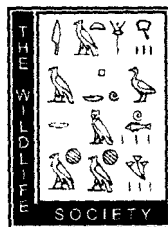


***MESOCARNIVORES
OF NORTHERN CALIFORNIA
Biology, Management, & Survey Techniques***



**August 12th -15th, 1997
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The Sierra Nevada Red Fox (*Vulpes vulpes necator*)

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DESCRIPTION

The following description has been modified from the account given in Larivière and Pashitschniak-Arts (1996): The red fox (*Vulpes vulpes*) is a relatively small, slender canid with an elongated muzzle, large pointed ears, and round bushy tail, usually as long as the head and body. There are 3 color phases: red, silver or black, and cross. In the typical red phase, yellow to reddish-brown fur predominates in the upper body; the cheeks, chin, throat, and abdomen are white; the face and rump are rusty; legs and ear tips are black; and the tail, with its distinctive white tip, is mixed generously with black. In the silver phase, coat color varies from silver to nearly black with a variable amount of frosting resulting from silver tips on the guard hairs. The cross phase is predominantly grayish-brown, and gets its name from the long black guard hairs that form one line down the back and another across the shoulders. Both the silver and cross phases are rare, but their prevalence varies geographically. In some areas, especially those having relatively cold climates, 10-25% of the population may be in the dark phases.

TAXONOMY

Variation in the North American red fox was first investigated by Merriam (1900), who recognized ten species and two subspecies, all of which were later given subspecific status under *Vulpes fulva* by Bailey (1936a). Churcher (1959) conducted an extensive re-evaluation of cranial and dental variation in North American and Eurasian red foxes, and concluded that red foxes worldwide were members of a single species, *Vulpes vulpes*. Churcher (1957) revised the North American subspecies, eliminating three

previously recognized forms and redrawing the distributional boundaries of others: *V. v. harrimani* is found on Kodiak Island in southwest Alaska; *V. v. alascensis* occupies Alaska, the Yukon and the western Northwest Territories; *V. v. abietorum*, the northern regions of British Columbia, Alberta, Saskatchewan, Manitoba and the southeastern Northwest Territories; *V. v. rubricosa*, the James Bay region of Ontario, northern Quebec, Newfoundland, Nova Scotia, Prince Edward Island and New Brunswick; *V. v. fulva*, the eastern United States east of the Mississippi River; *V. v. regalis*, the eastern United States west of the Great Lakes and the Mississippi River; *V. v. necator*, *V. v. cascadiensis*, and *V. v. macroura*, are restricted to the upper elevations of the Sierra Nevada, Cascade Range, and Rocky Mountains, respectively. The latter 3 subspecies are high-elevation, montane forms with a unique evolutionary history (Aubry 1983); these three forms are sometimes referred to as the “mountain foxes”.

GEOGRAPHIC DISTRIBUTION

The Sierra Nevada red fox is one of California's rarest and least known mammals (Schempf and White 1977). Only 18 museum specimens from 8 localities are known, the most recent of which was collected in 1934 (Grinnell, et al. 1937, Lewis, et al. 1995). Grinnell, et al. (1937) described the distribution of the Sierra Nevada red fox as continuous at high elevations of the Sierra Nevada from Tulare County north to Sierra County, and in the vicinity of Mt. Shasta and Lassen Peak westward to the Trinity Mountains in Trinity County (Fig. 1). The records they obtained occurred from 4,500 to

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11,500 ft. in elevation, but most were 'above 7,000 ft. Schempf and White (1977) gathered 62 additional sighting records which showed a similar but more continuous distribution than that of Grinnell, et al. (1937) (Fig. 2). The mean elevation of records from the northern Sierra was 6,400 ft. (range 4,300-8,500 ft.), whereas in the southern Sierra, the mean was 6,900 ft. (range 3,900-11,900 ft.). Over 1/3 of their records

were from the vicinity of Lassen Volcanic National Park, which they believed supported the densest population of Sierra Nevada red fox in California. Interestingly, the only verifiable records of Sierra Nevada red fox since 1937 are several photos taken at a remote camera station in 1993, 20 mi. east northeast of Lassen Peak, at an elevation of about 6,200 ft. (Kucera 1993, 1995), and a series of photos of two individuals

