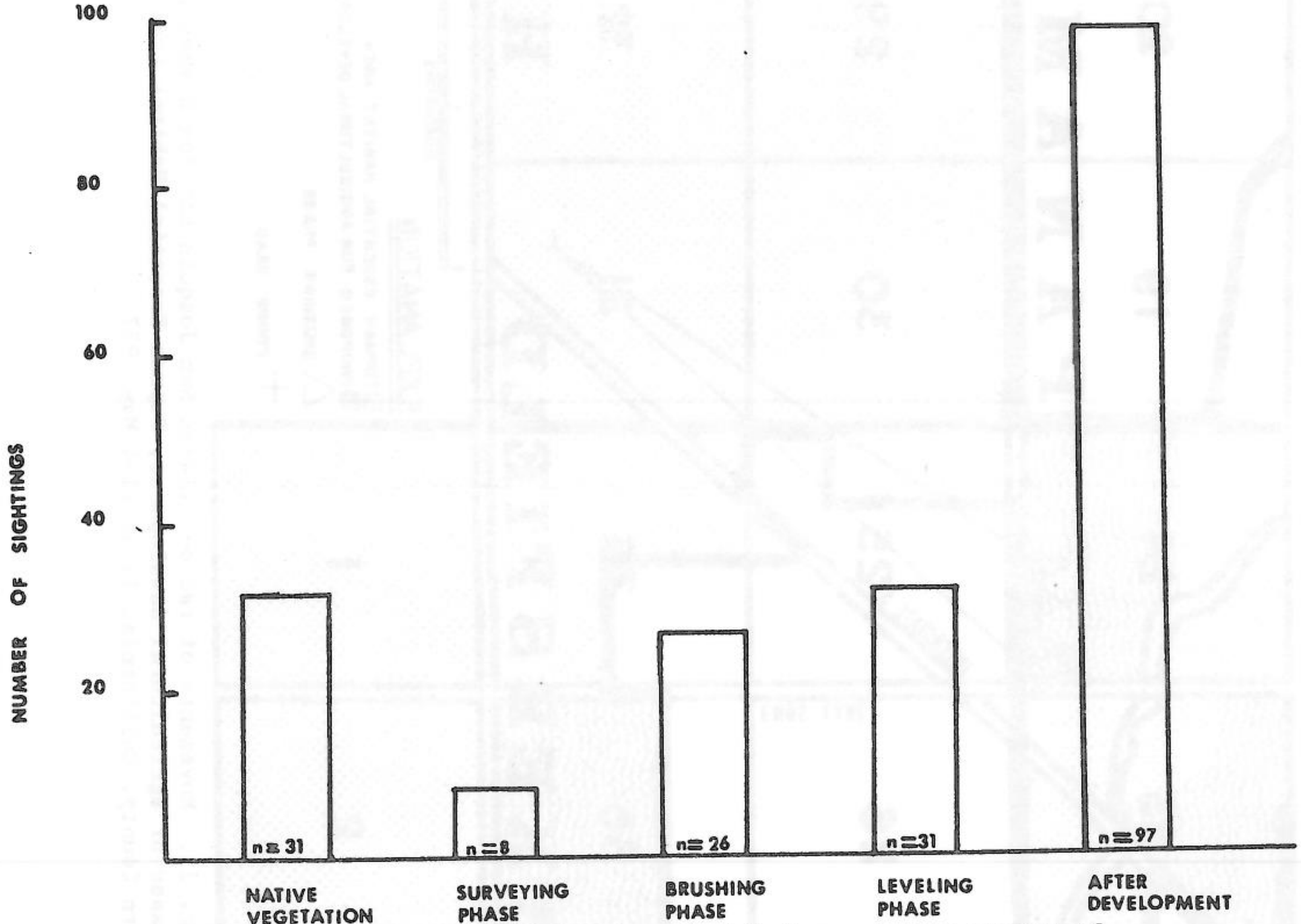

Fig. 14. Activity of radio-collared San Joaquin kit foxes during phases of agricultural development, Kern County, California, 19 April-30 December 1977.

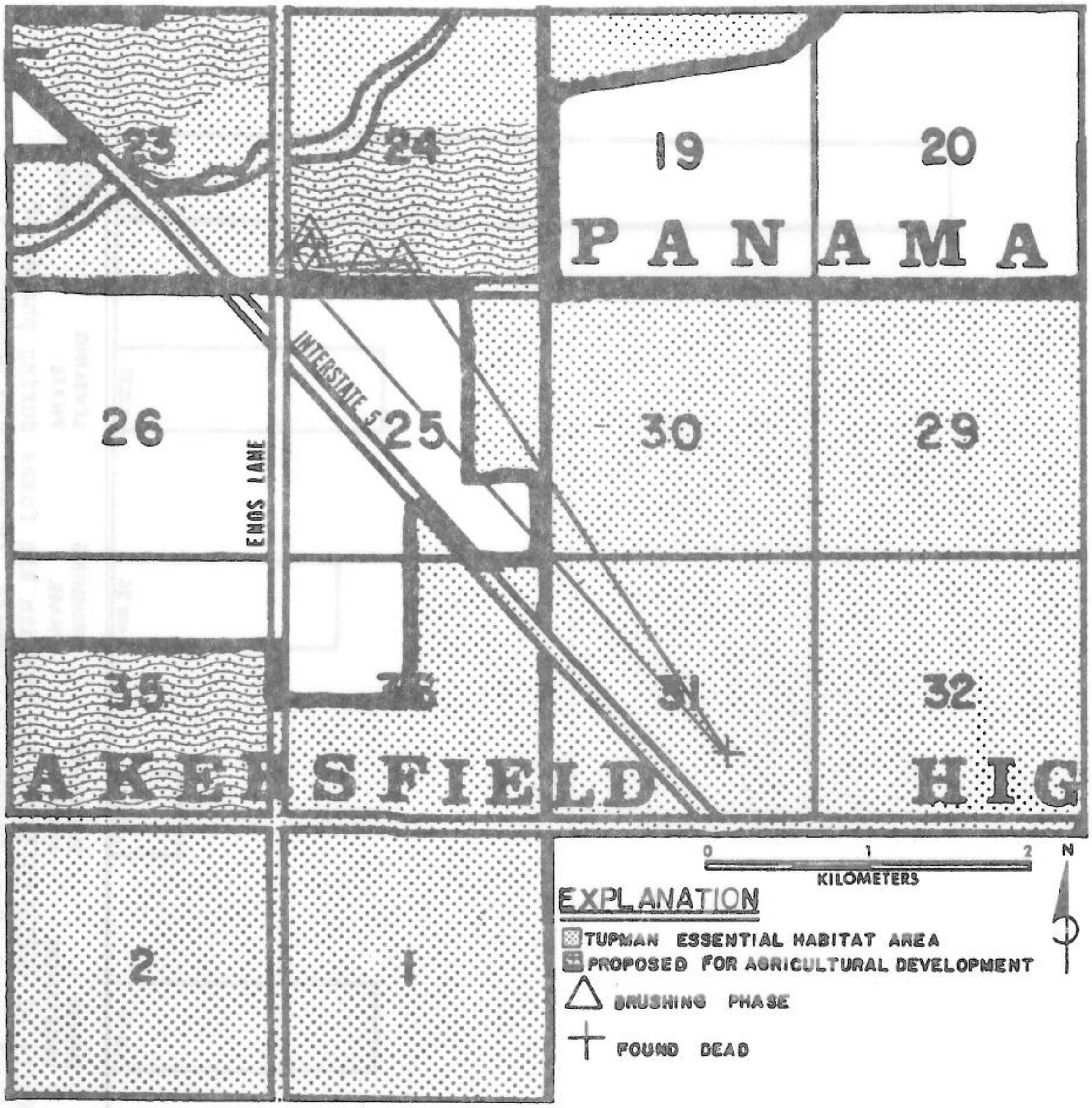

Fig. 15. Movements of radio-collared San Joaquin kit fox number 1A during phases of agricultural development, Tupman Essential Habitat Area, western Kern County, California, 19 April-4 May 1977.

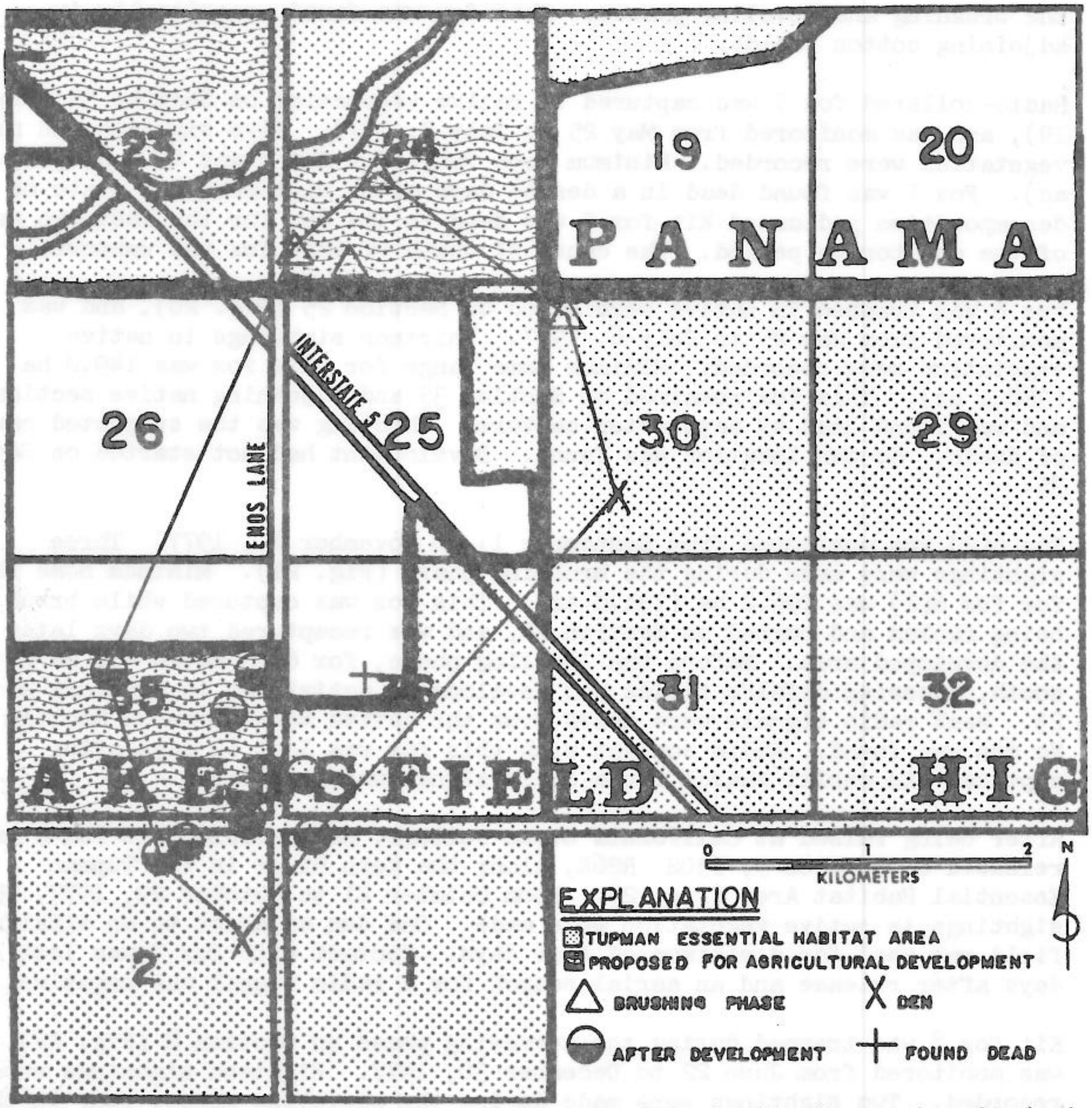

Fig. 16. Movements of radio-collared San Joaquin kit fox number 2A during phases of agricultural development, Tupman Essential Habitat Area, western Kern County, California, 19 April-19 November 1977.

Kit fox 4 was captured during the brushing phase on Section 24 (Fig. 18), and was monitored from May 6 to December 19, 1977. Fifty sightings were made as follows: one in the brushing phase, two in the leveling phase, and 47 after development was completed. Minimum home range for this fox was 479.6 ha (1,185 ac). This fox frequented the native vegetation adjacent to the developed area. After development, oil pipes at two different locations in native vegetation were used interchangeably as dens for a minimum period of 21 days. Fox 4 used the developed area through and after the completion of the brushing and leveling phases. This fox was found occasionally in adjoining cotton fields.

