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Report No. 6
San Joaquin Kit Fox
Vulpes macrotis mutica

Related Subspecies and the Swift Fox, Vulpes velox




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TABLE OF CONTENTS

## Introduction

The objective of this report is to provide Bureau of Land Management personnel with some of the latest and most up-to-date information on rare or endangered species occurring on public domain that is managed by the BLM in the eleven western states and Alaska. This will provide a basic reference tool for improved understanding of the interrelationships between the species and its environment and encourage an end product of enlightened land management which will fully consider the species' welfare in all management decisions.

## 1. Species Description

There are eight recognized subspecies of kit foxes in North America:

*Vulpes macrotis mutica* (San Joaquin kit fox, California)
*V. m. macrotis* (California, extinct)
*V. m. tenuirostris* (Baja California)
*V. m. devia* (Baja California)
*V. m. nevadensis* (Nevada, Oregon, Idaho, Utah)
*V. m. arsipus* (California, Nevada, Arizona, New Mexico, Colorado)
*V. m. neomexicana* (New Mexico, Arizona, Colorado, Texas, Mexico)
*V. m. zinseri* (Mexico)

Subspecies descriptions are essentially the same, except for minor size and color variations.

The general species characteristics include exceptionally large ears compared with other foxes, a body length ranging from fifteen to twenty inches, a tail length from nine to twelve inches, and a weight varying from three to six pounds. Dorsal coloration may be pale gray washed with rust, grizzled light gray-brown, gray, buffy gray, or buffy yellow. The belly is whitish and the tail is tipped with black (Burt and Grossenheider, 1952; Grinnel *et al*, 1937; Cahalane, 1947; Laughrin, 1970; Hall and Kelson, 1959). See Figure 1.

*V. m. mutica*, the San Joaquin kit fox, apparently is the largest of the subspecies. It has an average body length of twenty inches and a tail length of twelve inches. Its coloration is a grizzled light gray-brown. The sides of the muzzle in front of the eyes are blackish, and the tip of its tail is black. The hairs inside the ears are conspicuously white. Its average weight is four to five pounds (Laughrin, 1970; Grinnell *et al*, 1937; IUCN, 1969).

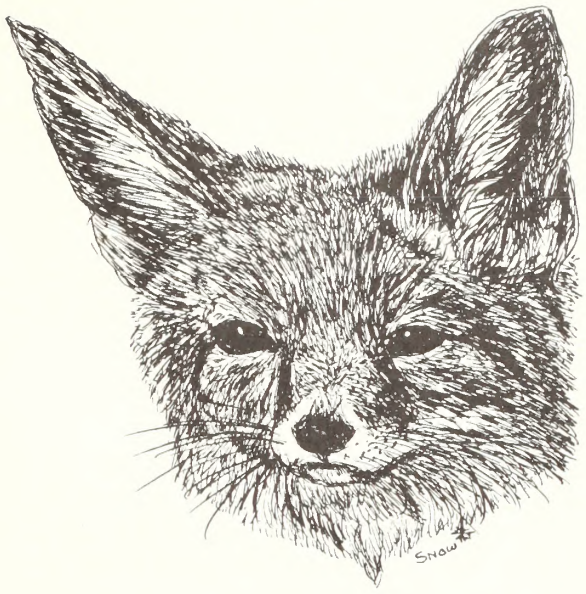
V. m. arsipus, commonly called the desert kit fox, is perhaps the smallest subspecies. It is lighter in color than the San Joaquin kit fox, has a consistently lighter-colored forehead, and the overhairs are finer in texture than in V. m. mutica. The sides of its muzzle are brownish or dark grayish, and it tends to have a dark brownish tail tip. Its weight ranges from three to three and one-half pounds (Hall, 1946; Grinnell et al, 1937).

V. m. nevadensis is known in Nevada as the kit fox, swift fox or desert fox. It is only slightly different from V. m. arsipus, making it questionable that there are really two subspecies. The primary differences are that V. m. nevadensis usually has black upper lips, a dark forehead and a black-tipped tail (Hall, 1946; Miller and McCoy, 1965).

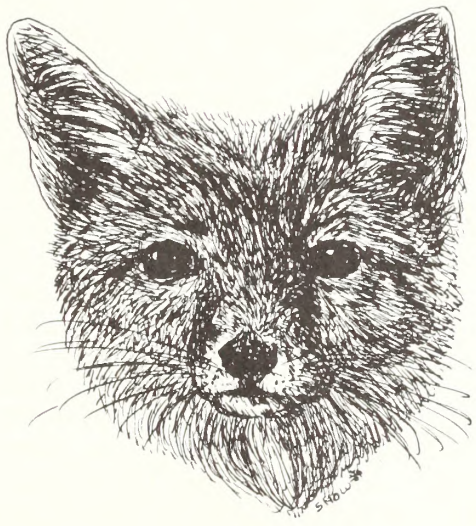
V. m. neomexicana, also referred to as the New Mexico desert fox, is somewhat larger than V. m. arsipus. Its dorsal coloration is plain buffy gray with clear buff along the sides and middle of the belly. It is white on the throat and the posterior parts of the belly. The tip of the tail is black (Bailey, 1931).

Vulpes velox, the swift fox, is ecologically and physically similar. The basic differences seem to be that V. velox has shorter ears, a broader skull, and is slightly larger than V. macrotis. Its average weight is four to six pounds. It may also be more buffy-yellow in color (Hall and Kelson, 1959; Burt and Grossenheider, 1952). See Figure 1.