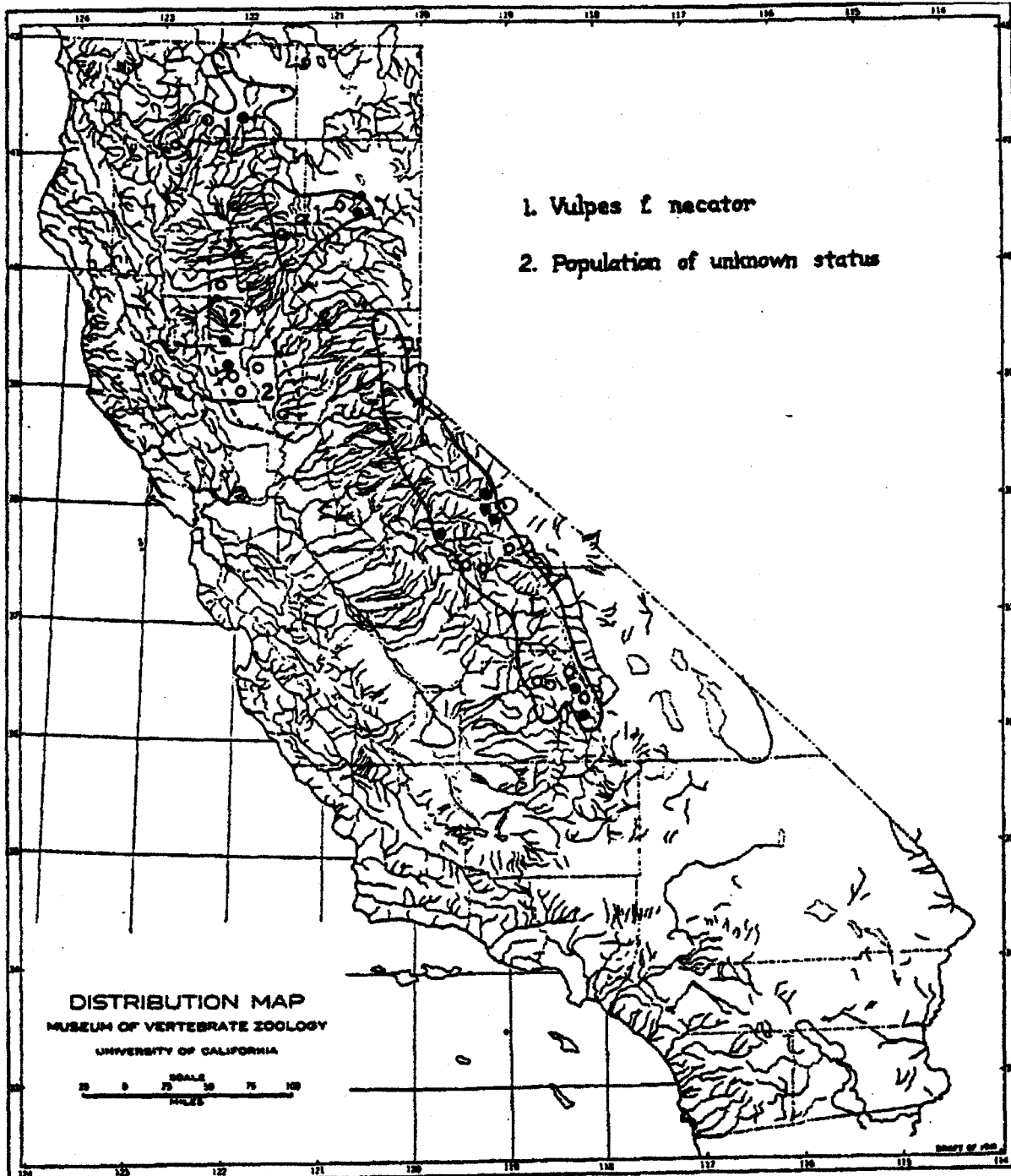


Figure 1. Red fox distribution in California, Grinnell, et al. (1937).

