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States and

RED FOXES

SIERRA NEVADA RED FOX

Vulpes fulva necator Merriam

OTHER NAMES.—*Vulpes fulvus argentatus*; *Vulpes macrourus*; *Vulpes fulva macroura*; *Vulpes pennsylvanica macrurus*; *Vulpes alopex*, var. *macrurus*; *Vulpes vulgaris pennsylvanicus*; *Vulpes cascadenis*; *Vulpes necator*; Red Fox; High Sierra Red Fox; Cascade Red Fox; Mountain Red Fox; Cross Fox; Silver Fox; Black Fox.

General characters.—Of largest fox size: length of body alone, from about 36 to 40 in.; of tail alone, about 14 in. Tail a thick "brush," cylindrical. Underfur heavy, overhair long and fine. General color of body, usually rich rusty reddish; backs of ears and front surfaces of both front and hind legs, usually blackish; tail mixed buff and black, abruptly and conspicuously tipped with white. In the "cross," "silver," and "black" phases the color of the animal varies from the usual red tone in different degrees toward black, but the tail tip is always white. (See Pl. IX, facing p. 440.)

Description.—Adults (prime winter pelts from Mono County): Brightest red color on forward half of back, varying from orange rufous to Sanford's brown; this color is most brilliant and pure on ends of long overhairs in the rather narrow middorsal stripe running forward to just behind the ears; there are faint indications of a spreading of this stripe across the shoulders to make a cross of deep color in the same position as the more conspicuous one of the "cross fox" phase. Sides of neck and chest, ochraceous-buff. A broad patch on posterior part of back and backwards onto root of tail, mixed mahogany red and whitish, the latter predominating so that a grayish red cast results, in contrast with the deeper color of the forward upper surface. Sides of body, hips, and outsides of thighs become dull ochraceous-buff; belly and insides of thighs, pure white; throat also pure white, and a median ventral tract, from white throat to white belly, dull grayish or buffy white; outsides of legs, rather bright ochraceous-orange; soles of feet, dull buffy white; top of each foot and front of leg, black, with no break between (close inspection shows some white hairs mixed in); claws dusky at bases, becoming translucent pale buffy white at tips. General color of tail, dull ochraceous-tawny, paling on middle lower surface to buffy white at extreme base, and with black hair-tippings showing along upper surface and aggregating into a black spot near upper base of tail, this spot being associated with a musk gland in the skin from which these black hairs spring; end of tail—the terminal 2 to 4 in. of it—pure white. A spiral trend of light and dark is often noticeable in the tail of a pelt; this is of course caused by twisting when the pelt is skinned out or dried. Backs of ears blackish (more exactly, deep mummy brown); hairs on insides of ears, pale buffy white; top of head from between ears to between eyes, area around eyes, and cheeks, ochraceous-tawny with a gray cast caused by mixture with white hairs; sides of snout from eyes nearly to nose pad, deep Sanford's brown; top of snout and area just short of nose pad, paler, almost ochraceous-tawny; margins of lips, whitish; chin dusky; whiskers black.

When prime, the pelage of the red fox is thick and deep all over. It is most abundant on the neck and shoulders, least so on the face, legs, and middle of belly. The pelage both in depth and mass consists largely of underfur. On the back of the neck (no. 33382, November 7) the underfur is 40 mm. long and the silky overhair 70 mm., 30 mm. longer; on rump, underfur 35, overhair 55; on middle of belly, underfur 30, overhair (very sparse and fine) 48; on back of ear (nothing apparently but fur) 10; on top of

snout (mostly overhair) 4; vibrissae (whiskers) up to 63. Middle of "brush," underfur 55, overhair 80; total diameter of brush, fluffed out, at thickest place (one-third distance toward end), 165 (6½ in.). Hard sole pads of toes of all feet small (no larger than 4 mm. in transverse diameter), and the dense pelage growing between and around them so abundant as to cover them completely; a red fox in winter has a veritable set of fur "shoes" to walk in.

Variations.—The one annual molt begins the first week of August and is completed before the end of the first week in November. Our material permits of no more exact statement than this. The summer coat appears to be not more than one-half as full as the prime winter coat. Examination (of no. 16252, August 25) shows that this reduction in mass of pelage is brought about by an almost complete loss of the overhairs (for their entire length, as if each hair were loosened at the base) and an apparent shortening of the underfur by wear. As a result the general color effects caused by the color of the ends of the overhairs is wanting; the body shows only the color of the underfur. Thus, in the August specimen cited (in red phase), the middorsal area from top of head to base of tail is amber brown to Sudan brown, the latter tone appearing on the rump. In this particular specimen, the white-ended new overhairs are part way in, their tips hardly flush as yet with the general surface of the old worn underfur. Wear has removed a good deal of the dense hair on the bottoms of the feet so that the hard toe soles come to the surface; this doubtless aids the fox in getting traction on the rock surfaces it travels over in the summer season.