The names kit fox and swift fox have been used interchangeably for both Vulpes macrotis and Vulpes velox. A number of people question whether or not the species distinction is genuine, but more critical studies are needed to decide this issue. The distinctiveness of some of the subspecies of Vulpes macrotis is also being questioned (Lechleitner, 1969; Hall, 1946; Burt and Grossenheider, 1952; Cahalane, 1947; Hall and Kelson, 1959; Weigand, 1965; Burt, personal communication, 1972). Hoffman (personal communication, 1972) has indicated that these foxes are two separate species. He referred to a paper by S. A. Rohwer and D. L. Kilgore, Jr. entitled "Interbreeding in the Arid-land Foxes, Vulpes velox and Vulpes macrotis." This is to be published in the March or June 1973 issue of Systematic Zoology. The authors found evidence of occasional hybridization between V. velox and V. macrotis in a zone of contact in west Texas and eastern New Mexico. Their evidence indicates that since only occasional interbreeding occurs, specific status for both forms is justified.



Kit Fox (V. macrotis)



Swift Fox (V. velox)

Figure 1. Kit Fox (V. macrotis) and Swift Fox (V. velox)

The American Society of Mammalogists' Committee on Vernacular Names for North American Mammals has recommended that the use of common names for subspecies be discontinued. The name "kit fox" should be reserved for V. macrotis and its subspecies, whereas the common name "swift fox" should apply only to V. velox and its subspecies (Egoscue, 1973).

In this report, only the San Joaquin kit fox (V. m. mutica) will be referred to by its common name. The other subspecies will be referred to by their scientific designations. The swift fox will be referred to by both its common and scientific names (V. velox).

2. Distribution

V. m. mutica formerly ranged over most of the plains and the low foothills of the San Joaquin Valley before California was settled by the white man. The present distribution of the San Joaquin kit fox extends from the Tehachapi Mountain foothills surrounding the southern end of the San Joaquin Valley, north along the foothills of the western part of the valley almost to Los Banos, and on the eastern edge of the valley north to approximately twenty miles south of Porterville (see Figure 2). The only area on the valley floor in which kit foxes occur in any numbers is the southwestern portion where some native vegetation remains (Laughrin, 1970).

V. m. arsipus is located in the Colorado and Mojave Deserts in California and Arizona. It is also found in southern Nevada and Grand County, Utah, and has been observed in Mesa County, Colorado (Hall, 1946; Grinnell et al, 1937; Hall and Kelson, 1959; Cockrum, 1960; Miller and McCoy, 1965; Armstrong, 1972). See Figure 3. If the identification of V. m. arsipus in Colorado and Utah is correct, there is a hiatus of several hundred miles between this population and the nearest V. m. arsipus population in southern Nevada (Egoscue, 1973).

V. m. nevadensis is found in the western part of Utah, in Nevada, northeastern California in the vicinity of Eaglesville, southeastern Oregon, and southwestern Idaho (Hall, 1946; Hall and Kelson, 1959; Allen, 1942; Egoscue, 1973). See Figure 3.

V. m. neomexicana is found in extreme southeastern Arizona and in appropriate habitat throughout most of western and southeastern New Mexico. It has also been reported in Montezuma County, Colorado (Cockrum, 1960; Hall and Kelson, 1959; Egoscue, 1964; Armstrong, 1972). See Figure 3.