taken in 1997, 8 mi. south of Lassen Peak at an elevation of about 5,800 ft. (Tom Rickman, pers. comm.). Although the photos were taken within the known range of the Sierra Nevada red fox, the taxonomic status of the animal in the pictures remains somewhat uncertain (Kucera 1995).

Non-native red foxes may have escaped from local fur farms, which were present in that area from the 1920's to 1940's (Lewis, et al. 1995), or invaded from the Sacramento Valley where they have occurred since the late 1800's (Grinnell, et al. 1937; see also Gould 1980; Gray 1975, 1977; Lewis, et al. 1993; Roest 1977; and Schempf and White 1977).

comes almost entirely from information obtained by Grinnell, et al. (1937). The information they presented came from carcasses they examined, their own field observations, and anecdotal reports from trappers who had trapped red foxes in the high Sierra. The Cascade red fox, which occurs at high elevations near tree line in the Cascade Range of Oregon and Washington, has habitat associations that are very similar to those of the Sierra Nevada red fox. Furthermore, these two subspecies are so similar morphologically, that Roest (1979) once proposed lumping them (along with the Rocky Mountain red fox) into a single subspecies. The only intensive field study of mountain foxes was research that I conducted on the Cascade red fox at elevations ranging from 5,000 to 7,000 ft. near Mt. Rainier in south-central Washington (Aubry 1983). Bailey (1936b) and Taylor and Shaw (1927) also present information on the life history characteristics of the Cascade red fox. As appropriate, I will also include information from these sources in the following sections.

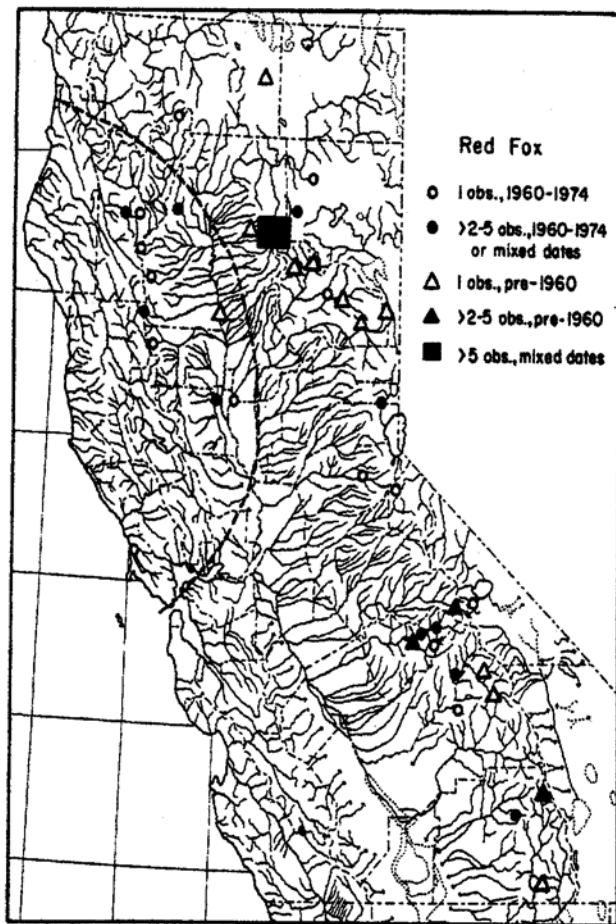


Figure 2. Distribution of red fox reports, Schempf and White (1977).