A summer pelt in cross phase (no. 16251, August 9) looks quite different from the red one. The middorsal area from back of neck to rump is mummy brown. More overhairs remain, and their terminal parts are weak honey-yellow in color; the legs and flanks are dull light brown; nowhere is there any of the bright rusty tone of the red phase. In both the summer specimens the brushes are small, surely less than half the bulk of the winter brush.

With respect to the frequency of occurrence of the several phases of color, we present the following figures, which are vouched for by the experienced trapper, A. J. Gardisky. Of 59 red foxes taken on the east slopes of the Sierra Nevada between Sonora and Mammoth passes over a period of seven years, 25 were "red," 28 were "cross," 5 were "silver," and 1 was "black." From trappers' reports we judge that the proportion of "fancy" foxes (that is, cross, silver, and black) in the fox population varies widely with locality. In the northern end of the State the typical red phase predominates; elsewhere, as in the Mono country, the reds may be decidedly in the minority.

Young.—The one young specimen available (no. 3296, a well-stuffed study-skin with skull) is from the slope of Mount Shasta at a 7000-ft. altitude, where it was taken by A. S. Bunnell on July 12, 1904. Its dimensions showed it to be probably less than half-grown. Flesh measurements were: total length, 680 mm. (26¾ in.); tail, 230 (9); hind foot, 128 (5); ear, 70 (2¾ in.). Coat copious and very woolly in texture, consisting almost entirely of underfur; the relatively few overhairs are short and fine. General color of body duller than that of adults, but still distinctly reddish; broad dorsal stripe from back of neck to base of tail, with cross arms at shoulders, ochraceous-tawny deepening to cinnamon-rufous on middle of back; sides of neck and body paler, near light buff; middle of lower surface from throat to base of tail, and insides of thighs, dull white; tops of all feet and lower fronts of forelegs, black; tail cylindrical but very small as compared with brush of adult, clay colored with abruptly white tip (this tip is as striking a feature as it is in an adult); a spot of black marks position of gland on upper surface of tail near base; backs of ears blackish; insides of ears dull white; top of head from between ears to muzzle, dull cinnamon with some grizzling caused by white tip-

"brush," underfur (one-third distance) (no larger than 4) and around them a veritable set of fur

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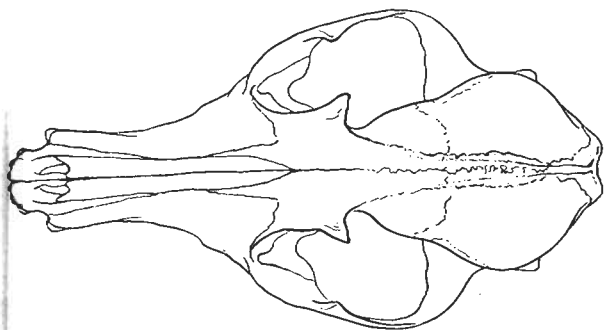


Fig. 139. Skull of Sierra Nevada red fox, dorsal view. Drawn from adult male, no. 33382, Mus. Vert. Zoöl., taken on November 7, 1922, at Saddlebag Lake, Mono County. $\times \frac{1}{2}$. Figures 139 to 141 show variations with respect to age. Compare also with kit fox (figs. 151, 155), gray fox (fig. 163), and coyote (fig. 1).

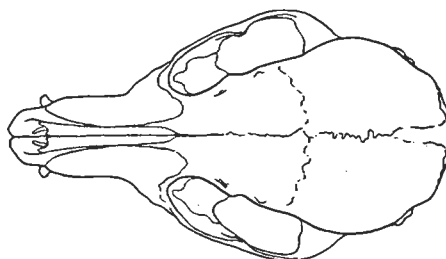


Fig. 141. Skull of Sierra Nevada red fox, dorsal view. Drawn from young male, probably less than half-grown; no. 3296, Mus. Vert. Zoöl., taken on July 12, 1904, on Mount Shasta, Siskiyou County. $\times \frac{1}{2}$.

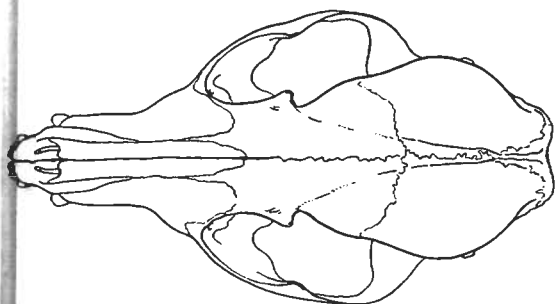


Fig. 140. Skull of Sierra Nevada red fox, dorsal view. Drawn from subadult male, no. 33474, Mus. Vert. Zoöl., taken on December 14, 1922, at Ellery Lake, Mono County. $\times \frac{1}{2}$.