Radio-collared fox 5 was captured in native vegetation on Section 35 (Fig. 19), and was monitored from May 25 to July 7, 1977. Five sightings in native vegetation were recorded. Minimum home range for fox 5 was 49.9 ha (113.5 ac). Fox 5 was found dead in a den 44 days after capture. The state of decomposition indicated kit fox 5 was dead in its den for the last two weeks of the monitoring period. The cause of death of this fox was unknown.

Fox 6 was trapped in native vegetation on Section 25 (Fig. 20), and was monitored from May 25 to July 6, 1977. Thirteen sightings in native vegetation were recorded. Minimum home range for this fox was 149.0 ha (368.1 ac). This fox remained on Section 35 and adjoining native sections and was found dead 43 days after capture. Shooting was the suspected cause of death. No den location was found. Development had not started on Section 35.

Fox 6(2) was monitored from September 14 to November 11, 1977. Three sightings were made during the brushing phase (Fig. 21). Minimum home range for fox 6(2) was 296.2 ha (731.8 ac). This fox was captured while brush was being racked and burned on Section 10, and was recaptured two days later in the developed area. Before the leveling phase, fox 6(2) moved 4.8 km (3 mi) south, crossing alfalfa fields and development activities in Sections 22 and 23. Weak radio signals were heard from the native vegetation on Section 25. No den was found. Radio contact with this fox was lost 59 days after capture. An aerial search for a radio signal was negative.

After being raised at California State College, Bakersfield, kit fox 7 was released on Section 9, T30S R26E, along the Kern River in the Tupman Essential Habitat Area (Fig. 2). From October 21 to October 29, 1977, three sightings in native vegetation were made. One den adjacent to an alfalfa field was used for a minimum of four days. Contact with fox 7 was lost nine days after release and an aerial search for a radio signal was negative.

Kit fox 8 was trapped during the surveying phase on Section 8 (Fig. 22), and was monitored from June 22 to December 30, 1977. Eighteen sightings were recorded. Two sightings were made during the surveying phase, four in the brushing phase, two in the leveling phase, and ten after development was completed. Minimum home range during the brushing phase was 90.0 ha (222.4 ac). One den was found after development was completed. This den was utilized for a minimum of three days. Fox 8 was found on Section 8 early in the brushing phase, but not late in the brushing phase or in the leveling phase. No sightings were made on the leveled area after land conversion operations were completed.

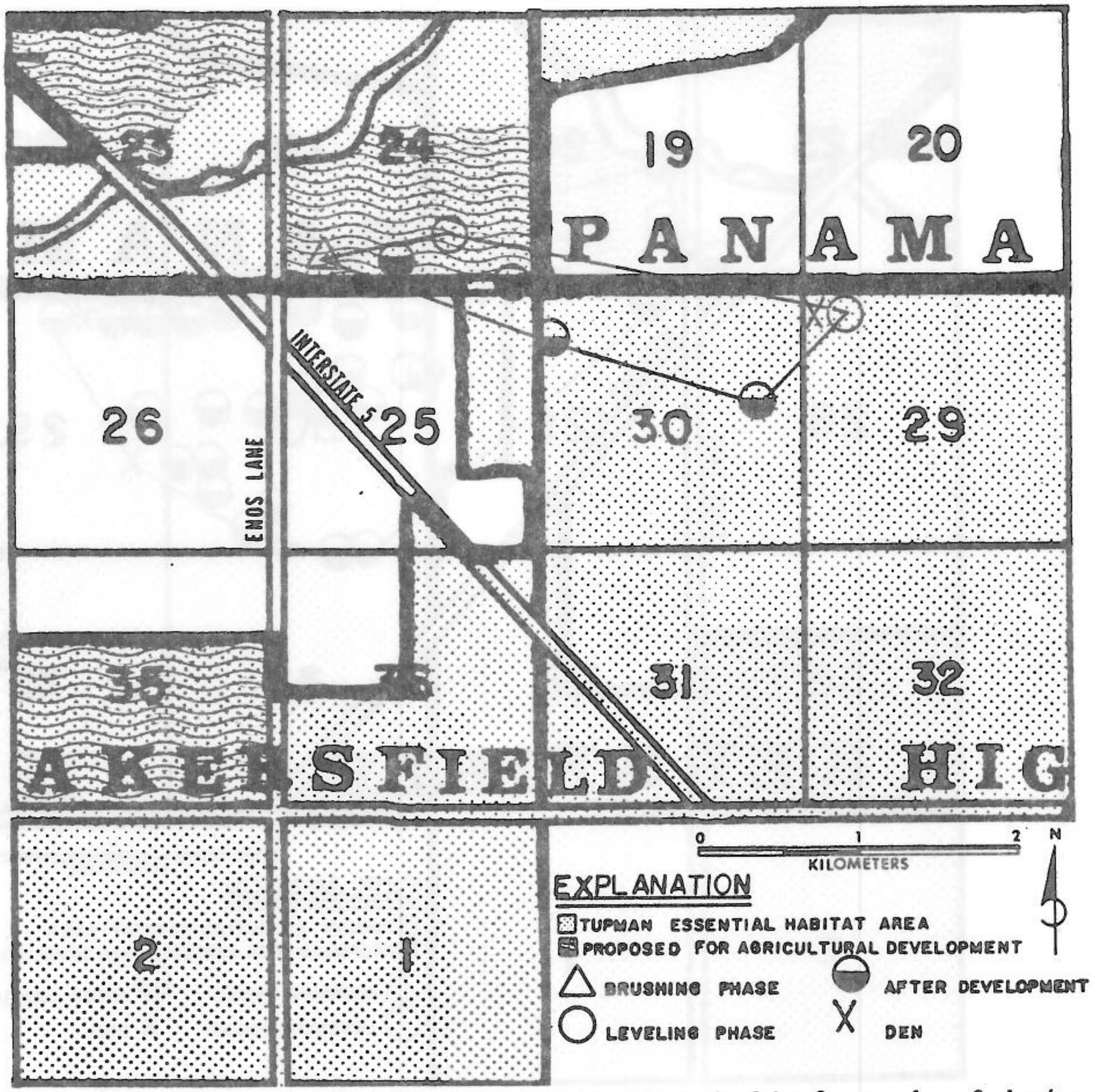

Fig. 17. Movements of radio-collared San Joaquin kit fox number 3 during phases of agricultural development, Tupman Essential Habitat Area, western Kern County, California, 5 May-8 June 1977.

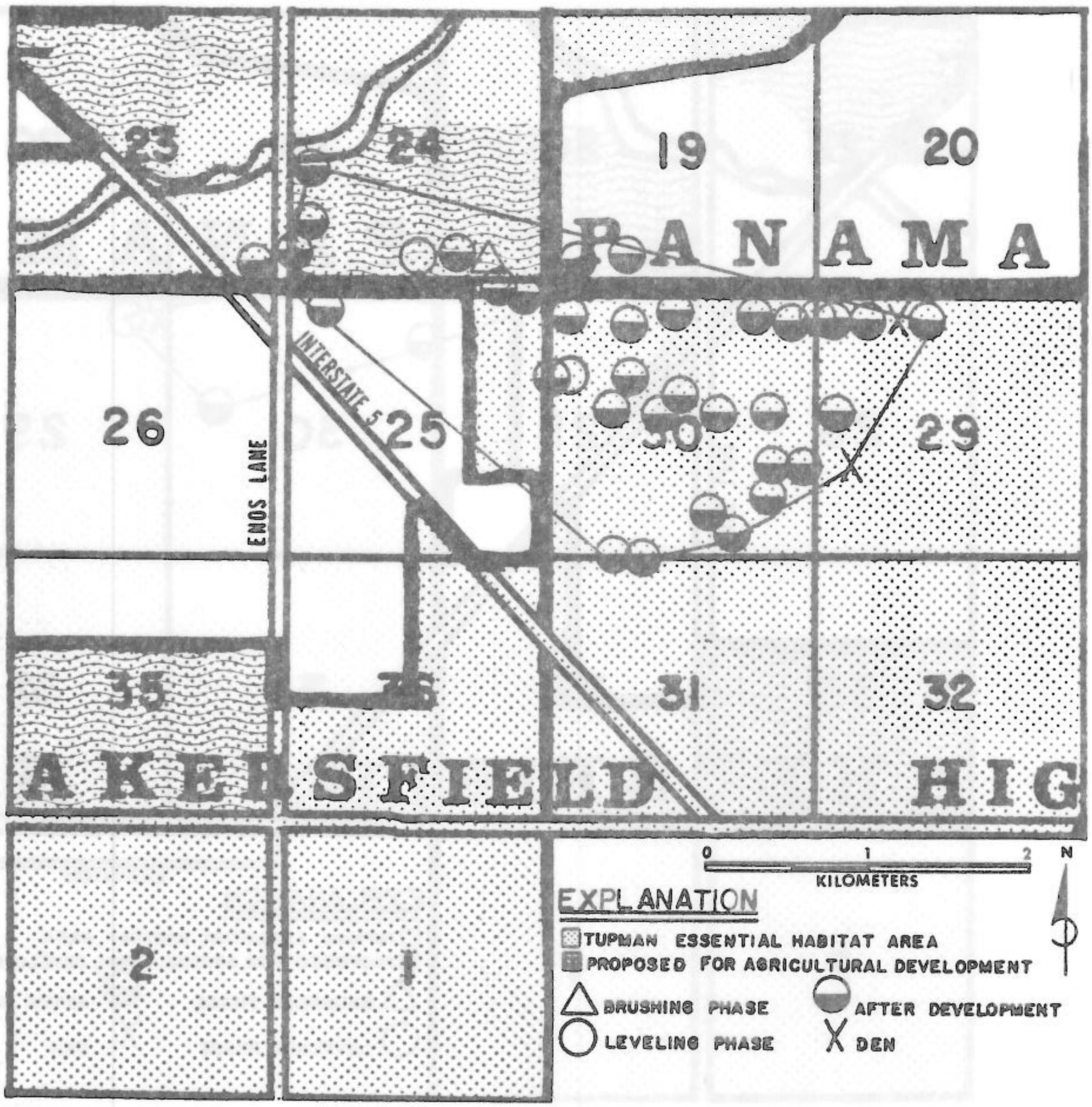

Fig. 18. Movements of radio-collared San Joaquin kit fox number 4 during phases of agricultural development, Tupman Essential Habitat Area, western Kern County, California, 6 May-19 December 1977.

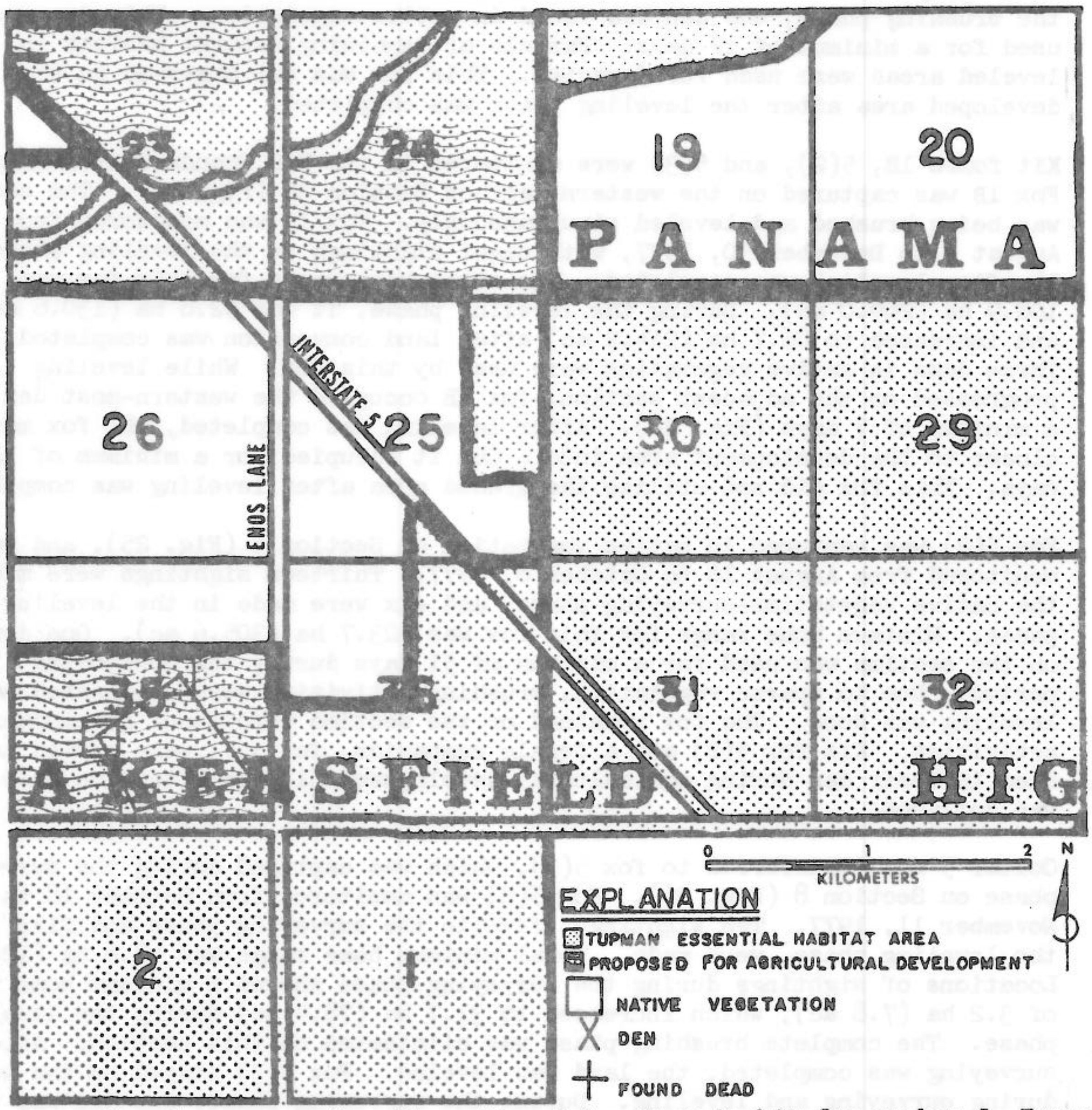

Fig. 19. Movements of radio-collared San Joaquin kit fox number 5, Tupman Essential Habitat Area, western Kern County, California, 25 May-7 July 1977.