BIOLOGY AND ECOLOGICAL RELATIONSHIPS

Information on the biology and ecology of Sierra Nevada red foxes is extremely limited, and

REPRODUCTIVE BIOLOGY

Although the Sierra Nevada red fox occurs in extremely harsh environments with a relatively short growing season, there is no evidence to suggest that mountain foxes have markedly different reproductive characteristics than red foxes occurring elsewhere in North America. Unlike many mustelids, such as the American marten (*Martes americana*) and fisher (*M. pennanti*), implantation of the blastocyst is not delayed in red foxes. According to Ables (1975), red foxes typically mate sometime between December and April, but most matings occur during January and February. Both male and female red foxes are capable of breeding during their first winter. Gestation lasts for just over 50 days, at which time red foxes give birth to an average of 4.5 to 5.5 pups, with a range of about 1 to 10 per litter.

Available data indicate that mountain foxes breed at about the same time of year as red foxes in other regions of North America. Based on pairs of tracks found together in the snow on about February 15 in California, Grinnell, et al. (1937) concluded that Sierra Nevada red fox

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mating took place at about this time. Using known dates at which permanent teeth sequentially replace milk teeth in the red fox, I estimated that Cascade fox pups captured during the summer in Washington had been born in the second week of March and, thus, conceived in the first or second week of February (Aubry 1983). As elsewhere, mountain foxes can breed before they are 1 year old. Of two female pups I radio-collared during their first summer, one stayed with her parents and did not breed, whereas the other dispersed a distance of about 8 km and gave birth to a litter of at least 3 pups during her first winter. Grinnell, et al. (1937) reported that litter size for Sierra Nevada red fox varied from 3 to 9 with an average of 6.

DENS

One of the trappers consulted by Grinnell, et al. (1937) had found several dens of Sierra Nevada red foxes, but never one that was dug into the ground. He was of the opinion that “the [Sierra Nevada red fox] does not normally use earthen dens, but chooses to live in natural cavities in the huge rock slides and talus slopes prevalent in its domain...”. Another individual “knew of a den that was used by foxes year after year. It was most inaccessible, being situated in a huge pile of riven granite in a very wild spot...”. However, these reports represent only a few anecdotal observations. Although the Sierra Nevada red fox clearly uses rock dens, it seems unlikely that they would not also use earthen dens. Rather, these reports probably reflect either soils that were too rocky to provide suitable earthen den sites, or the greater likelihood of discovering Sierra Nevada red fox dens in rocky outcrops, since earthen dens would probably be located in timbered areas, making them more difficult to discover. During the course of my field work, I located several dens of Cascade red foxes; all were typical earthen dens situated in relatively dense timber. I did not observe them denning in rocks, even though rocky outcrops and talus slopes were present in my study area (Aubry 1983). Although the use of rock dens is unusual among red foxes in North America (Ables 1975), Sierra Nevada red foxes probably den in the most suitable site available, whether in rocks or underground.

MORTALITY

Information on sources of natural mortality for mountain foxes is very scant. Grinnell, et al. (1937) described several instances of golden eagles (*Aquila chrysaetos*) preying on Sierra Nevada red foxes when they were caught in traps, suggesting that they may also prey upon them in other circumstances. They also speculated that bobcats (*Lynx rufus*) and mountain coyotes (*Canis latrans lestes*) may be predators of Sierra Nevada red foxes. Bailey (1936b) stated that Cascade foxes generally “occupy the areas where coyotes are not common, either because they are rival hunters of mice and small game, or because they are old time enemies with the size advantage all in favor of the coyote”. There is no published information on diseases infecting mountain foxes.

It is likely that Sierra Nevada red foxes once suffered additional human-caused mortality during predator control operations in the early part of this century. According to a trapper quoted by Grinnell, et al. (1937), sheep were once herded throughout the high mountains, and “the practice of placing poison in all dead sheep was universal, the result being that thousands of fur animals were destroyed”. Although trapping was once a source of mortality for Sierra Nevada red foxes, they have been protected from trapping since 1974 (Kucera 1993).