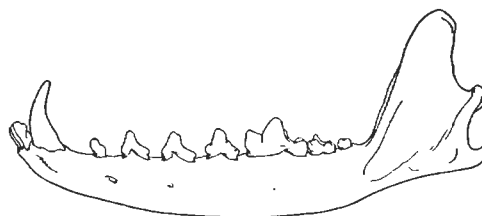


Fig. 142. Mandible of Sierra Nevada red fox, outer side. Drawn from adult, no. 33587, Mus. Vert. Zoöl., taken in February, 1923, at Saddlebag Lake, Mono County. $\times \frac{1}{2}$. Compare with coyote (fig. 4), kit fox (fig. 152), and gray fox (fig. 164).

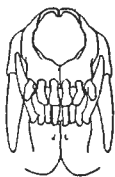


Fig. 143. Skull of Sierra Nevada red fox, front view. Drawn from adult, no. 33587, Mus. Vert. Zoöl., taken in February, 1923, at Saddlebag Lake, Mono County. $\times \frac{1}{2}$. Compare with gray fox (fig. 165), kit fox (fig. 153), and coyote (fig. 194).

pings of overhairs, and cheeks similar but lighter; sides of snout and chin dusky (more precisely, grizzled fuscous). Other young foxes should be examined.

Measurements.—See table on page 385.

Skulls.—The accompanying drawings (figs. 139-143) show the general features of the red fox skull as compared with those of other foxes and those of coyotes. The very long slender rostrum, the temporal ridges on the brain case, which closely approach one another, and the long, slender, curved canine teeth are distinctive skull features of the red fox. Changes that take place in the growth of the individual include elongation of the rostrum, appearance and great development of the postorbital processes, spreading of the zygomatic arches, and development of the sagittal and lambdoidal ridges on the cranium. (See figs. 139-143.)

Cranial measurements.—The material available is not sufficient to give significant averages for age classes in each sex. For measurements of individuals, see table on this page; study of this table in connection with the drawings and in comparison with the tables of measurements of other species of foxes will reveal the main proportional characteristics of *Vulpes fulva necator*.

MEASUREMENTS (IN MILLIMETERS) OF SKULLS OF ADULT OR SUBADULT
Vulpes fulva necator FROM CALIFORNIA

No. M.V.Z.	Sex	Age	Locality	Greatest length of skull	Condylobasal length	Basilar length	Palatilar length	Zygomatic breadth	Mastoid breadth	Breadth across post-orbital processes	Interorbital width	Width of rostrum	Height of brain case at bullae
33587	♂(?)	adult	Saddlebag Lake, Mono Co.	151.0	144.0	135.0	72.1	77.0	47.5	35.2	27.6	22.0	50.0
33586	♂(?)	adult	Saddlebag Lake, Mono Co.	145.3	137.8	129.3	70.8	75.3	47.0	36.8	29.5	22.4	52.7
33382	♂	adult	Saddlebag Lake, Mono Co.	143.4	136.7	128.5	68.1	76.0	47.0	36.0	28.7	21.7	50.6
33381	♂	subad.	Saddlebag Lake, Mono Co.	142.6	135.7	126.8	67.2	74.8	48.3	33.5	27.0	21.5	52.9
32800	♂	subad.	Ellery Lake, Mono Co.....	137.0	129.9	121.3	62.7	68.0	45.1	32.0	24.5	19.6	48.6
33474	♂	subad.	Ellery Lake, Mono Co.....	132.5	127.6	118.5	61.8	70.5	45.1	32.5	26.6	21.8	52.0
32809	♀	adult	Virginia Lakes, Mono Co...	137.2	130.7	122.8	66.1	73.1	45.5	34.2	25.4	19.9	49.0
33473	♀	adult	Saddlebag Lake, Mono Co.	137.0	130.8	122.8	65.0	73.2	45.0	32.8	24.2	20.5	51.5
33472	♀	subad.	Saddlebag Lake, Mono Co.	125.5	121.0	112.7	57.5	66.2	41.1	25.2	17.9	47.2
16251	♀	adult	Whitney Meadow, Tulare Co.....	131.5	125.4	117.4	63.2	72.1	46.4	36.2	25.7	21.0	48.8
16374	♀	subad.	Monache Meadows, Tulare Co.....	137.2	132.7	124.0	68.8	72.8	44.4	35.5	26.9	21.0	50.3
16252	♀	subad.	Whitney Meadow, Tulare Co.....	132.0	127.5	119.2	64.0	69.5	43.8	35.0	24.7	18.2	48.2

Weights.—The "largest and heaviest" Sierra Nevada red fox of which we have record is one weighed by A. J. Gardisky. This fox was fat and tipped the scales at "11 pounds." Mr. Gardisky says that he has found the average weight for males to be about 9¼ lb., for females 7¼ lb. This statement, together with the few figures given in the table on page 385, leads us to infer that females are about 80 per cent as large as males.