Kit fox 9 was captured during the brushing phase on Section 8 (Fig. 23), and was monitored from July 6 to December 19, 1977. Eighteen sightings were recorded for this fox as follows: one in the surveying phase, five in the brushing phase, five in the leveling phase, and seven after development was completed. Total minimum home range for this fox was 325.8 ha (805.1 ac).

During the leveling phase, the minimum home range was 141.0 ha (348.3 ac). After completion of development, it decreased to 83.9 ha (207.2 ac). During the brushing phase, one den was found in native vegetation. This den was used for a minimum of 12 days. Parcels of remaining natural habitat in leveled areas were used for foraging. This fox was not observed on the developed area after the leveling phase was completed.

Kit foxes 1B, 5(2), and 5(3) were monitored in the 7th Standard Area (Fig. 3). Fox 1B was captured on the western half of Section 36 (Fig. 24). The section was being brushed and leveled simultaneously. Fox 1B was monitored from August 4 to December 30, 1977, with eight sightings in the leveling phase and 14 after leveling was completed. The total home range for this fox was 108.9 ha (269.0 ac). During the leveling phase, it was 52.8 ha (130.6 ac) and increased to 86.7 ha (214.2 ac) after land conversion was completed. Three dens in native vegetation were used by this fox. While leveling progressed on the adjacent section, fox 1B occupied the western-most den for a minimum of 7 days (Fig. 24). After leveling was completed, the fox moved closer to the development area into a den it occupied for a minimum of 11 days. This fox did not utilize the graded area after leveling was completed.

Fox 5(2) was captured in native vegetation on Section 6 (Fig. 25), and was monitored from August 10 to October 8, 1977. Thirteen sightings were made in the native vegetation-surveying phase, and six were made in the leveling phase. Minimum home range for this fox was 123.7 ha (305.6 ac). One den on the section was used for a minimum of 51 days during the monitoring period. Due to sparse vegetation, brushing activities were eliminated but leveling was done. The fox remained on the section throughout development activities. Kit fox 5(2) and a female companion, fox 557, were buried and died in their den during agricultural development 61 days after the male was collared.

Collar 5 was transferred to fox 5(3), which was captured during the surveying phase on Section 8 (Fig. 26). Fox 5(3) was monitored from October 18 to November 11, 1977. Ten sightings, five in the surveying phase and five in the leveling phase, were made. Total minimum home range was 48.6 ha (120.2 ac). Locations of sightings during the surveying phase showed a minimum home range of 3.2 ha (7.8 ac), which increased to 31.7 ha (78.4 ac) during the leveling phase. The complete brushing phase was eliminated on this section. After surveying was completed, the land was leveled. Fox 5(3) stayed on the section during surveying and leveling. During the surveying phase, one den was used for a minimum of six days. During agricultural development, fox 5(3) was buried and died in a new den 25 days after being collared. No other fox was found in the den.

Home Range

Radio telemetry showed that nine of 11 kit foxes which were monitored on conversion areas stayed on or near the converted areas during all phases of development. The two other radio-collared foxes were relocated to wildlife

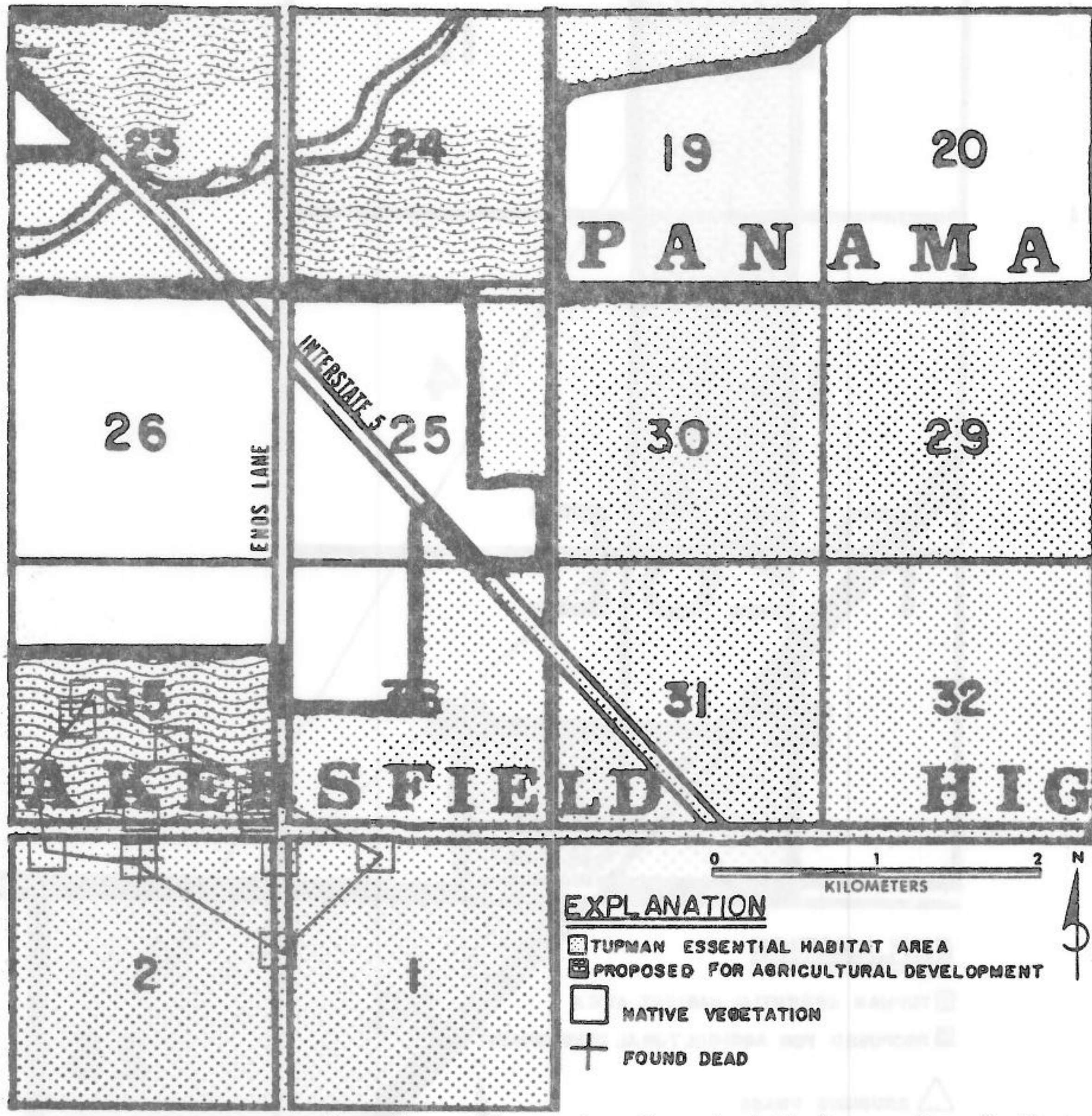

Fig. 20. Movements of radio-collared San Joaquin kit fox number 6, Tupman Essential Habitat Area, western Kern County, California, 25 May-6 July 1977.

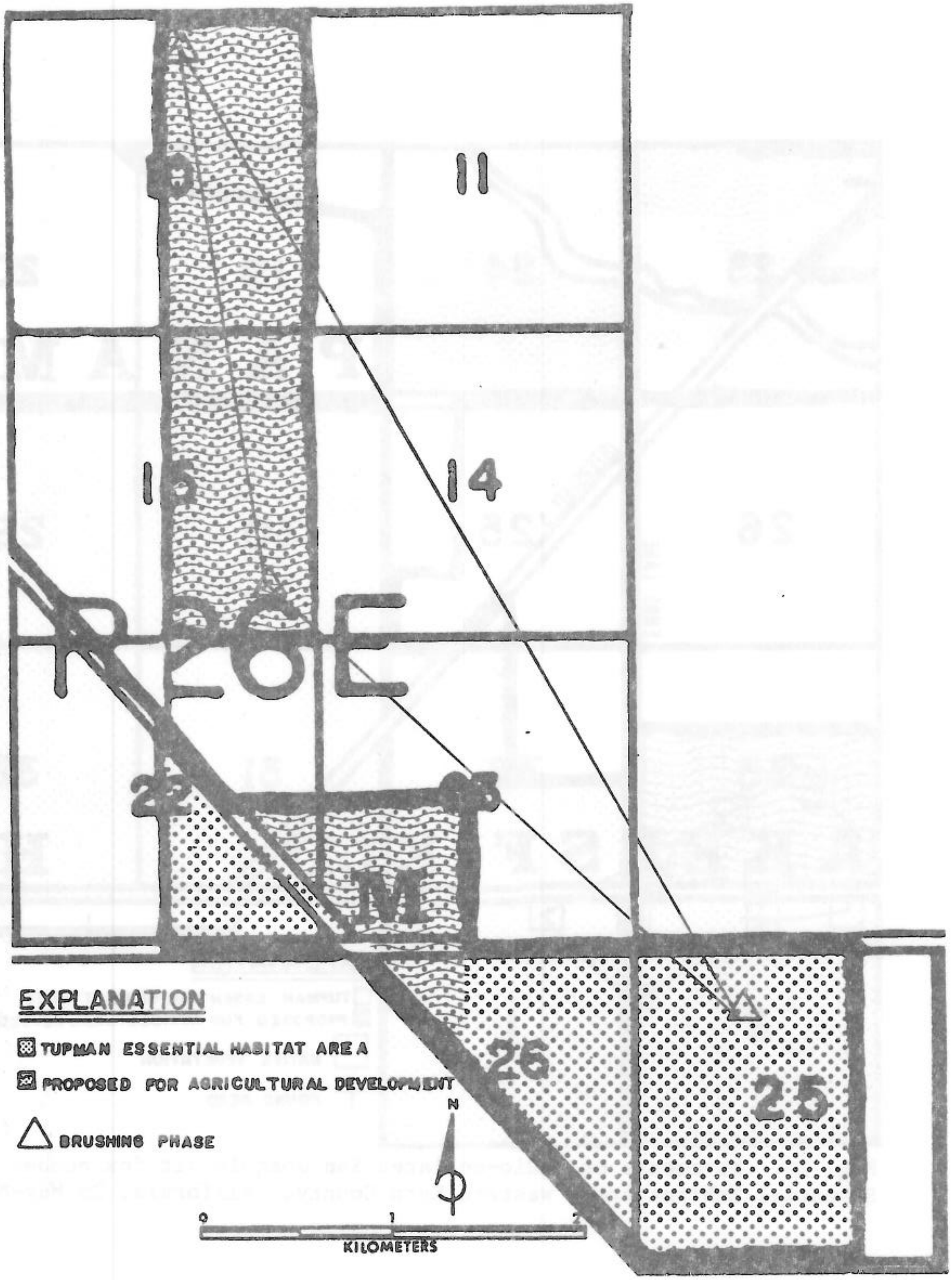

Fig. 21. Movements of radio-collared San Joaquin kit fox number 6(2) during phases of agricultural development, Tupman Essential Habitat Area, western Kern County, California, 14 September-11 November 1977.