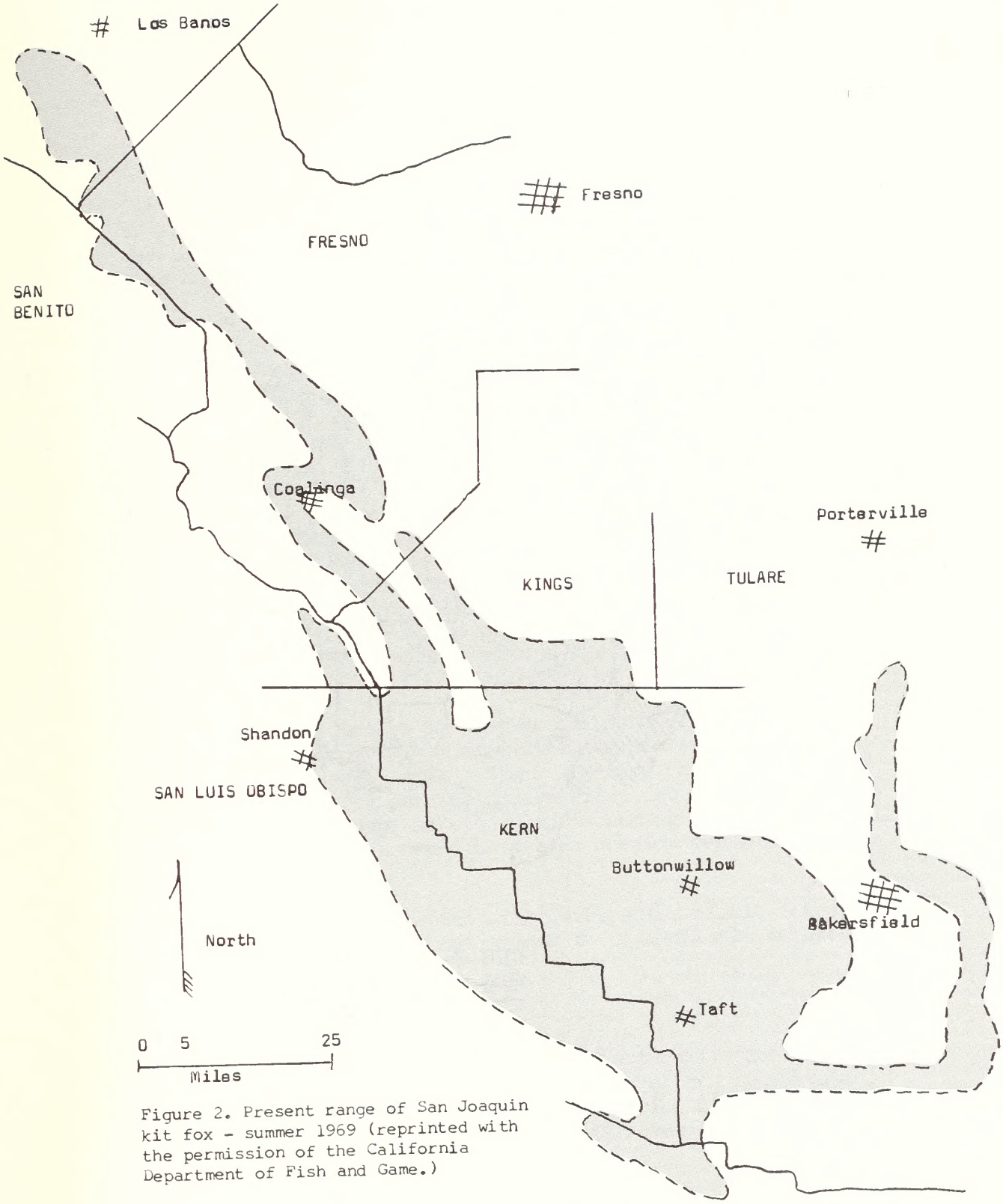



Figure 2. Present range of San Joaquin kit fox - summer 1969 (reprinted with the permission of the California Department of Fish and Game.)

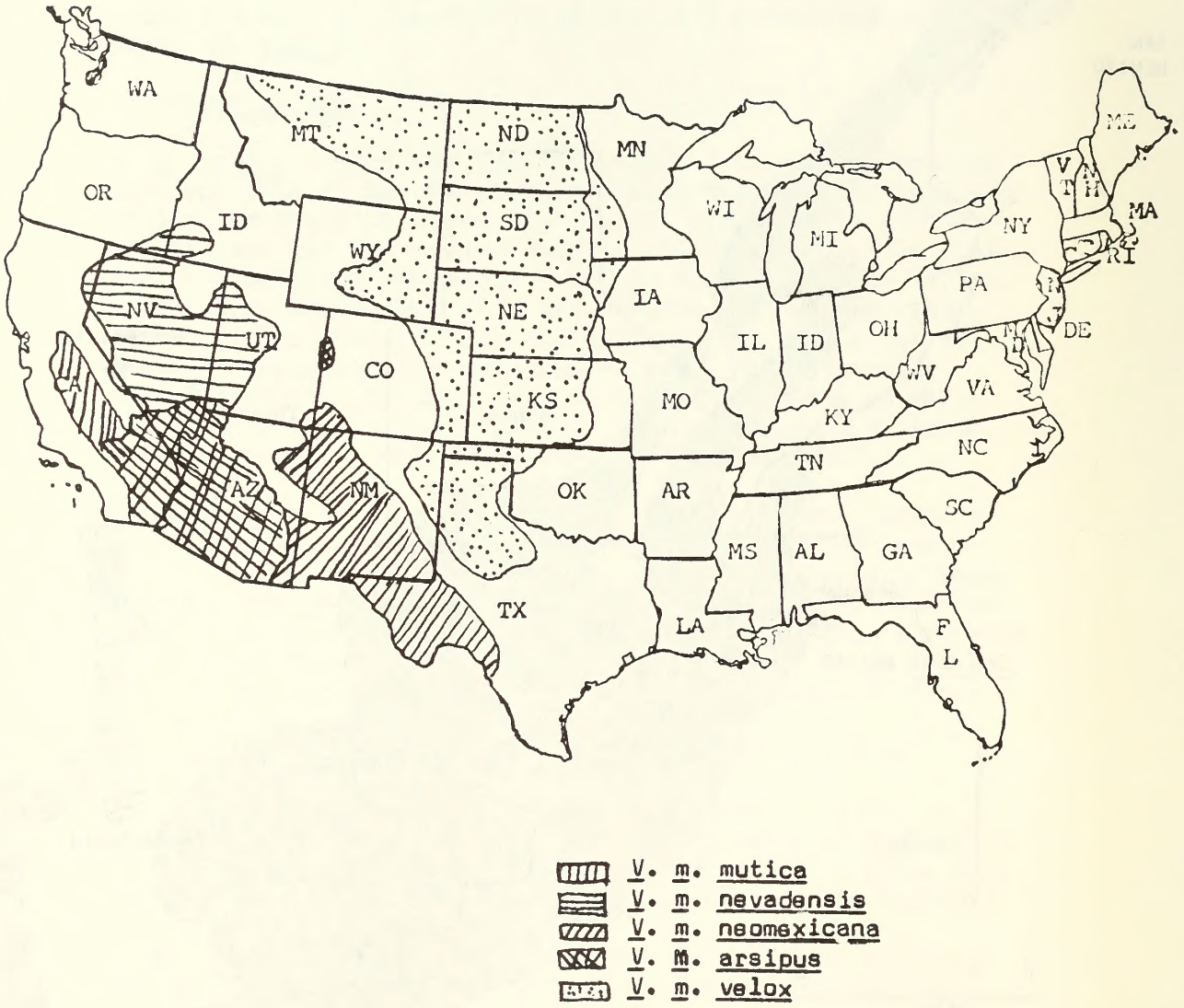



Figure 3. Approximate distribution of the kit fox, Vulpes macrotis, and the swift fox, Vulpes velox , in the United States.

Vulpes velox is found in eastern New Mexico, eastern and northern Colorado, and parts of Wyoming and Montana. It is also found in northwestern Texas, western Kansas, the Panhandle of Oklahoma, and nearly all of Nebraska, South Dakota and North Dakota, up into Canada (Hall and Kelson, 1959). See Figure 3.