HOME RANGE

The only available information on home range size for the Sierra Nevada red fox are estimates provided by a trapper to Grinnell, et al. (1937). After trapping for many seasons in what he considered to be the best Sierra Nevada red fox country, he stated that “on the average there is about one red fox to each square mile [259 ha]. Under favorable circumstances, three or even four foxes may be trapped in a single square mile”. These estimates are remarkably similar to home range sizes I estimated for 4 adult Cascade red foxes using radio-telemetry (Aubry 1983). For these 4 foxes (2 males and 2 females), home range sizes varied from 65 to 308 ha, with a mean of 193 ha. During the summer that one of the females whelped pups, her home range was

much more restricted in extent than her mate's (65 vs. 132 ha), suggesting that her activities were more restricted to the vicinity of the den than the male. During the next summer, when she did not breed, her home range size was over three times larger than it had been the previous summer (223 ha).

FOOD HABITS

As with red foxes elsewhere, mountain foxes feed on a variety of animal and plant foods, but probably rely most heavily on small mammals. Grinnell, et al. (1937) reported finding the following prey remains in scats: mice, bushy-tailed woodrat (*Neotoma cinerea*), Douglas' squirrel (*Tamiasciurus douglasii*), Belding's ground squirrel (*Spermophilus beldingi*), alpine chipmunk (*Tamias alpinus*), and white-tailed jack rabbit (*Lepus townsendii*). These authors also report observations of Sierra Nevada red foxes pursuing golden-mantled ground squirrels (*Spermophilus lateralis*) and meadow mice (*Microtus* sp.). Carrion of large mammals was often used as bait to trap Sierra Nevada red foxes.

Bailey (1936b) described Cascade red foxes as stealthy hunters of small game, including mice, chipmunks, ground squirrels, birds, and rabbits, whereas Taylor and Shaw (1927) reported that scats they examined contained only insects and fruit. As explained below, the latter report is probably indicative of scats collected only in late summer or early fall. I described the seasonal food habits of Cascade red foxes by examining 413 scats containing 760 food items. Mammals were the most important item in the yearly diet, comprising 57% of all items found; fruits [strawberries (*Fragaria* sp.) and blueberries (*Vaccinium* sp.)] represented 20% of the diet; insects (mainly grasshoppers and beetles), 17%; birds, 4%; and other items, 2%. The importance of each dietary category varied seasonally, suggesting a diet driven largely by the seasonal availability of potential food items. In winter, the diet consisted of 89% mammals, 6% birds, and 5% other items. In order of importance, the most prevalent mammals in the winter diet were snowshoe hares (*Lepus americanus*), southern red-backed voles (*Clethrionomys gapperi*),

northern pocket gophers (*Thomomys talpoides*), and heather voles (*Phenacomys intermedius*). During the summer months, however, mammals represented only 53% of food items found; fruits, 22%; insects 19%; birds, 4%; and other items, 2%. Interestingly, the northern pocket gopher was preyed upon more often than any other mammal species, and was the most commonly occurring item in the diet. Southern red-backed voles, heather voles and, especially, snowshoe hares, occurred at much lower prevalence in the summer than in winter. The general patterns I found are in accordance with virtually all food habits studies of the red fox conducted in North America. The most striking finding was the importance of pocket gophers in the diet, which occur only at trace levels in other studies. Although these findings may simply reflect a greater availability of pocket gophers to the foxes I studied, it is tempting to speculate that mountain foxes, which primarily occupy subalpine meadows and parklands that also support populations of pocket gophers, may have become specialists on this particular prey species.