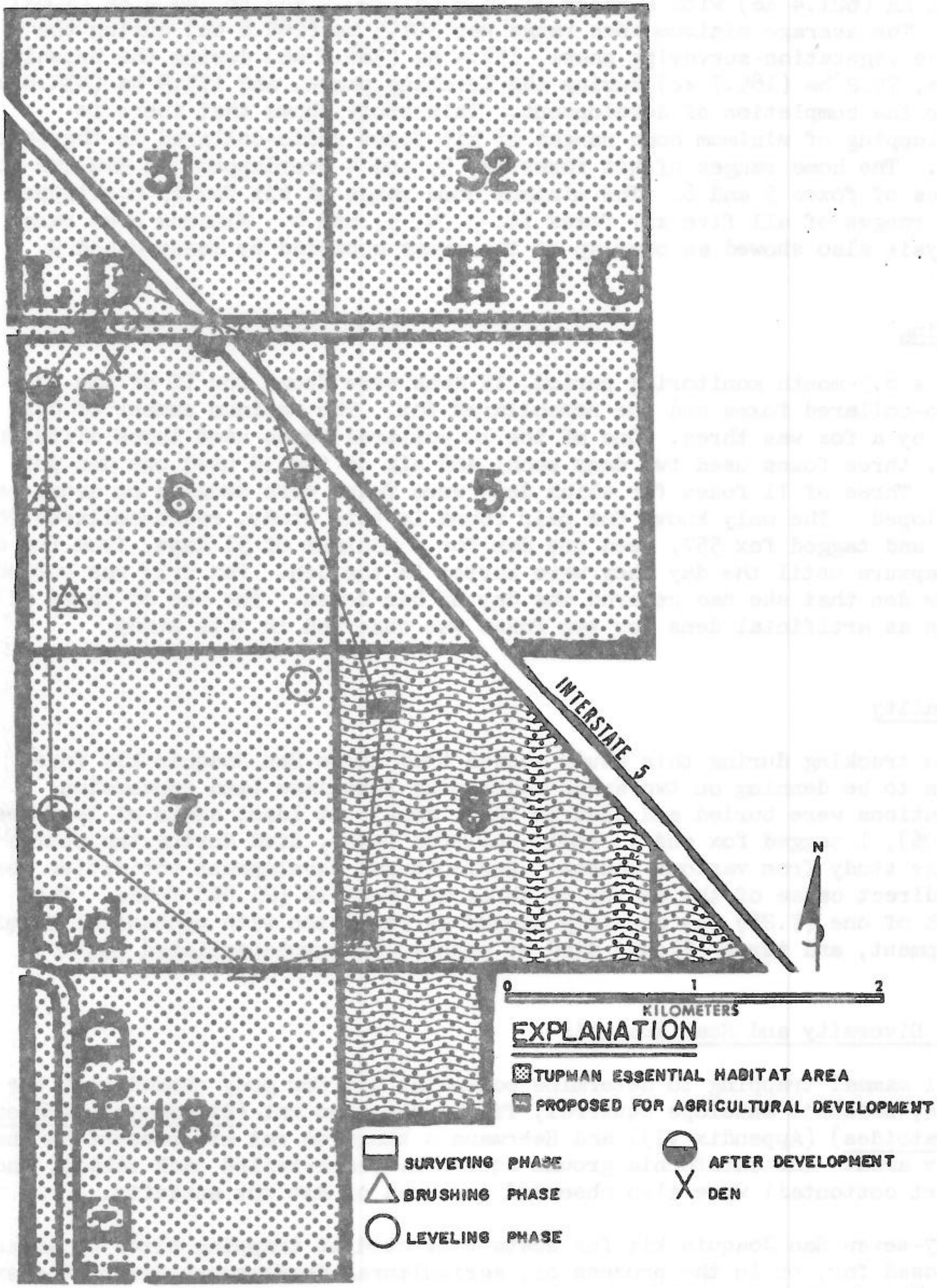

Fig. 22. Movements of radio-collared San Joaquin kit fox number 8 during phases of agricultural development, Tupman Essential Habitat Area, western Kern County, California, 22 June-30 December 1977.

areas upon capture. The average of nine total minimum home ranges was 251.6 ha (621.4 ac) with a range of 48.6 ha (120.2 ac) to 749.2 ha (1,851 ac). The average minimum home range was 107.5 ha (265.6 ac) during the native vegetation-surveying phase, 157.4 ha (388.8 ac) during the brushing phase, 75.2 ha (185.7 ac) during the leveling phase, and 175.9 ha (434.4 ac) after the completion of development. This study shows that there is overlapping of minimum home ranges of kit foxes radio-collared in the same area. The home ranges of kit foxes 1A, 3, and 4 overlapped, as did the home ranges of foxes 5 and 6. The minimum home range of kit fox 2A overlapped the home ranges of all five kit foxes 1A, 3, 4, 5, and 6. Minimum home range analysis also showed an overlap of the areas occupied by foxes 8 and 9.

Denning

Over a 8.5-month monitoring period, 15 dens were found for 10 of the 13 radio-collared foxes and one noncollared fox. The maximum number of dens used by a fox was three. One of the 10 collared foxes used three different dens; three foxes used two dens each; and six of the 10 used one den per fox. Three of 11 foxes for which dens were found were denning on areas being developed. The only known fox pair found in this study, radio-collared fox 5(2) and tagged fox 557, used one den for a minimum of 51 days, from the date of capture until the day they were buried in the den. Fox 5(3) was buried in a new den that she had entered the day of her death. The use of three oil pipes as artificial dens for two foxes was observed in this study.

Mortality

Radio tracking during this study showed that three San Joaquin kit foxes known to be denning on two areas undergoing immediate land conversion operations were buried and died in their dens. At least seven of 14 foxes (50.0%), 1 tagged fox and 13 radio-collared foxes, died during the course of the study from various causes. Agricultural development activities were the direct cause of the deaths of three of these 14 (21.4%) foxes. The death of one (7.2%) was possibly caused by collision with mechanical farming equipment, and three (21.4%) died of unknown or unsubstantiated causes.

Prey Diversity and Scat Analysis

Small mammal trapping to determine potential kit fox prey showed that the deer mouse, Nelson's antelope squirrel, Tipton kangaroo rat (Dipodomys nitratoides nitratoides) (Appendix VI), and Heermann's kangaroo rat are present in the study area. The California ground squirrel, black-tailed jack rabbit, and desert cottontail were also observed in areas of kit fox activity.

Forty-seven San Joaquin kit fox scats collected at trapping sites on areas proposed for, or in the process of, agricultural development during the study were analyzed at the DFG Field Station. Thirty of the scat samples were from foxes captured during the native vegetation-surveying phase, eight from the brushing phase, and nine from the leveling phase. The analysis indicates that cottontails are the main food item of the kit fox in all phases of development (Table 5). Jack rabbits represent the next most frequent vertebrate in the scats. Invertebrates such as beetles, ants, and scorpions were found frequently in all phases of development. Grasses were found in all scats.

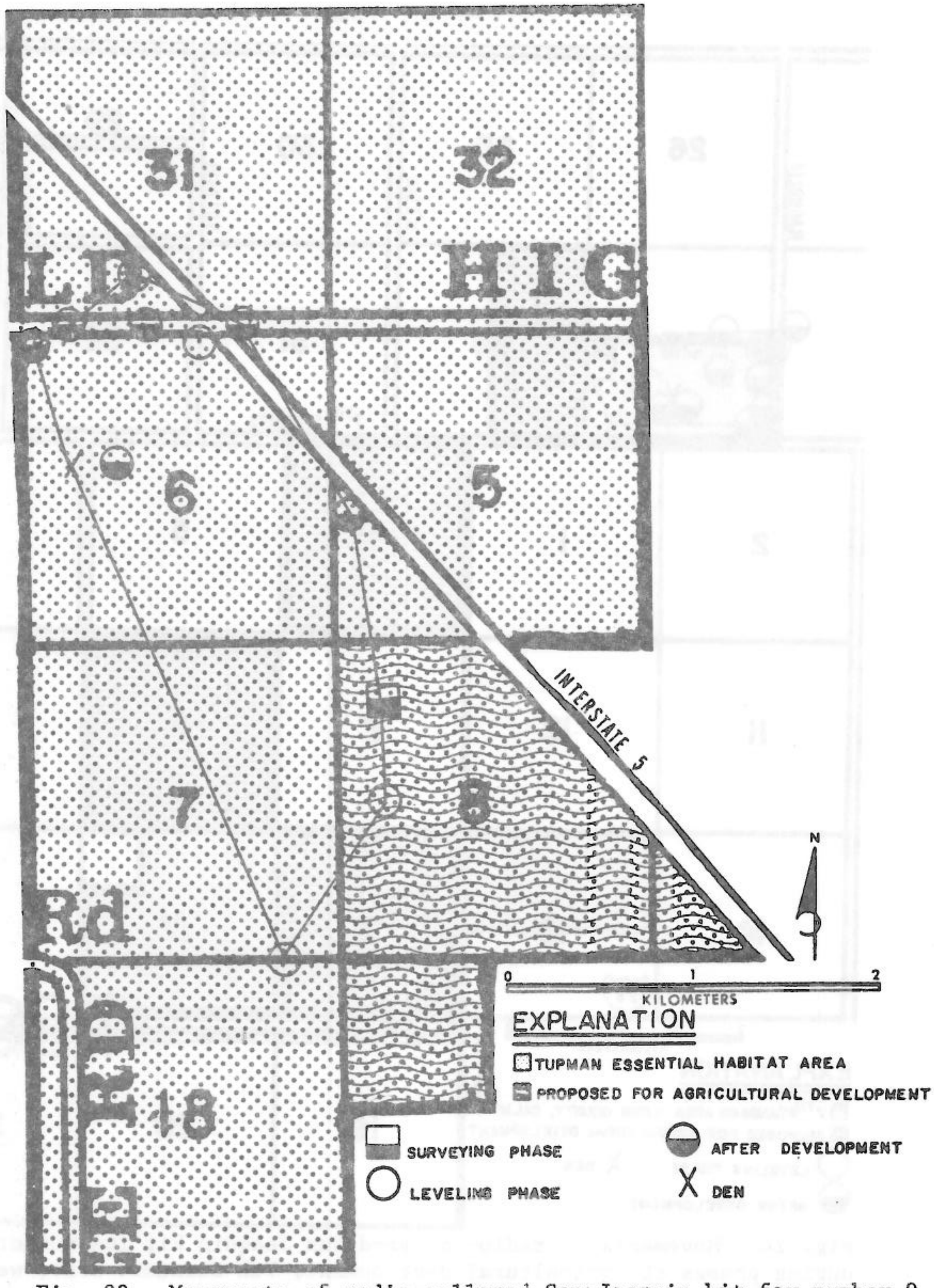

Fig. 23. Movements of radio-collared San Joaquin kit fox number 9 during phases of agricultural development, Tupman Essential Habitat Area, western Kern County, California, 6 July-19 December 1977.

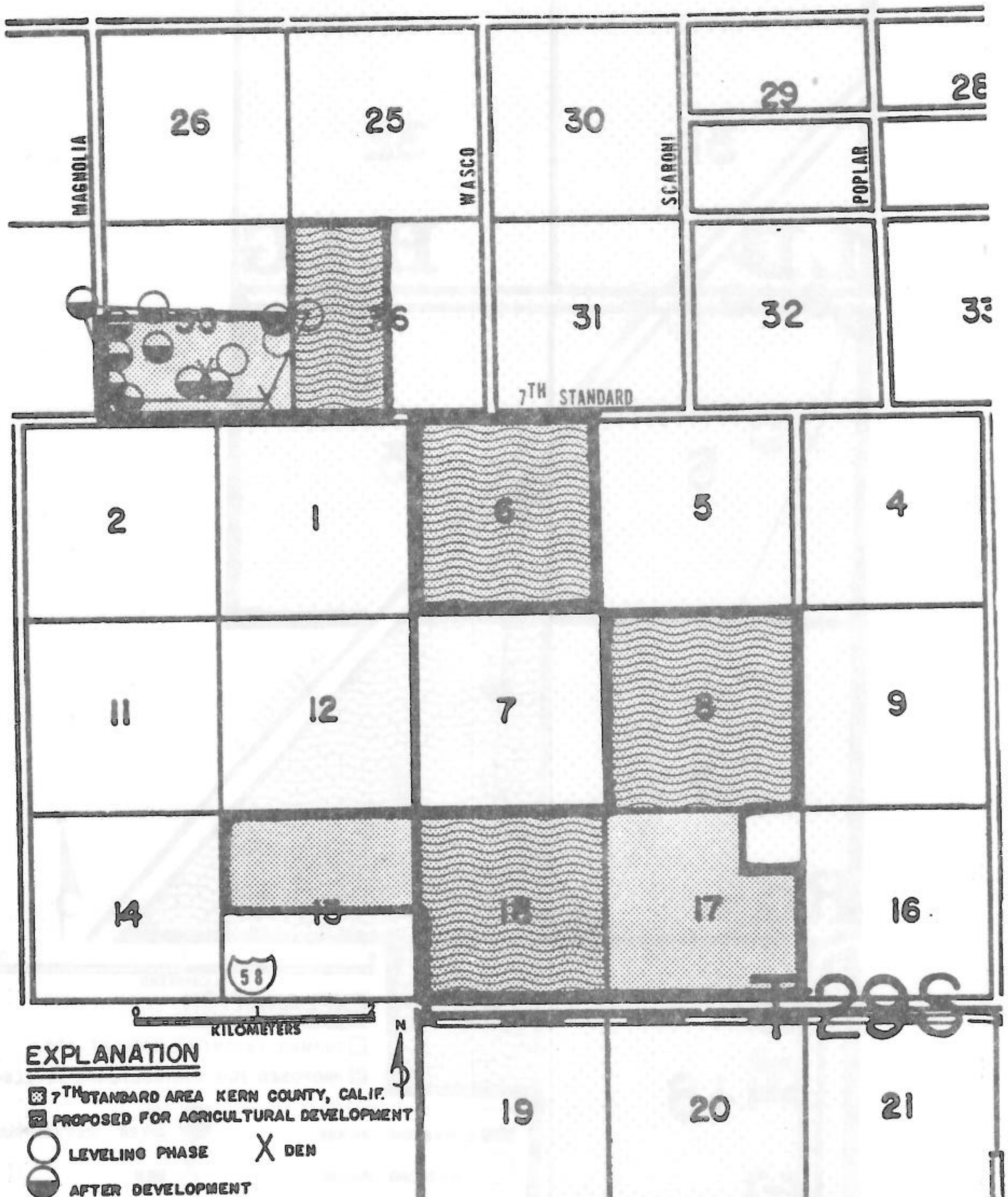

Fig. 24. Movements of radio-collared San Joaquin kit fox number 1B during phases of agricultural development, 7th Standard Area, western Kern County, California, 4 August-30 December 1977.