## 3. Status and Population Trend

The San Joaquin kit fox is listed in the 1968 edition of the U. S. Department of Interior Red Book as endangered. It is currently considered rare by the California Department of Fish and Game.

The San Joaquin kit fox appears to be the only subspecies being studied in any detail at present. Grinnell et al (1937) made a population estimate for V. m. mutica of one fox per square mile throughout their entire range before 1925. They felt that the kit fox population was reduced by fur trapping from 1917-1920 and that a great number were destroyed by poison campaigns which were directed against coyotes. Laughrin (1970) estimated the same population density in the optimum habitat at the southern end of the San Joaquin Valley. Current population estimates are based on a den survey conducted on 140,000 acres of brush and rangeland in an Atriplex (saltbush) community. The present range has about three thousand square miles (two million acres) of suitable habitat. The population of V. m. mutica for 1969 was estimated to be between one thousand and three thousand, with a likely figure of two thousand.

In 1956, Egoscue made a population estimate of one pair of V. m. nevadensis per 3.6 square miles on his study area in south-central Tooele County, Utah. In 1962, his population estimate was one fox per two square miles from October through March. After the pups were born and assuming that no mortality occurred, this figure would have been one fox per .8 square mile.

Population estimates for the other subspecies of kit foxes and for the swift fox do not appear to be available in published literature.

## 4. Life History

The kit and swift foxes are basically nocturnal. Most hunting is done after dark, although kit foxes have been seen hunting as early as one hour before sunset (Laughrin, 1970; Morrell, 1972). Egoscue (1973) has observed kit foxes hunting as late

as 30 minutes before sunrise in western Utah. Diurnal activity is confined to the den area (Egoscue, 1956; Cahalane, 1947; Lechleitner, 1969; Morrell, 1972).

There are contradictory opinions as to the general behavior of the kit and the swift fox. Some authors maintain that they are very shy and wary of man (Cahalane, 1947), but most feel that they are unwary, unsuspicious and easily fall victim to certain of man's activities (Egoscue, 1956, 1962; Allen, 1942; Laughrin, 1970; Hall, 1946).

Kit and swift foxes apparently use dens all year long. They have been considered poor diggers (Cahalane, 1947) and excellent diggers (Lechleitner, 1969). Their dens are usually located in soil that is easy to dig, but Egoscue (1973) feels that this is coincidental. These foxes frequently utilize and modify rodent burrows and other already-constructed dens (Morrell, 1972).

Since kit and swift foxes are predators, their food habits have been of primary interest to investigators. The basic categories of food items are small mammals, small birds, small reptiles, amphibians and insects. Prey varies with the area, although there is an upper size limit. Egoscue (1962) noted that kit foxes sometimes have considerable difficulty killing adult jack rabbits (Lepus californicus) and that they consume a number of them as road-killed carrion. Cutter (1958) noted that the remains of jack rabbits and cottontails (Sylvilagus sp.) that he found in the scats and stomachs of swift foxes were those of immature animals.

Other food items include grasshoppers, kangaroo rats (Dipodymus sp.), horned toads (Phrynosoma sp.), pocket mice (Perognathus sp.), deer mice (Peromyscus sp.), rock squirrels (Otospermophilus sp.), antelope ground squirrels (Ammospermophilus sp.), pocket gophers (Thomomys sp.), thirteen-lined ground squirrels (Citellus tridecemlineatus), brown-shouldered lizards (Uta stansburiana), sand crickets (Stenopelmatus sp.), harvest mice (Reithrodontomys sp.), horned larks (Eremophila alpestris), burrowing owls (Speotyto cunicularia), meadowlarks (Sturnella sp.), and carrion (Egoscue, 1956, 1962; Laughrin, 1970; Burns, 1960; Grinnell et al, 1937; Morrell, 1971, 1972; Hawbecker, 1943; Weigand, 1965). Swift foxes have also eaten lark buntings (Calamospiza melanocorys), cowbirds (Molothrus ater), slate-colored juncoes (Junco hyemalis), and field sparrows (Spizella pusilla) (Cutter, 1958).

Records of food eaten by kit foxes in captivity indicated that adults provided with food in excess of needs ate an average of 175 g. of fresh meat every twenty-four hours. In a parallel study it was noted that the food requirements of the pups were about one-third those of the adults for roughly the first thirty-seven days. In the following twenty-seven days after this initial period, the pups consumed one-half of what the adults did. Average family requirements for 64 days were calculated to be 44,605 g. of food. The total weight of animals taken by a fox family during this period of time was judged on the basis of remains to be 38,100 g., or 85% of the required food (Egoscue, 1962). Weigand (1965) reported an average adult food consumption rate of 6 ounces a day and 2 ounces a day for pups.

In Morrell's study (1971, 1972) on the San Joaquin kit fox, kangaroo rats were the major prey. In his studies on V. m. nevadensis, Egoscue (1962) noted that black-tailed jack rabbits were a primary food item. Cutter (1958) noted that the staple food for swift foxes in his study area was cottontail rabbits (Sylvilagus sp). Morrell (1971, 1972) and Grinnell et al (1937) have noted that there is a close coincidence of the ranges of kit foxes and kangaroo rats, but the indications are that these foxes are opportunists and not solely dependent on kangaroo rats for a food source.

Egoscue observed an apparent dependence of the kit fox upon black-tailed jack rabbits for food in western Utah. In 1965, a crash occurred in the jack rabbit population throughout western Utah and parts of adjacent states. In 1966, the kit fox population had not been significantly affected, but in 1967 he observed the first non-breeding adult females ever recorded in his thirteen years of study. There were fewer litters but the average litter size was the same. The number of adults was not significantly different and jack rabbits remained scarce.