HABITAT

Detailed knowledge of the habitat relationships of the Sierra Nevada red fox is lacking. According to Grinnell, et al. (1937), the Sierra Nevada red fox is "restricted to the highest timbered peaks of the Sierra Nevada", but because of its association with boreal habitats is "found at much higher altitudes in the southern part of its range than in the northern parts". These authors further assert that "although the Sierra Nevada red fox forages well above timber line during the fall and even in midwinter, it breeds lower down amid the white-barked pines and alpine hemlocks". Ingles (1965) considered habitats occupied by Sierra Nevada red foxes to include red fir, lodgepole, and subalpine forests, as well as alpine fell-fields. Schempf and White (1977) reported that their records from the northern Sierra Nevada were more or less evenly distributed among fir, mixed-conifer, lodgepole pine, and pine vegetation types. In the southern Sierra, however, almost half of their records were in the mixed-conifer zone, but lodgepole and fir forest types were also important, and

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several records were found in oak woodland and barren (treeless) zones. Interestingly, they also noted that Sierra Nevada red fox sightings occurred in similar vegetation types as those of the American marten and wolverine (*Gulo gulo*).

The habitat affinities of the Sierra Nevada red fox are probably very similar to those of the Cascade red fox to the north. In Washington and Oregon, the Cascade fox occupies subalpine forests, parklands, and meadows near tree line in the Cascade Range; it does not occur in densely forested habitat (Dalquest 1948; Aubry 1983, 1984). According to Bailey (1936b) they "are absent from the densely timbered or brushy areas west of the Cascades, as well as from the arid sagebrush valleys east of the range. Open grassy parks and meadows afford their favorite hunting grounds, and the greatest abundance of mice and small rodents on which they largely subsist".

CONSERVATION STATUS

The Sierra Nevada red fox is completely protected in California; trapping was prohibited in 1974, and they were listed as threatened by the California Fish and Game Commission in 1980 (Kucera 1993). After evaluating the distribution and abundance of sightings made since the work of Grinnell, et al. (1937), Schempf and White (1977) concluded that the Sierra Nevada red fox was either maintaining itself at a low level or, more likely, was declining. They concluded that the Sierra Nevada red fox was of greater conservation concern than any of the other five species they surveyed, including the wolverine, fisher, American marten, river otter (*Lutra canadensis*), and ringtail (*Bassariscus astutus*). They recommended that field surveys be conducted throughout its range, and that subsequent conservation measures be undertaken to ensure the continued existence of the red fox in the Sierra Nevada.

Lewis, et al. (1995) raised the possibility that introduced non-native red foxes may have expanded their range into the high Sierra, interbred with the Sierra Nevada red fox, and altered the genetic integrity of its populations. Because these two forms occupy dramatically

different habitats, such hybridization could result in lowered survival rates for the Sierra Nevada red fox and ultimately affect its ability to maintain viable populations. Although work I conducted in western Washington showed that introduced red foxes in the Puget Sound region are restricted to low-elevation habitats (Aubry 1984), such may not be the case in California where the geographic and genetic origins of introduced red foxes could be substantially different. Sierra Nevada and non-native red foxes cannot be reliably distinguished on the basis of coat color (Grinnell, et al. 1937; Kucera 1995); consequently, genetic studies may be the only way to conclusively ascertain the taxonomic status of extant red foxes in the Sierra Nevada (Lewis, et al. 1995; Kucera 1995).

MANAGEMENT CONSIDERATIONS

The management of Sierra Nevada red fox populations was addressed by the California Dept. of Fish and Game when it granted this species complete protection from trapping in 1974. Because our knowledge of the current distribution, habitat relationships, and population status of the Sierra Nevada red fox is so limited, recommendations for habitat management seem unwarranted at this time. What is needed is to gather new data from additional population surveys and intensive field research to fill in these information gaps. Because Sierra Nevada red foxes occupy an elevational zone that receives ample snowfall each year, and their tracks are easily distinguished from other species occurring within their range, snow-tracking would seem to be a particularly effective way to survey large areas for their presence. Remote cameras would also be useful for survey work, and have been shown to record their presence (Kucera 1995). Finally, although it will be extremely challenging, intensive field research on the Sierra Nevada red fox using radio-telemetry techniques will be an essential precursor to any reliable conservation strategy.

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