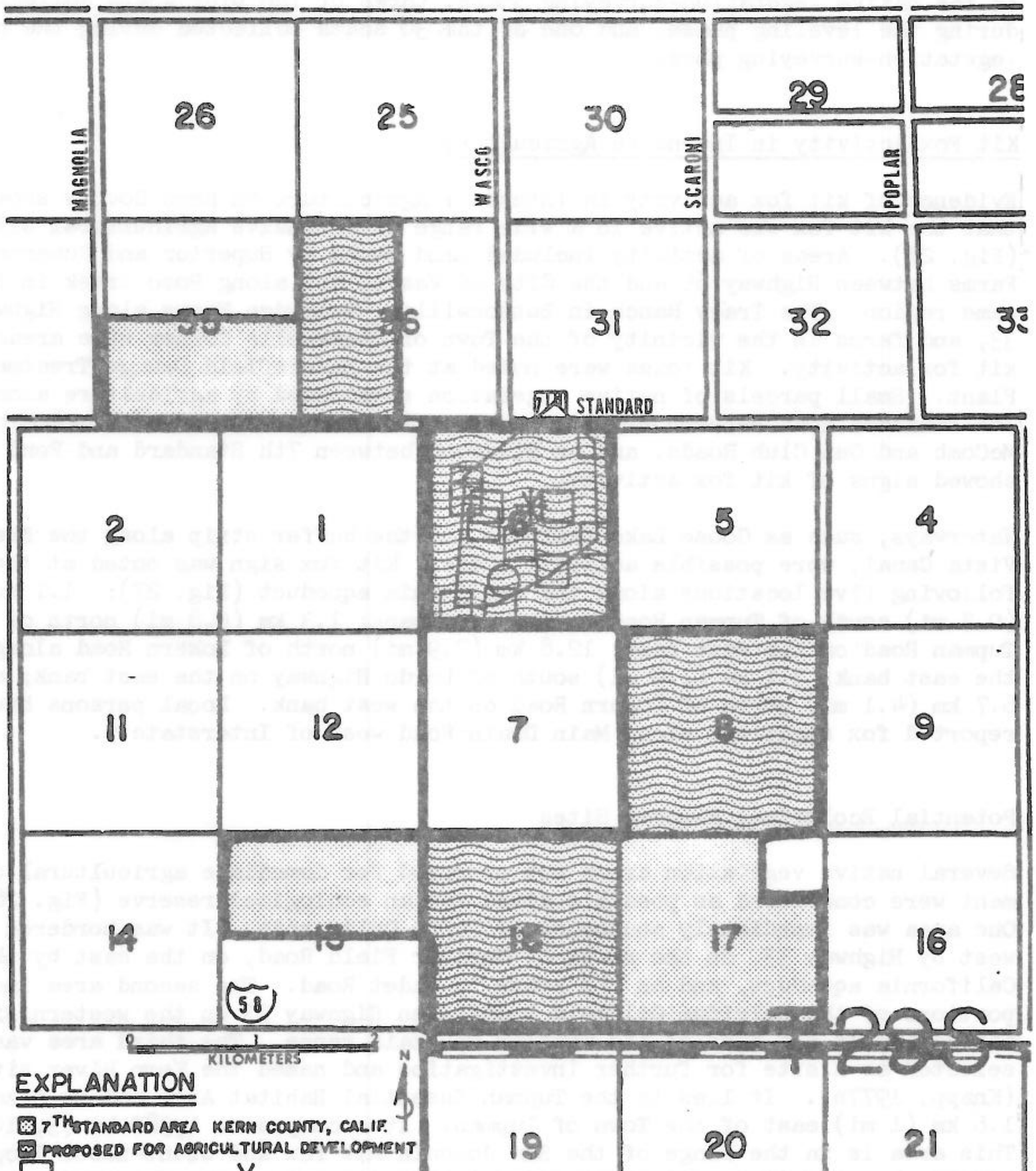

Fig. 25. Movements of radio-collared San Joaquin kit fox number 5(2) during phases of agricultural development, 7th Standard Area, western Kern County, California, 10 August-8 October 1977.

Schismus arabicus, Bromus spp., and other Gramineae were found in all phases. Filaree (Erodium spp.) and saltbush (Atriplex spp.) were frequent in scats. San Joaquin kit fox hair was found in two of the 30 scats collected on areas in the native vegetation-surveying phase, three of the nine scats collected during the leveling phase, and one of the 30 scats collected during the native vegetation-surveying phase.

Kit Fox Activity in Intensive Agriculture

Evidence of kit fox activity in intensive agriculture in Kern County showed that the kit fox was active in a wide range of intensive agricultural situations (Fig. 27). Areas of activity included land owned by Superior and Roberts Farms between Highway 65 and the City of Wasco, and along Poso Creek in the same region. The Tracy Ranch in Buttonwillow, Belridge Farms along Highway 33, and farms in the vicinity of the Town of Blackwells Corner were areas of kit fox activity. Kit foxes were noted at the Bakersfield Sewage Treatment Plant. Small parcels of native vegetation surrounded by agriculture along 7th Standard Road between Juniper Avenue and Highway 43, at the intersection of McComb and Gun Club Roads, and on Wildwood between 7th Standard and Pond Roads showed signs of kit fox activity.

Waterways, such as Goose Lake Drainage and the buffer strip along the Buena Vista Canal, were possible activity sites. Kit fox sign was noted at the following five locations along the California aqueduct (Fig. 27): 1.1 km (0.7 mi) south of Tupman Road on the west bank; 1.3 km (0.8 mi) north of Tupman Road on the west bank; 12.8 km (7.9 mi) north of Lokern Road along the east bank; 3.1 km (1.9 mi) south of Lerdo Highway on the east bank; and 6.7 km (4.1 mi) north of Lokern Road on the west bank. Local persons have reported fox sightings along Main Drain Road west of Interstate 5.

Potential Ecological Reserve Sites

Several native vegetation areas not proposed for immediate agricultural development were considered as possible sites for an ecological reserve (Fig. 28). One area was immediately southeast of Taft, California. It was bordered on the west by Highway 33, on the north by Gardner Field Road, on the east by the California aqueduct, and on the south by Cadet Road. The second area included portions of the Belridge Oilfield located on Highway 33 on the western side of the valley at the base of the Temblor Mountain range. The third area was selected as a site for further investigation and named the Kern River site (Knapp, 1977b). It lies in the Tupman Essential Habitat Area and is located 1.6 km (1 mi) east of the Town of Tupman. It encompasses 1,380 ha (3,410 ac). This area is in the range of the San Joaquin kit fox and blunt-nosed leopard lizard, has mesqiite, and plant and wildlife diversity. It is owned by Tenneco West, Inc., and oil production is the only intensive land use. The Kern River site is described in more detail in a report by Knapp (1977b).

DISCUSSION

One of the causes of San Joaquin kit fox mortality is the conversion of its natural habitat to cropland. Land conversion operations directly caused the deaths of three (21.4%) kit foxes followed during this study, when the foxes

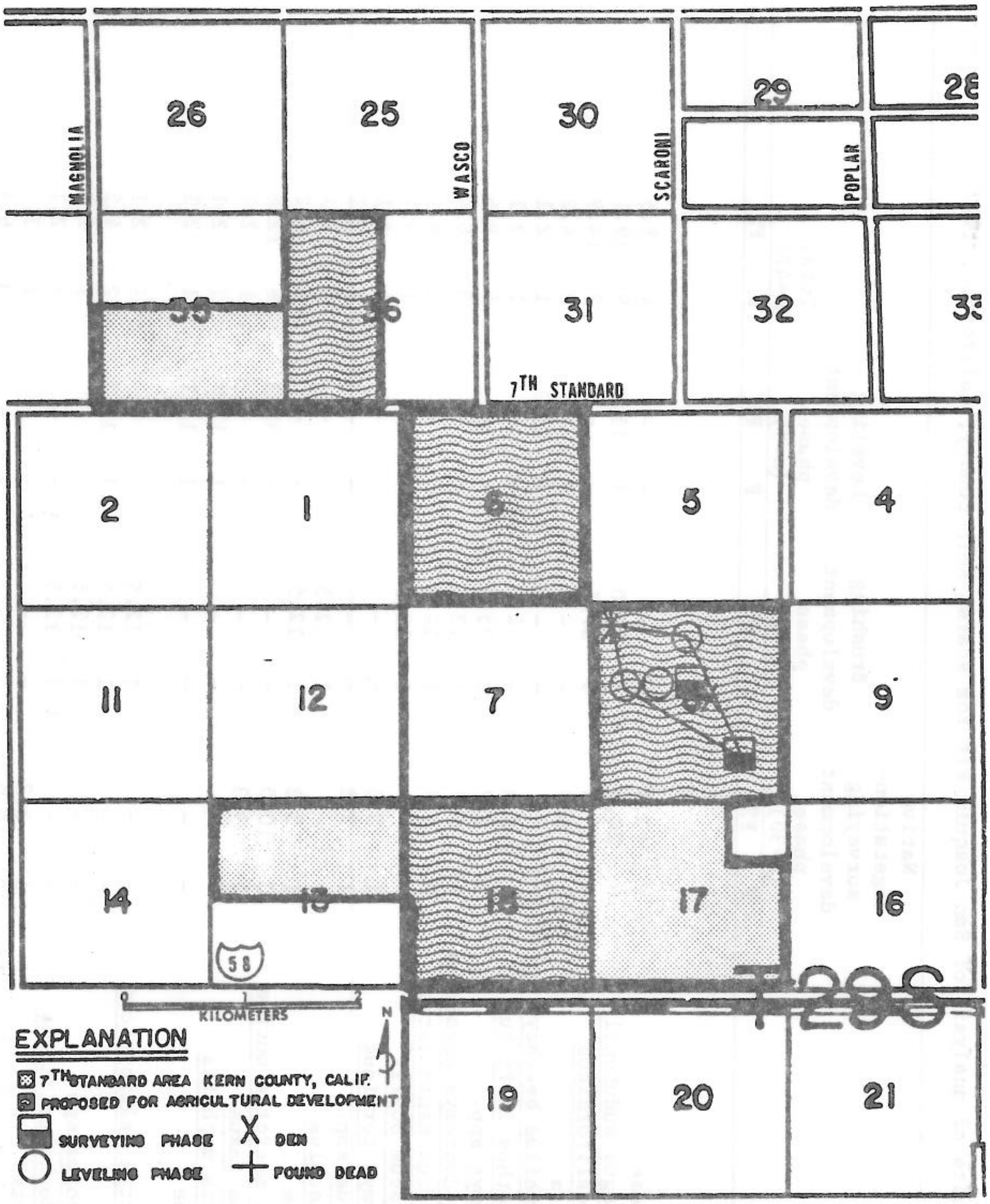

Fig. 26. Movements of radio-collared San Joaquin kit fox number 5(3) during phases of agricultural development, 7th Standard Area, western Kern County, California, 18 October-11 November 1977.

Table 5. Results of analysis of San Joaquin kit fox scats, Kern County, California, 1977.