In 1968 most adult females did not breed and the average litter size was about half of what it was when the population was stable. The adult fox population declined, and rabbits still were scarce. The foxes hunted more birds and rodents but still caught some rabbits. In 1969 only two litters of pups were located, but the average litter size had increased. The adult population was about half of what it had been in 1966. Two pups born in 1968 established residence as adults and were the first pups to do this as far as is known. The sparseness of the adults apparently made it easier for young foxes to stay in this area. The jack rabbit population began to increase.

The last years of Egoscue's study in Utah were concerned with population dynamics. He found that approximately six years were required for a complete turnover to occur in a relatively undisturbed population. Seven years was the maximum known age attained by a wild fox. Forty to fifty percent of the resident foxes consisted of new individuals each year. In a stable population vacancies were filled by foxes from outside that population. For more than ten years not one pup out of more than one hundred born on the study area ever established itself there as an adult. The exception occurred when the population declined as described above (Egoscue, 1973).

Evening activity of the adults begins when they emerge from their dens around sunset. Morrell (1971, 1972) has observed a general behavior pattern prior to hunting. The fox looks out of its den, surveys the surrounding area and then comes out completely if there is no danger. It stretches, urinates, defecates, lies down on top of the den, then leaves to hunt. Kit foxes hunt sporadically throughout the night and foxes from different family groups will hunt the same area, but not simultaneously. This suggests the lack of a defended hunting territory.

Tracks indicate that when hunting, the kit fox systematically meanders, circling clumps of brush and wandering back and forth where cover is scarce. When likely prey is observed, a stealthy approach is made, then a swift rush which results in the death of the prey if the fox is successful. Kit foxes may consume parts of large prey species at the site of the kill and cache the rest, or carry it back to the den (Egoscue, 1962; Grinnell et al, 1937).

Reeder (1949) made an incidental observation of a kit fox swimming a canal without apparent difficulty, indicating that swimming may not be unusual behavior in a situation necessitating such activity.

Egoscue (1962) has distinguished five vocalizations for V. m. nevadensis: a bark, a growl, a purr, a croak and a snarl. A bark constitutes a warning. Morrell (1971, 1972) reported this sound for V. m. mutica as being similar to the barking of a small dog. A growl is also a warning to a closely approaching enemy. Egoscue (1962) reported what he designated as the "lonesome call," which both adults and pups made. Phonetically this sound is "whar whar whar whar" uttered rapidly for two to three seconds and usually repeated several times. A captive male that was separated from his mate did this several days in a row. Captive pups also made this sound. He believed it to be communication between separated pups and

adults. He also observed captive adults making a purring sound when inspecting food. For V. m. mutica, Morrell (1971, 1972) reported a sound that he called a burp, which is a bubbling noise resembling that made by a perking coffee pot. This sound was made by most of the adults that he captured, but was made only occasionally by pups that were trapped. This burp is the sound that Egoscue labeled as a croak (Egoscue, 1973).

Kit foxes have no set "sign" stations or scent posts. Scats are found along trails, at the dens and occasionally near objects such as animal remains. As the kit lives in a den all year long, one or more tunnels of the den may also be used for deposition of scats. Kit fox scats can be distinguished from fecal deposits of all other local animals with the possible exception of young coyotes, but by the time coyote pups leave their dens, their feces are larger than those of adult kit foxes (Egoscue, 1962).

The San Joaquin kit fox develops two coats in a year. The summer coat is tan and the winter coat is a silver gray. Pups acquire the black-tipped tail at around two months of age. The adult summer coat replaces puppy fur at the age of four to five months. Weight gains average 3/4 to 1 pound a month, and adult weight is reached at about five months of age (Morrell, 1971, 1972). In his studies of V. m. nevadensis Egoscue (1962) noted a weight gain of about .4 pound every ten days for pups. He did not observe distinct color phases, but noted that foxes of given age groups could be separated into two, and possibly three, variations in shading: pale, dark and intermediate. He also observed both light and dark pups in the same litter, suggesting that this variation was under genetic control.

The gait of the kit fox when chased is a swift run with sudden bursts of speed that evolve into zigzags if a fox is pursued for any length of time (Grinnell et al, 1937). In spite of this swiftness, many kit foxes are killed by automobiles where they have been scavenging on other road kills (Ingles, 1965; Egoscue, 1962). The other major mortality factor seems to be death by shooting. When Morrell (1971, 1972) began his study of the San Joaquin kit fox, six adults and eight pups occupied his study area. Four males had died or been killed. A total of six foxes died in a two-mile study area. Three pups and one adult had been killed by varmint hunters, and another young adult was shot. The remains of a radio-tagged fox were too decomposed to determine the cause of death. From this evidence, Morrell concluded that indiscriminate and illegal shooting was the most significant mortality factor affecting this particular population.

## 5. Reproduction

Although a number of studies have been conducted on kit foxes, comparatively little is yet known about reproduction.

Breeding season for kit and swift foxes generally extends from late December through January and in some situations to early February. Gestation for both is assumed to be the same as for the red fox (Vulpes fulva), 49-55 days. In the southern deserts, kit foxes may be born as early as February, but most pups farther north are born in March or early April. Swift fox pups have also been observed during these months (Egoscue, 1956, 1962; Lechleitner, 1969; Cahalane, 1947; Morrell, 1971, 1972; Kilgore, 1969).

In the past, kit and swift foxes were assumed to be monogamous, perhaps mating for life, with mated pairs staying together throughout the year. More recent studies indicate that this assumption is not necessarily valid for kit foxes. On two occasions during his study, Egoscue observed two lactating females occupying the same den site. None of these polygamous trios persisted for more than one year (Egoscue, 1956; Kilgore, 1969). Morrell (1971, 1972) has observed that, from June through October, most adult San Joaquin kit foxes are solitary. During October and November, males join females in large brood dens. Evidence which he acquired indicates that although a male fox will usually have one mate in a season, the same males and females do not pair year after year. One male he observed had at least three different mates in two breeding seasons. Morrell also noted that kit foxes do not breed successfully their first year.

Egoscue observed that pair bonds between a male and a female might last as long as three years, whereas other pairs would be together for only one breeding season. Both members of such a pair were part of the adult population in the following year but were paired with new mates. Females tended to be older than the males when breeding pairs were formed. Egoscue feels that the expression "pairing for life" can be misleading because very frequently one member of a breeding pair may disappear after only one season. He suspects that death is responsible for the disappearances rather than a shift in home ranges because once established a breeding fox's fidelity to its home range is often of life-long duration (Egoscue, 1973).

While suckling very young pups, females spend most of their time in the den and the male does the hunting. Four to five pups constitute the average litter size, although litters may

number from two to seven pups. The pups never appear above ground until they are at least a month old. Both parents hunt for the pups and care for them until they are four to five months old. At this age, the pups begin to forage for themselves and the family group tends to separate, although a pup and one of its parents may stay together in one den through autumn. The pups may stay together in a group for some time after the family separates (Lechleitner, 1969; Egoscue, 1956, 1962; Cahalane, 1947; Morrell, 1971, 1972).

Observations have been made of newborn and one-month-old kit foxes. Egoscue (1966) described a newborn male V. m. nevadensis as having buffy red fur on the head, neck and lower sides of the body. The back, thighs and proximal half of the tail were gray-brown. Except for the feet, ears, inguinal region and the distal half of the tail, the body was covered with short, soft hairs one to three millimeters long. The weight was 39.9 grams.

Egoscue (1956) also described a one-month-old V. m. nevadensis pup. By this time, the body is covered with short, woolly puppy fur with definitely longer black guard hairs showing through brown fur on the back and the hips. The fur is very reddish about the shoulders and front legs. The dark area on the muzzle is pronounced, and the tail is grayish-black with brown undertones. The underparts are white, and the eyes are gray-blue, while the adults have yellow-brown eyes. Average weight is 575 g.

Grater (1939) observed some behavior at a den site when the pups were old enough to leave the den for short periods of time at night. Around dusk, the male emerged cautiously from the den and disappeared after a few moments. For approximately half an hour there was no activity, then the female appeared when it was completely dark. She called the pups up from the den and then they would play.

Morrell (1971, 1972) observed pups playing outside but close to the den entrance in the afternoon, usually sometime between 2 p.m. and 6 p.m., with at least one adult watching their activities.

6. Habitat Requirements

Distinctions between the habitat requirements of Vulpes macrotis and Vulpes velox have been ignored for the most part by those investigators who have implied that kit foxes and swift foxes are members of a single species. However, V. macrotis is ecologically adapted to the desert shrub biome,

whereas V. velox apparently evolved in a prairie environment where grasses were the dominant plants. V. velox may now occupy what was originally marginal habitat because most of its prime habitat has disappeared as a result of settlement and modern agricultural practices. Most of the original habitat occupied by V. macrotis is still unchanged and available, except for vegetation changes brought about by overgrazing and the loss of most of the San Joaquin Valley in California through development (Egoscue, 1973).

Apparently a suitable den is a critical habitat requirement, as kit foxes and swift foxes use dens all year long. The habitat types in which dens are found varies.

Egoscue (1956, 1963) conducted extensive studies of V. m. nevadensis on the Dugway Proving Ground in Tooele County, Utah. His study area was 25 square miles and contained three distinct communities: vegetated sand dunes, greasewood flats and shadscale flats.

Eighty percent of the dens which Egoscue found were located in sparsely vegetated shadscale flats where the vegetation averaged eight to ten inches in height and consisted of the following species in order of importance: shadscale, Atriplex confertifolia; grey molly, Kochia vestita; seepweed, Suaeda torreyana.

The greasewood flats were next in abundance of fox dens. The dominant plant was greasewood, Sarcobatus vermiculatus, which was three to five feet tall and generally widely spaced. Ground cover between these bushes was scarce and consisted mainly of low-growing shrubs such as grey molly, seepweed, and shadscale.

Only one fox den was found in the vegetated dunes. All stages of dune succession were evident. Most dunes had loose sandy soil and plant cover dominated by desert shrubs such as four-winged saltbush (Atriplex canescens), rabbitbrush (Chrysothamnus sp.), greasewood (Sarcobatus sp.), horse brush (Tetradymia sp.) and shrubby buckwheat (Eriogonum dubium). Indian rice grass (Oryzopsis hymenoides) was the dominant grass. The prime value of the dunes was as a hunting area, as they were inhabited by nine species of small rodents and two species of lagomorphs.

The shadscale flats possibly were preferred habitat because the low vegetation permitted good visibility and the silty

clay soil was easy to dig in. However, the dunes contained more prey species and were more productive for hunting than the other areas.

Cahalane (1947) indicated that kit and swift fox dens are usually found on flat ground, on a sand dune or near the crest of a small bank or arroyo wall. He felt that these foxes live in a sandy plains habitat because of the rodents that live there. Hall (1946) indicated that, in Nevada, kit foxes occur only in the lower Upper Sonoran Life Zone or below it in the lower sandy parts of valleys or the edges of valleys.

Laughrin (1970) has noted an arid climate for San Joaquin kit fox habitat in California. The vegetation varies, much of it being grassland with primarily annual grasses on the western side of San Joaquin Valley. Towards the southern end, perennial shrubs occurred among the grasses, such as saltbush (Atriplex polycarpa), seepweed (Suaeda torreyana), pickle-weed (Salicornia subterminalis), iodine bush (Allenrolfea occidentalis), alkali heath (Frankenia grandifolia) and introduced tumbleweed (Amaranthus albus). On the valley floor these species are intermixed.