Food Items	Native vegetation-surveying development phase (n=30)		Brushing development phase (n=8)		Leveling development phase (n=9)		Total (n=47)	
	F	F%[a]	F	F%	F	F%	F	F%
Vertebrates								
Mammalia								
Leporidae	4	13.3	-	-	-	-	4	8.5
Sylvilagus audubonii	6	20.0	2	25.0	1	11.1	9	19.1
Lepus californicus	4	13.3	3	37.5	-	-	7	14.9
Rodentia	2	6.7	-	-	-	-	2	4.2
Spermophilus beecheyi	-	-	-	-	1	11.1	1	2.1
Perognathus inornatus	1	3.3	-	-	-	-	1	2.1
Dipodomys spp.	2	6.7	2	25.0	-	-	4	8.5
Reithrodontomys megalotus	2	6.7	1	12.5	-	-	3	6.4
Peromyscus maniculatus	2	6.7	1	12.5	-	-	3	6.4
Peromyscus boylii	-	-	1	12.5	-	-	1	2.1
Onychomys torridus	1	3.3	-	-	-	-	1	2.1
Microtus spp.	1	3.3	-	-	-	-	1	2.1
Mus musculus	-	-	1	12.5	-	-	1	2.1
Canidae	1	3.3	1	12.5	-	-	2	4.2
Vulpes macrotis mutica	3	10.0	-	-	3	33.3	6	12.8
Taxidea taxus	1	3.3	-	-	-	-	1	2.1
Mephitis mephitis	-	-	-	-	1	11.1	1	2.1
Felidae	-	-	-	-	1	11.1	1	2.1
Aves								
Lophortyx californicus	-	-	1	12.5	-	-	1	2.1
Reptilia	-	-	1	12.5	1	11.1	2	4.2
Sceloporus spp.	-	-	1	12.5	-	-	1	2.1
Cnemidophorus tigris	-	-	1	12.5	-	-	1	2.1
Serpentes	1	3.3	-	-	-	-	1	2.1
Ophidia	3	10.0	-	-	-	-	3	6.4

Table 5. (cont.)

Food Items	Native vegetation-surveying development phase (n=30)		Brushing development phase (n=8)		Leveling development phase (n=9)		Total (n=47)	
	F	F%	F	F%	F	F%	F	F%
<u>Invertebrates</u>								
Arthropoda	3	10.0	–	–	1	11.1	4	8.5
Arachnida	–	–	1	12.5	–	–	1	2.1
Scorpionida	17	56.7	2	25.0	2	22.2	21	44.7
Ixodides	2	6.7	–	–	–	–	2	4.2
<u>Ornithodoros parkeri</u>	1	3.3	–	–	–	–	1	2.1
Araneida	1	3.3	–	–	–	–	1	2.1
Solpugida	3	10.0	1	12.5	1	11.1	5	10.6
Scolopendromorpha	2	6.7	–	–	–	–	2	2.1
Insecta	3	10.0	3	37.5	4	44.4	10	21.3
Ephemeroptera	1	3.3	–	–	–	–	1	2.1
Odonata	1	3.3	–	–	–	–	1	2.1
Orthroptera	5	16.7	2	25.0	–	–	7	14.9
Acrididae	5	16.7	–	–	–	–	5	10.6
Gryllidae	1	3.3	–	–	1	11.1	2	4.2
<u>Stenopelmatus longispina</u>	1	3.3	–	–	–	–	1	2.1
Cicadidae	–	–	1	12.5	–	–	1	2.1
Coleoptera	18	60.0	2	25.0	5	55.5	25	53.2
Scarabaeidae	3	10.0	1	12.5	–	–	4	8.5
Tenebrionidae	5	16.7	–	–	–	–	5	10.6
Silphidae	1	3.3	–	–	–	–	1	2.1
Diptera	2	6.7	–	–	1	11.1	3	6.4
Formicidae	17	56.7	1	12.5	3	33.3	21	44.7
Vegetation								
<u>Selaginella</u> spp.	1	3.3	–	–	2	22.2	3	6.4
<u>Malva rotundifolia</u>	1	3.3	–	–	–	–	1	2.1

Table 5. (cont.)

Food Items	Native vegetation-surveying development phase (n=30)		Brushing development phase (n=8)		Leveling development phase (n=9)		Total (n=47)	
	F	F%	F	F%	F	F%	F	F%
Erodium spp.	5	16.7	3	37.5	5	55.5	13	27.6
Lepidium spp.	–	–	1	12.5	–	–	1	2.1
Atriplex spp.	8	26.7	2	25.0	2	22.2	12	25.5
Trifolium spp.	–	–	1	12.5	–	–	1	2.1
Gramineae	8	26.7	3	37.5	3	33.3	14	29.8
Bromus spp.	11	36.7	5	62.5	6	66.6	22	46.8
Festuca spp.	–	–	1	12.5	–	–	1	2.1
Hordeum vulgare	1	3.3	–	–	–	–	1	2.1
Lolium spp.	–	–	1	12.5	–	–	1	2.1
Schismus arabicus	19	63.3	3	37.5	6	66.6	28	59.6
Avena spp.	1	3.3	–	–	–	–	1	2.1
Forb	1	3.3	–	–	–	–	1	2.1
Seeds	1	3.3	1	12.5	1	11.1	3	6.4
Stems and leaves	3	10.0	2	25.0	–	–	5	10.6
Miscellaneous								
Animal fragments	15	50.0	4	50.0	2	22.2	21	44.7
Aves feathers	7	23.3	1	12.5	2	22.2	10	21.3
Black lichen or fungus	–	–	–	–	1	11.1	1	2.1
Eggshell	2	6.7	–	–	–	–	2	4.2
Sand	18	60.0	8	100.0	5	55.5	31	65.9
String	2	6.7	–	–	–	–	2	4.2
Twigs	9	30.0	1	12.5	5	55.5	15	31.9
Unknown	–	–	1	12.5	4	44.4	5	10.6

[a] F = frequency; F% = frequency percentage

were buried during the leveling phase of development. The data from this study suggest that kit foxes denning on areas under development are subject to a high direct mortality rate, due to the tendency of foxes to remain in their dens at the approach of heavy equipment. Observation of kit fox activity and number of sightings during development indicates that the leveling phase caused the highest amount of disturbance to foxes. The leveling phase was the only phase in which direct kit fox mortality occurred. The brushing phase had the second highest amount of disturbance and the surveying phase had the least disturbance.

The unwillingness of three kit foxes to move out of areas of immediate agricultural development led to their deaths. Life history studies of San Joaquin kit foxes in native vegetation (Morrell, 1972) indicated that a small home range of 518 ha (1,280 ac) was characteristic of this subspecies of kit fox. The present study shows that the average minimum home range in developed areas, 251.6 ha (621.4 ac), is less than half of the average home range which was found by Morrell (1972). The characteristic small home range of the San Joaquin kit fox may be a factor resulting in kit fox deaths during land conversion since the fox is effectively restricted to a relatively small area and may hesitate to leave familiar surroundings, even at the approach of heavy equipment. During the reproductive season this factor may be multiplied because paired kit foxes raising pups are likely to be less mobile than at any other time of the year.

The use of a den for a long period of time, as shown by nine of the 10 foxes for which den locations were found, also indicates that the kit fox is not a mobile animal. This finding is in conflict with previous findings of multiple den use by kit foxes in native vegetation (Morrell, 1972). Conversion of native vegetation reduces the number of available den sites, thus forcing the kit fox to be less mobile in areas of development than in its natural habitat. Artificial dens in oil pipes in the home range area were utilized rather than dens outside of the development area.

Morrell's study (1972) suggested that kit foxes will move out of an area when the density of prey species has been reduced. Scat analysis in the present study shows that during the brushing phase preferred prey species are taken more often. Clearing of escape cover probably increases the vulnerability of prey species to kit foxes and, therefore, decreases the probability that the foxes will move out of the converted area before the leveling phase. Analysis of scats collected during the leveling phase shows a decline in the number of preferred prey species taken. There is an increase of alternative food items such as skunks, cats, ground squirrels, beetles, and vegetation. The occurrence of trace amounts of kit fox hair in kit fox scats is attributed to grooming. However, the occurrence of 40% and 90% hair by volume in two scat samples suggests the consumption of carrion or cannibalism.

The results of scat analysis in this study conflict with the results of previous studies in that the cottontail appears to be the main food item of the kit fox in agricultural development areas rather than kangaroo rats as in native vegetation areas (Hawbecker, 1943; Morrell, 1972). During the brushing phase, the loss of escape cover may have made cottontails and jack rabbits more available than kangaroo rats, which use burrows for escape (Tappe, 1941). During the leveling phase, no scat samples contained kangaroo rats. It is probable that the kangaroo rats did not move out of areas being leveled and were buried in their burrows.

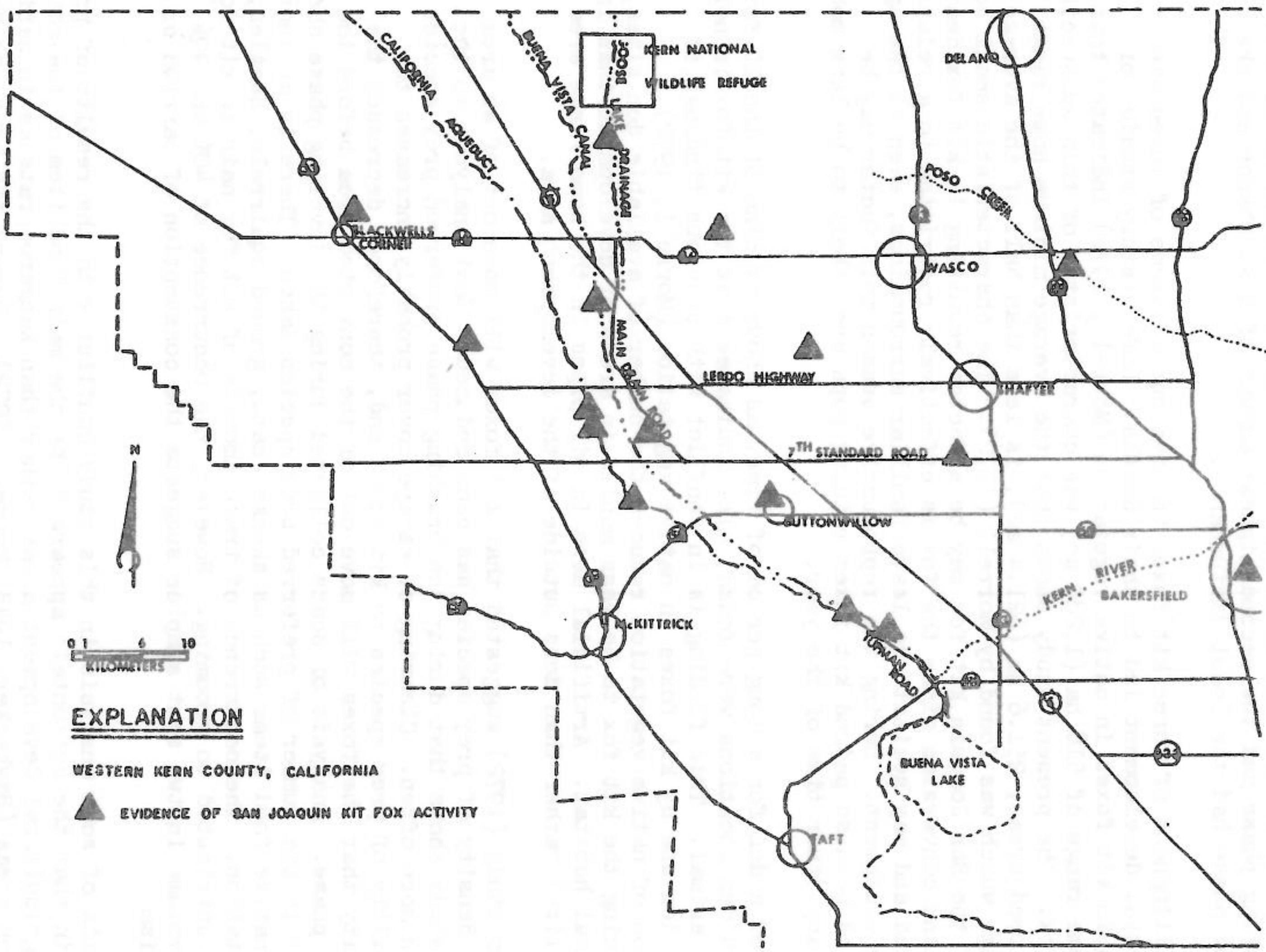

Fig. 27. Locations of San Joaquin kit fox activity in intensive agriculture, western Kern County, California, 1977.

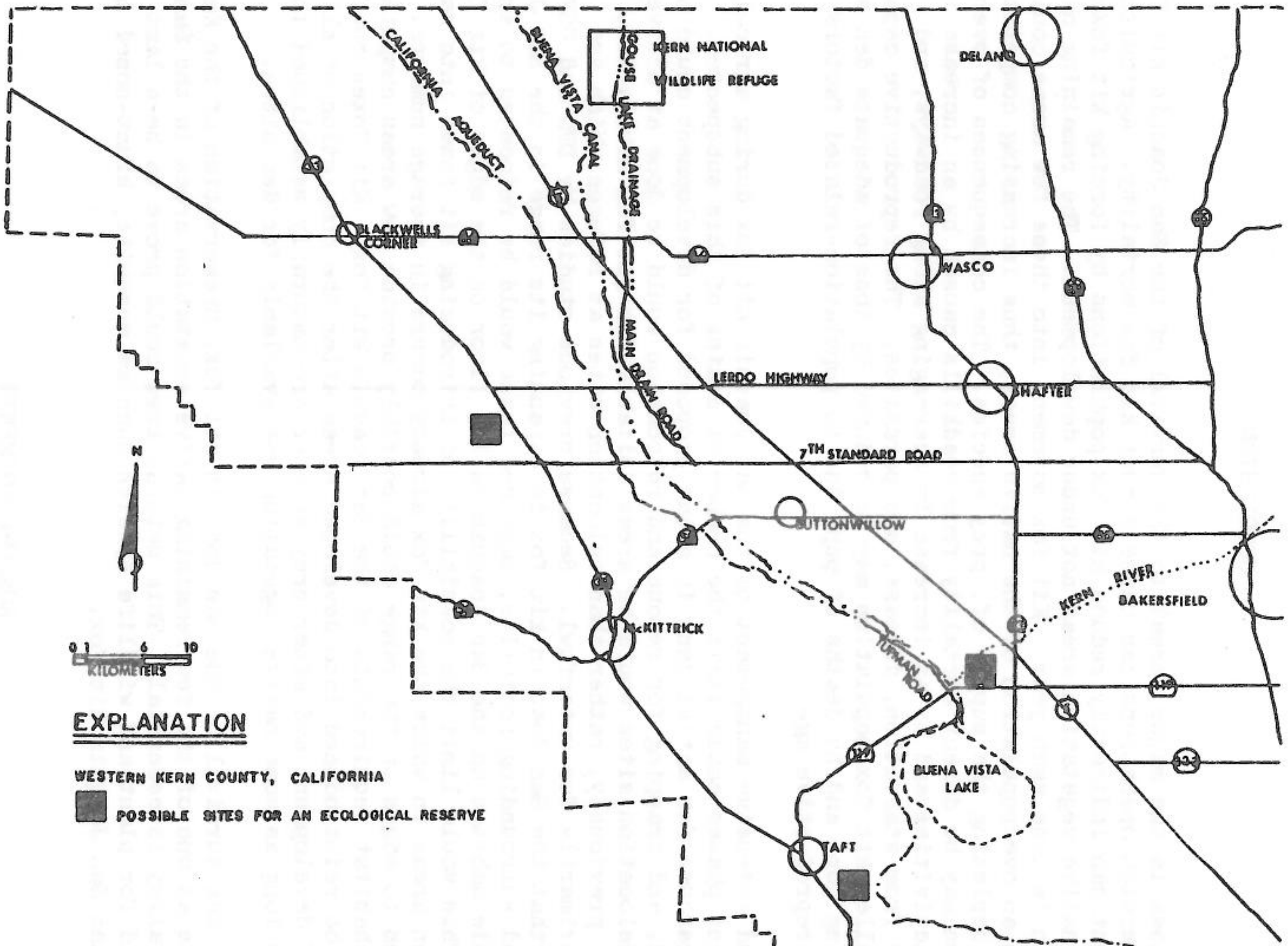

Fig. 28. Areas considered for ecological reserve status, western Kern County, California, 1977.

Information on kit foxes relocated to a new environment is lacking. Data provided by this study are minimal. Relocation of kit foxes to the Mendota Wildlife Area was not known to be successful. However, a last contact with the kit fox released along the Kern River in the Tupman Essential Habitat Area showed it to be alive and denning in an area with an adequate density of prey species.

CONCLUSION

Habitat loss is the major threat to the survival of the San Joaquin kit fox. Land conversion operations can cause direct kit fox mortality. Agricultural development can indirectly reduce kit fox populations by forcing kit foxes to seek out native vegetation areas not under development. The remaining native vegetation is less each year. Kit fox movement into these few areas could result in an overpopulation of the native areas, thus increasing competition for, and depleting the supply of, prey species. The consequences of over-population may be direct mortality from roadkills caused by an increase in hunting activities and by an increase in scavenging along roadways, and mortality from starvation, disease, and parasites. The reproductive capacity of the Valley kit fox population may be reduced by loss of adequate den sites for raising pups and by deaths of pups due to population-related factors before reaching reproductive age.

Proper and intensive management of the San Joaquin kit fox during agricultural development phases could limit the number of deaths of this subspecies. Ground searches for active dens in areas proposed for development could be conducted, and trapping for rescue and relocation could be done at active den sites. Relocation sites would be areas suitable for kit fox habitation, as described previously, rather than relocation sites at refuges which are managed primarily for waterfowl. Because previous studies by DFG and USFWS indicate that the San Joaquin kit fox is expanding its range in the San Joaquin Valley and surrounding foothills, captured foxes would be relocated to areas of suitable habitat on the San Joaquin Valley floor on the edges of kit fox range. This would limit the possibility of introducing kit foxes into native vegetation areas in which the kit fox already occurs in average numbers. Relocation to edges of the range could possibly provide new areas compatible with the habitat requirements of the San Joaquin kit fox. Kit foxes could possibly be reintroduced into developed areas after the completion of all eight phases of development and after prey species are naturally established in the crops, as long as some native vegetation was available for den sites.

To ensure the survival of the San Joaquin kit fox, preservation of the Kern River site as one of the few remaining native vegetation areas in the San Joaquin Valley is essential. This natural area could prove to be a last stronghold for plant and wildlife species such as mesquite, blunt-nosed leopard lizard, and San Joaquin kit fox.

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Appendix I. Plant species representative of the alkali-sink and streambank plant associations, western Kern County, California.[a]

Alkali-sink Association

alkali larkspur	*Delphinium recurvatum*
mallow	*Malva neglecta*
alkali mallow	*Sida hederacea*
red-stemmed filaree	*Erodium cicutarium*[b]
tamarisk	*Tamarix pentandra*
tamarisk	*Tamarix tetranda*
Frankenia	*Frankenia grandifolia* var. *campestris*
jackass clover	*Wislizenia refracta*
peppergrass	*Lepidium dictyotum*
sea-purslane	*Sesuvium verrucosum*
goosefoot	*Nitrophila occidentalis*
saltbush	*Atriplex patula* ssp. *spicata*[b]
saltbush	*Atriplex argentea* ssp. *expansa*
saltbush	*Atriplex coronata*
saltbush	*Atriplex Serenana*
common saltbush	*Atriplex polycarpa*[b]
quailbush	*Atriplex lentiformis*[b]
saltbush	*Atriplex spinifera*
goosefoot	*Kochia californica*
goosefoot	*Bassia hyssopifolia*
iodine bush	*Allenrolfea occidentalis*[b]
pickleweed	*Salicornia subterminalis*
seepweed	*Suaeda Torreyana*
seepweed	*Suaeda fruticosa*[b]
Russian thistle	*Salsola Kali* var. *tenuifolia*
tumbleweed	*Amaranthus albus*
alkali weed	*Cressa truxillensis* var. *vallicola*
heliotrope	*Heliotropium curassavicum* var. *oculatum*[b]
borage	*Plagiobothrys acanthocarpus*
mesquite	*Prosopis glandulosa* var. *Torreyana*[b]
milkvetch	*Astragalus Hornii*
goldifelds	*Lasthenia chrysantha*
goldfields	*Lasthenia Ferrisiae*
goldfields	*Lasthenia minor*
aster	*Aster intricatus*
tule	*Scirpus maritimus* var. *paludosus*
soft chess	*Bromus mollis*[b]
foxtail chess	*Bromus rubens*[b]
fescue	*Festuca microstachys* var. *simulans*
saltgrass	*Distichlis spicata*[b]
barley	*Hordeum depressum*
common foxtail	*Hordeum glaucum*[b]
barley	*Hordeum vulgare*
Arabian grass	*Schismus arabicus*

Streambank Association

buckwheat	*Eriogonum* spp.[b]
heliotrope	*Heliotropium curassavicum* var. *oculatum*[b]

Appendix I. (cont.)

mesquite	Prosopis glandulosa var. Torreyana[b]
Fremont cottonwood	Populus Fremontii[b]
yellow willow	Salix lasiandra
willow	Salix Gooddingii[b]
red willow	Salix laevigata
buttonwillow	Cephalanthus occidentalis var. californicus
sunflower	Helianthus spp.[b]
cocklebur	Xanthium strumarium var. canadense[b]
composite	Baccharis spp.[b]

[a]Taken from Twisselmann (1967) and Munz (1968).
[b]Observed by D. Knapp during this study.

Appendix II. A partial list of vertebrate species with geographic ranges which include the alkali-sink and streambank associations, western Kern County, California.[a]

AMPHIBIANS[a]

western spadefoot toad	Scaphiopus hammondi[b]
California toad	Bufo boreas
Pacific treefrog	Hyla regilla[b]
bullfrog	Rana catesbeiana[b]

REPTILES[a]

southwestern pond turtle	Clemmys marmorata
blunt-nosed leopard lizard	Crotaphytus wislizenii silus[b, c]
western fence lizard	Sceloporus occidentalis[b]
California side-blotch lizard	Uta stansburiana[b]
coast horned lizard	Phrynosoma coronatum[b]
California whiptail	Cnemidophorus tigris[b]
coachwhip	Masticophis flagellum
gopher snake	Pituophis melanoleucus
kingsnake	Lampropeltis getulus
long-nosed snake	Rhinocheilus lecontei
western black-headed snake	Tantilla planiceps
Pacific rattlesnake	Crotalus viridus

BIRDS

turkey vulture	Cathartes aura[b]
white-tailed kite	Elanus leucurus[b]
red-tailed hawk	Buteo jamaicensis[b]
red-shouldered hawk	Buteo lineatus
golden eagle	Aquila chrysaetos
marsh hawk	Circus cyaneus[b]
prairie falcon	Falco mexicanus
American kestrel	Falco sparverius[b]
California quail	Lophortyx californicus
ring-necked pheasant	Phasianus colchicus[b]
killdeer	Charadrius vociferus[b]
rock dove	Columba livia
mourning dove	Zenaida macroura[b]
roadrunner	Geococcys californianus[b]
barn owl	Tyto alba[b]
great horned owl	Bubo virginianus[b]
burrowing owl	Athene cunicularia[b]
lesser nighthawk	Chordeiles acutipennis[b]
Anna's hummingbird	Calypte anna
Nuttall's woodpecker	Picoides nuttallii
western kingbird	Tyrannus verticalis[b]
ash-throated flycatcher	Myiarchus cinerascens
Say's phoebe	Sayornis saya
horned lark	Eremophila alpestris[b]
cliff swallow	Petrochelidon pyrrhonota[b]

scrub jay	Aphelocoma coerulescens
yellow-billed magpie	Pica nuttalli
common raven	Corvus corax
common crow	Corvus brachyrhynchos
mockingbird	Mimus polyglottos
California thrasher	Toxostoma redivivum
LeConte's thrasher	Toxostoma lecontei
loggerhead shrike	Lanius ludovicianus[b]
starling	Sturnus vulgaris
house sparrow	Passer domesticus[b]
Brewer's blackbird	Euphagus cyanocephalus[b]
house finch	Carpodacus mexicanus
American goldfinch	Caroleulis tristis
white-crowned sparrow	Zonotrichia leucophrys[b]

Wet Season or Irrigated Areas

western grebe	Aechmophorus occidentalis
white pelican	Pelecanus erythrorhynchos
great blue heron	Ardea herodias
green heron	Butorides striatus
great egret	Casmerodius albus[b]
black-crowned night heron	Nycticorax nycticorax
American bittern	Botaurus lentiginosus[b]
white-faced ibis	Plegadis chihi
Canada goose	Branta canadensis
snow goose	Chen caerulescens
Ross's goose	Chen rossii
mallard	Anas platyrhynchos
pintail	Anas acuta
cinnamon teal	Anas cyanoptera
northern shoveler	Anas clypeata
ruddy duck	Oxyura jamaicensis
American coot	Fulica americana
black-bellied plover	Squatarola squatarola
long-billed curlew	Numenius americanus[b]
whimbrel	Numenius phaeopus
American avocet	Recurvirostra americana
black-necked stilt	Himantopus mexicanus

MAMMALS[d]

Virginia opossum	Didelphis virginiana
Yuma myotis	Myotis yumanensis
California myotis	Myotis californicus
western mastiff bat	Eumops perotis
desert cottontail	Sylvilagus audubonii
black-tailed jack rabbit	Lepus californicus
Nelson's antelope squirrel	Ammospermophilus nelsoni[b]
California ground squirrel	Spermophilus beecheyi
Botta's pocket gopher	Thomomys bottae

Appendix II. (cont.)