The only suitable kit fox habitat on the east side of San Joaquin Valley is the grassland on the rolling hills, which has the appearance of overgrazing. Overgrazing in this situation possibly increases the suitability of the habitat for foxes and rodents. Where there was no grazing, grasses were two to three feet tall and there was very little evidence of rodent activity. Morrell (1971, 1972) noted that the soil type in his study area was sandy clay on the hillsides and sandy on the valley floor.

Kilgore (1969) conducted an ecological study of V. velox in the Oklahoma Panhandle. His study area was located in short-grass plains habitat. The area had been extensively cultivated, and much of the native vegetation had been replaced by Russian thistle (Salsola sp.), common sunflower (Helianthus annuus), cocklebur (Xanthium commune), lamb's-quarter (Chenopodium album), bindweed (Convolvulus sp.), western ragweed (Ambrosia psilostachya), grassbur (Cenchrus sp.) and pricklypear (Opuntia sp.).

Cutter (1958) located numerous dens in open, sparsely vegetated habitats, on sloping plains, hilltops or other well-drained situations in northern Texas. He found V. velox dens in three general situations: overgrazed pastures, plowed fields, and fence rows that had wind-formed soil banks one to two feet high. Most of the dens he found were in overgrazed

pastures which were devoid of any bushes or tall plants. The next highest frequency of dens occurred along fence rows. The fewest were found in the plowed fields.

Grinnell et al (1937) indicated that while open, level, sandy ground was preferred habitat for kit foxes in California, V. m. arsipus was also found in the high, rocky, juniper-covered hills of the Mojave Desert.

Egoscue (1956) noted that kit foxes have definite den preferences. Areas already containing dens were apparently more attractive than areas without dens, and kit foxes moving into an area tended to choose old den sites rather than digging new dens. He also observed that the dens were not randomly scattered, but were located in groups. Favored areas varied in size from one-half acre or less with one or two den sites, to a square mile or more with numerous dens. As many as eight to ten dens were grouped together on two or three acres of shadscale flats that were surrounded by hundreds of acres of the same habitat type where no dens were found.

Morrell (1971, 1972) noted a great abundance of dens on his study area, most of which were unoccupied at any given time. Burrowing owls frequently took up residence in unused dens. His observations produced evidence that for three months following breeding season, adults occupy smaller dens. Most of these dens have three entrances or less. In September and October, the females reoccupy larger dens, cleaning and enlarging them, and sometimes adding new entrances. In October and November, males join the females in these "brood" dens and will stay there until May or June of the following year. Four or five dens may be used in one month during the summer. The male may inhabit a den separately from his family, but nearby. The reasons for den changes are not known. Morrell observed that a family of five foxes used as many as forty-one dens during the fifteen months of his study. He also noted that, unlike hunting territories, each family of foxes has dens which are used by the members of that family only.

Most openings are a little higher than wide and usually too narrow to permit passage of animals such as badgers and coyotes. The diameter of measured den entrances has ranged from seven to ten inches. Most dens have multiple entrances, ranging from two to seven, although Egoscue (1962) reported one den with twenty-four entrances. Three to four entrances are most frequent.

Kit and swift fox dens are essentially similar in structure. Occupied dens can be recognized by mounds of fresh earth at the entrances which are deposited during the excavation of the

den. Fresh scats, animal remains and tracks will also be present. Shallow forms in which these foxes rest in the shade of adjacent shrubs have also been observed near den entrances. Unoccupied dens can be recognized by a weathered appearance, rounded den entrances, and cobwebs across the tunnel openings.

Dens which are used constantly are frequently renovated. While all entrances have a mound of dirt extending from the opening, it is not unusual for one entrance to have a narrow ramp-like mound of earth extending outward five to eight feet from the mouth of the tunnel. Most mounds of dirt measure two to five feet long.

The average length of measured kit fox burrows has varied from eight to fifteen feet, total length. The tunnels in the dens twist and turn so that the specific chamber where the pups are born may be quite close to the entrance. These chambers have been measured from twelve to eighteen inches wide and twelve inches high. Large dens contain numerous chambers, tunnels and entrances and probably reach such complexity as a result of many years of continual use (Morrell, 1971, 1972; Grinnell et al, 1937; Cahalane, 1947; Cutter, 1958; Egoscue, 1956, 1962; Kilgore, 1969).

7. Limiting Factors

Loss of suitable habitat appears to be a limiting factor for the San Joaquin kit fox. In the past ten years there has been a 34% reduction in the native habitat of this fox. More acres are being put into cultivation every year, decreasing the amount of habitat available for the San Joaquin kit fox (Laughrin, 1970).

Laughrin (1970) has indicated that kit foxes are very vulnerable to night-hunting through varmint-calling techniques. Indiscriminate hunting could possibly in some situations be a detrimental factor to kit fox populations. Morrell (1971, 1972) substantiates this observation.

The most serious factors affecting V. m. arsipus on the Mojave and Colorado Deserts seem to be indiscriminate killing and habitat disturbance by motorcycle and dune buggy enthusiasts (Laughrin, 1970). Since there are no estimates for these populations, there is no way to judge what impact these activities are having.

A very difficult factor to evaluate is the effect of predator and rodent control. Not only is the subject an explosive one to deal with, but there are not any comprehensive studies

directed toward obtaining objective information. Comments in the literature pertain largely to incidental observations and are not backed up with substantial data.

Indications are that, at least in some situations, predator and rodent control may have an effect on kit fox populations. One specific figure available in published literature is that given by Grinnell et al (1937) in the San Joaquin Valley. An observation was made near Buena Vista Lake in January 1925 of seven kit foxes within a distance of one mile that had been killed by strychnine baits put out for coyotes. Grinnell et al (1937) then expressed the opinion that intensive trapping, poisoning campaigns, and an extraordinary seasonal or food condition unfavorable to kit foxes might eliminate the San Joaquin Valley population.

Cahalane (1947) made the statement that kit and swift foxes readily eat poison baits that coyotes would not touch. Allen (1942) quoted a trapper as saying that kit foxes would take a poisoned bait the first night it was set out, whereas coyotes tended to take such baits after a longer time of exposure.

Benson (1938) was of the opinion that kit foxes are so unsuspicious that they are easily trapped and poisoned. He proceeded to say that wherever trappers were active, and especially where poisoning was conducted against other predators also living in the areas inhabited by kit foxes, the foxes were greatly reduced in number or entirely eliminated.

Robinson (1953) offered contrary evidence. He conceded that coyote getters were definitely hazardous to non-coyote canids, and that kit foxes had been taken during control programs, but that 1080 stations did not constitute a hazard to kit foxes because they were much more widely spaced. Since the kit fox is relatively sedentary, it was not exposed to as much of a chance of encountering any of the widely spaced 1080 stations which carried only the minimum amount of poison in each one. He went on to say that the available evidence indicated an increase in small furbearer populations, including the kit fox.

Since the use of poisons to control predators on public lands is now illegal, poisons should no longer constitute a hazard to kit and swift foxes. However, rodent control programs are still being carried out and may be detrimental to these foxes.

8. Protective Measures Instituted

a. Legislative or Regulatory

The San Joaquin kit fox is the only subspecies of kit fox listed as endangered in the rare and endangered lists of the IUCN (International Union for the Conservation of Nature and Natural Resources) and U. S. Department of Interior. It is fully protected by California state laws and has been since 1965. V. m. nevadensis is fully protected in Oregon. The swift fox, Vulpes velox, is not considered endangered or rare.

b. Captive Breeding

There are no known captive breeding projects. However, kit and swift foxes occasionally breed in zoos. V. m. nevadensis bred in 1972 at the Calgary Zoo in Canada. These foxes came from Utah (Egoscue, 1973).

c. Habitat Protection and Improvement

The withdrawal of Federal land from public domain for use by the military has had some beneficial effects on kit foxes. Specific areas with kit fox populations include the Dugway Proving Grounds and Wendover Bombing Range in Utah, the White Sands Proving Ground in New Mexico, China Lake Naval Station in California, the Atomic Testing Grounds in Nevada and bombing ranges in the Black Rock Desert of northwestern Nevada. On these particular areas, grazing by livestock has been restricted or excluded, as has predator control. This has been beneficial to both the habitat and any predators resident on these areas (Egoscue, 1973).

d. Reintroduction

There have been no attempts at reintroduction into parts of the former range of any of these species or subspecies.

9. Species and Habitat Management Recommendations

1. Survey BLM lands in likely habitat to determine the presence of kit and swift foxes and obtain population estimates of these species.

2. Support research oriented to life history, population dynamics and the effects of dune buggy and motorcycle use on kit fox habitat that is presently inhabited by kit foxes.

3. Support investigations on the impact or lack of impact that rodent control programs may be having on kit and swift foxes.

4. Support studies to determine the impact of illegal and legal hunting on kit and swift foxes.

5. Investigate the possibilities of cooperation with the military and the coordination between the Bureau of Land Management and the military in establishing habitat management plans for wildlife on military reservations and adjacent BLM lands.

10. Ongoing Research Projects

California Department of Fish and Game has been conducting studies on the life history and ecology of the San Joaquin kit fox.

11. Authorities

1. Harold J. Egoscue (kit fox)
Smithsonian Institution
National Zoological Park
Washington, D.C. 20009

2. Stephen Morrell (San Joaquin kit fox)
California Department of Fish and Game
1416 Ninth Street
Sacramento, California 95814

12. Governmental, Private and International Organizations Actively Involved With This Species' Welfare

A. 1. California Department of Fish and Game
The Resources Agency
1416 Ninth Street
Sacramento, California 95814

2. This agency is responsible for the protection and management of the San Joaquin kit fox.

13. Photographic Material Available

California Department of Fish and Game has several photos of San Joaquin kit foxes in their publications on this subspecies. Harold J. Egoscue has numerous photos, both black and white prints and color slides of V. macrotis dens, adults, pups and habitat.

14. Desert and Prairie Foxes

There is comparatively little published information on kit and swift foxes. Although they may be separate species living in somewhat different habitats, many elements of their life history, such as food habits, reproduction and denning behavior, are similar.

Information which is available on the various subspecies of kit foxes may assist in permitting a better understanding of any one of the subspecies and in formulating appropriate management plans. Although only the San Joaquin kit fox is considered rare, altered environmental conditions induced by human pressures could change the status of any of these foxes.

Egoscue (1973) has already indicated that swift foxes may now be living in what was formerly marginal habitat because most of their prime habitat has been altered to such an extent by man's activities that they can no longer exist there. Increasing development of mineral resources on public lands may alter present kit and swift fox habitat to such a degree that their numbers may be diminished. A more intense use of public lands by the public to which they belong may also create problems for the foxes as less and less suitable habitat is available.

The impact of various human activities on fox populations has yet to be studied in many areas. Information is needed on population dynamics, behavior, interspecies relationships and adaptability to changing conditions. Although the coyote (Canis latrans) is proving to be highly adaptable, insufficient data has been accumulated to determine how much pressure kit and swift foxes can withstand.

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