San Joaquin pocket mouse	Perognathus inornatus
Heermann's kangaroo rat	Dipodomys heermanni[b]
Fresno kangaroo rat	Dipodomys nitratoides[b]
western harvest mouse	Reithrodontomys megalotis
deer mouse	Peromyscus maniculatus[b]
brush mouse	Peromyscus boylii
southern grasshopper mouse	Onychomys torridus[b]
desert woodrat	Neotoma lepida
California vole	Microtus californicus
house mouse	Mus musculus
coyote	Canis latrans[b]
San Joaquin kit fox	Vulpes macrotis mutica[b, c]
gray fox	Urocyon cinereoargenteus
raccoon	Procyon lotor
long-tailed weasel	Mustela frenata
badger	Taxidea taxus[b]
western spotted skunk	Spilogale gracilis
striped skunk	Mephitis mephitis[b]
bobcat	Felis rufus

[a]Common and scientific names from Stebbins (1966).
[b]Observed by D. Knapp during this study.
[c]Species on federal endangered list.
[d]Common and scientific names from Jones et al. (1975).

Appendix III. Reports of San Joaquin kit fox (*Vulpes macrotis mutica*) activity, Kern County, California, 1977.[a]

Sightings

1. Manner Street south of China Grade Loop, Golden Bear Refinery.
2. 1.6 km (1 mi) east of Shell Park off Round Road near Hart Park.
3. 4.7 km (2.9 mi) north of Highway 46 and Highway 65.
4. Herring Road and Wheeler Ridge Road (agriculture).
5. Last year on North American Rockwell B1 microwave plant site, one den with four foxes.
6. 0.8 km (0.5 mi) north of Bakersfield Speedway on Bakersfield-Glennville Road (oilfield).
7. 91.4 m (100 yds) east of Highland Knowl Golf Course (oilfield).
8. West of James Road and Oilfields Road.
9. Southwest corner of Highway 46 and Highway 65.
10. 0.8 km (0.5 mi) north of the intersection of Highway 46 and Highway 65 (short grass and *Atriplex*) at petroleum storage tanks.
11. Intersection of Twisselman Road and I5 at Lost Hills.
12. 19 August 1977, 0425, along Panama Lane 0.24 km (0.15 mi) west of Road #3, going into native vegetation of Section 30, T30S, R26E.
13. 22 August 1977, 2240, 0.32 km (0.2 mi) north of Taft Highway and Highway 43 intersection, went east from Section 35 to 36, T30S, R25E.
14. 23 August 1977, 0030, at corner of Panama Lane and Wible Road.
15. 23 August 1977, 2100, Section 6, T29S, R25E, 0.64 km (0.4 mi) south of the northeast corner and 0.64 km (0.4 mi) west of east border.
16. 23 August 1977, 0200, three kit foxes observed by a California Highway Patrol Officer at Stockdale Highway and I5 overpass feeding on garbage within the cloverleaf.
17. 7 November 1977, 1830, east border of Section 35, T30S, R25E, 0.16 km (0.1 mi) north of southeast corner, native vegetation.
18. 11 November 1977, 0255, moving from Section 25 (cotton) to Section 24 (graded) T30S, R25E, along Panama Lane, south border of Section 24, 0.8 km (0.5 mi) east of southwest corner.
19. 19 November 1977, 0255, border between Section 19 and Section 30, T30S, R26E, 0.88 km (0.55 mi) east of west border, cotton to native vegetation.
20. 27 July 1977, Buttonwillow area, 0.56 km (0.35 mi) north of Lokern Road Road along the east bank of the California aqueduct.
21. 23 June 1977, 0555, observed heading west from Section 8, T31S, R26E approximately 0.8 km (0.5 mi) south of the border.

Roadkills

1. 2.4 km (1.5 mi) north of Derby acres.
2. Along Stockdale Highway at California State College, Bakersfield.

Other

1. Skull found at Belridge Oilfield.

[a]As reported by Donna Knapp (DFG) and Dan Holland (Bureau of Land Management).

Appendix IV. Sightings of blunt-nosed leopard lizards (Crotaphytus wislizenii silus), San Joaquin Valley, Kern County, California, 1977.

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1. 21 July, 2.7 km (1.7 mi) north of Tupman Road along the west bank of the California aqueduct.
2. 27 July 1977, Buttonwillow Area, 5.2 km (3.25 mi) north of Lokern Road along the east bank of the California aqueduct.
3. 27 July 1977, Buttonwillow Area, 13.0 km (8.05 mi) north of Lokern Road along the east bank of the California aqueduct- 2 lizards seen.
4. 18 August 1977, 1000, section 8 T29S R25E, southwest quarter of northwest quarter 0.32 km (0.2 mi) from west border of section.
5. 23 August 1977, 1250, 1.8 km (1.1 mi) north of Highway 58 along west border of section 8 T29S R25E.
6. 26 August 1977, 0900, section 8 T29S R25 E 0.16 km (0.1 mi) east of west border and 1.1 km (0.7 mi) north of southwest corner.
7. 1 September 1977, 1300, 0.64 km (0.4 mi)north of southwest corner and 0.8 km (0.5 mi) east of west border of section 35 T28S R24E.
8. 1 Septmber 1977, 1600, 0.32 km (0.2 mi) south of northwest corner and 0.16 km (0.1 mi) east of west border of section 6 T29S R25E.
9. 1 Septmber 1977, 1615, 0.48 km (0.3 mi) south of northwest corner and 0.32 km (0.2 mi) east of the west border of section 6 T29S R25E.
10. 1 Septmber 1977, 1730, 0.48 km (0.3 mi) south of the northwest corner and 0.8 km (0.5 mi) east of the west border of section 6 T29S R25E.
11. 1 September 1977, 1215, 0.64 km (0.4 mi) north of southwest corner and 0.64 km (0.4 mi) east of west border of section 35 T28S R24E.

Appendix V. Information on San Joaquin kit foxes (Vulpes macrotis mutica) tagged in Kern County, California, 1977.

Radio Collar Number	Tag Number	Sex	Date of Capture	Number of Recaptures	Capture Site	Release Site	Date of Relocation
1A	[b]551	F	19 April	-	Sec 24 T30S R25E	capture site	-
1A	534	F	14 June	-	Sec 23 T31S R26E	Mendota Wildl. Area	18 June
1B	592	F	4 August	-	Sec 36 T28S R24E	capture site	-
2A	[b]578	M	19 April	2	Sec 24 T30S R25E	capture site	-
2B	[b]590	M	2 August	-	Sec 36 T28S R24E	Mendota Wildl. Area	5 August
3	552	F	5 May	1	Sec 24 T30S R25E	capture site	-
4	577	M	6 May	-	Sec 24 T30S R25E	capture site	-
5	[b]529	M	25 May	2	Sec 35 T30S R25E	capture site	-
5(2)	[a,b]584	M	10 August	1	Sec 6 T29S R25E	capture site	-
5(3)	[a,b]593	F	17 August	6	Sec 8 T29S R25E	capture site	-
6	[b]530	F	25 May	3	Sec 35 T30S R25E	capture site	-
6(2)	558	M	14 September	1	Sec 10 T31S R26E	capture site	-
7	580	F	13 May	-	Tulare County	Sec 9 T30S R26E	21 October
8	553	F	22 June	2	Sec 8 T31S R26E	capture site	-
9	583	M	6 July	-	Sec 8 T31S R26E	capture site	-
-	526	F	4 June	-	Sec 35 T30S R25E	capture site	-
-	528	M	3 June	1	Sec 35 T30S R25E	capture site	-
-	531	M	4 June	-	Sec 35 T30S R25E	capture site	-
-	532	F	10 June	-	Sec 35 T30S R25E	capture site	-
-	554	F	25 August	-	Sec 8 T29S R25E	capture site	-
-	555	M	10 August	-	Sec 6 T29S R25E	Elk Hills Nav. Pet. R.	12 August
-	556	F	24 August	4	Sec 8 T29S R25E	Mendota Wildl. Area	23 October
-	[a,b]557	F	10 August	1	Sec 6 T29S R25E	capture site	-
-	559	M	4 October	-	Sec 18 T29S R25E	capture site	-
-	560	F	4 October	2	Sec 18 T29S R25E	capture site	-
-	561	F	4 October	1	Sec 18 T29S R25E	capture site	-
-	571	M	20 October	-	Sec 6 T29S R25E	Mendota Wildl. Area	23 October
-	572	M	6 October	1	Sec 18 T29S R25E	Los Banos Wildl. Area	19 November
-	573	M	5 October	1	Sec 18 T29S R25E	capture site	-
-	574	F	-	-	CA State Coll. Bak.	Sec 9 T30S R26E	6 October
-	579	F	10 August	-	Sec 6 T29S R25E	Elk Hills Nav. Pet. R.	12 August
-	[b]581	M	17 April	-	Sec 36 T28S R24E	escaped at CSCB	-

Appendix V. (cont.)

Radio Collar Number	Tag Number	Sex	Date of Capture	Number of Recaptures	Capture Site	Release Site	Date of Relocation
-	582	F	8 June	-	Sec 35 T30S R25E	capture site	-
-	585	F	2 August	-	Sec 36 T28S R24E	Elk Hills Nav.Pet.R.	4 August
-	586	M	2 August	-	Sec 36 T28S R24E	capture site	-
-	587	F	2 August	-	Sec 36 T28S R24E	Elk Hills Nav.Pet.R.	4 August
-	[b]588	F	2 August	-	Sec 36 T28S R24E	Mendota Wildl. Area	5 August
-	589	M	2 August	-	Sec 36 T28S R24E	Elk Hills Nav.Pet.R.	4 August
-	591	F	2 August	-	Sec 36 T28S R24E	Elk Hills Nav.Pet.R.	4 August
-	594	M	17 August	7	Sec 8 T29S R25E	capture site	-
-	-	-	4 August	-	Sec 36 T28S R24E	escaped at CSCB	-

[a]Death caused by agricultural development activities.

[b]Dead

Appendix VI. Capture sites of the Tipton kangaroo rat (*Dipodomys nitratoides nitratoides*), San Joaquin Valley, Kern County, California, 1977.

Date	Area	Number(Sex)
Tupman Essential Habitat Area		
25 May	Sec 35 T30S R25E	1(F)
2 June	Sec 35 T30S R25E	2(M)
3 June	Sec 35 T30S R25E	2(M), 1(F)
4 June	Sec 35 T30S R25E	1(M), 2(F)
9 June	Sec 35 T30S R25E	1(M)
10 June	Sec 35 T30S R25E	1(M), 1(F)
24 June	Sec 8 T31S R26E	2(M), 1(F)
28 June	Sec 8 T31S R26E	1(M), 1(F)
29 June	Sec 8 T31S R26E	2(M), 1(F)
30 June	Sec 8 T31S R26E	1(M)
30 June	Sec 17 T31S R26E	1(F)
6 July	Sec 8 T31S R26E	2(F)
6 July	Sec 17 T31S R26E	1(M)
7 July	Sec 8 T31S R26E	1(M)
8 July	Sec 17 T31S R26E	1(M), 1(F)
14 September	Sec 15 T31S R26E	1(M)
16 September	Sec 10 T31S R26E	2(M), 2(F)
7th Standard Area		
2 August	Sec 36 T28S R24E	1(M)
4 August	Sec 36 T28S R24E	1(M), 1(F)
5 August	Sec 36 T28S R24E	3(M), 1(F)
10 August	Sec 6 T29S R25E	2(M), 2(F)
12 August	Sec 6 T29S R25E	1(M)
16 August	Sec 6 T29S R25E	2(M)
25 August	Sec 8 T29S R25E	3(M)
26 August	Sec 8 T29S R25E	1(F)
28 September	Sec 8 T29S R25E	1(M)
29 September	Sec 8 T29S R25E	2(M), 1(F)
4 October	Sec 18 T29S R25E	1(F)
5 October	Sec 18 T29S R25E	1(M), 2(F)
13 October	Sec 8 T29S R25E	1(F)
18 October	Sec 8 T29S R25E	2(M), 1(F)
19 October	Sec 6 T29S R25E	2(F)[a]
20 October	Sec 6 T29S R25E	2(M)[a], 1(F)[a]
21 October	Sec 6 T29S R25E	2(M)

[a] Collected for specimens.