Type locality.—Whitney Meadow, "altitude 9500" ft., "near Mt. Whitney, High Sierra," Tulare County, California (Merriam, 1900b, p. 664).

Critical comment.—Merriam (*op. cit.*), in describing the two new "species" *Vulpes necator* and *Vulpes cascadenis*, ascribed both to California, recording a specimen of the latter (the type locality of which is near Mount Adams, Washington) from as far

south in the Sierra Nevada as "Mt. Raymond in Mariposa [= Madera] County." Until now it has been customary to follow Merriam and to call the red foxes of the Yosemite region and northward *cascadensis*; so far as we know, this has been done without any further study of the matter. The senior author has made a rather thorough analysis of the material in hand, tackling the problem *de novo* and then comparing results with the diagnostic characters mentioned by Merriam. He found no basis in the material for recognizing more than one form of red fox within California. *Cascadensis* may be, and indeed likely is, a perfectly good race; but that foxes even from Mount Shasta should bear that name (as indicating distinctness from *necator*) appears to be doubtful at present. Geographically, the animals of Mount Shasta and westward through the Trinity Mountains should at least approach in characters the race of the Cascade Mountains. But definite proof of this must await the acquisition of adequate material. In this connection, we find the variation in our series of specimens from the central Sierra Nevada to be so wide, both in coloration and in cranial features, that it is difficult to escape the inference that some of Merriam's diagnostic characters were probably individual.

Distribution area in California.—Chiefly the high Sierra Nevada above the 7000-ft. level. Occurs, probably continuously or very nearly so, north from the vicinity of Monache Meadows, Tulare County, to Sierra County; also on the two mountain masses of which Lassen Peak and Mount Shasta are the highest points (see map, fig. 144). Westernmost reported occurrence: west of Mount Shasta, near Coffee, Trinity County, in the Trinity Mountains; nowhere else does it reach even that near to the coast belt. There is an outlying southern record of capture by trappers on the summit of the Piute Mountains, in Kern County, across the Kern "gap" from the high southern Sierra. Altitudinally, stations of known occurrence extend from 4500 ft. (Buck Meadows, Tuolumne County) to 11,500 ft. (south side of Cirque Peak, Tulare County). Life zones, mainly Hudsonian and Canadian. The animals individually are wide ranging and occur on all sorts of ground within the general range of the species. (A "colony" of red foxes exists on the floor of the upper Sacramento Valley, but these are of doubtful status [see below].)

Specimens examined from California.—Skins-with-skulls (some with complete skeletons), or skulls-only, contained in the Museum of Vertebrate Zoology: Siskiyou County: Mount Shasta at 7000 ft., 1. Lassen County: near Eagle Lake, 2. Mariposa County: "Big Meadows" (= Crane Flat, 6000 ft.), Yosemite Park, 1. Mono County: Virginia Lakes, 10,000 ft., 1; Saddlebag Lake, 10,000 ft., 7; Ellery Lake, 9500 ft., 3. Tulare County: Whitney Meadow, 9800 ft., 2; Monache Meadows, 8000 ft., 1. Total, 18.

The red fox of the upper Sacramento Valley.—In 1924 a trapper living in or near Red Bluff assured one of us (G.) that he captured many red foxes on the "badlands" near Corning, Tehama County, about 1896. Another trapper was reported to have taken red foxes in the near vicinity of Red Bluff "within a few years." It seemed unlikely that either man had confused the red fox with the well-known gray fox still not uncommon in the foothills of the general region. (A published record from "Red Bluff" [Townsend, 1887, p. 188] turned out to have been based upon a specimen really taken at the east base of Lassen Peak [see Grinnell, Dixon, and Linsdale, 1930, p. 470].)

In March, 1923, one of us (G.) became personally acquainted with Mr. Sam Lamme, of Colusa, who has lived all his life in that vicinity. Lamme is an acute observer and of proved accuracy of statement. The following facts were furnished by him in interviews. Red foxes formerly existed in "great numbers" on the plains in the neighborhood of the Marysville Buttes. He himself had trapped many for fur until about thirty years before. In periods of high water in the Sacramento River, when much of the lowland

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Interorbital width	Width of rostrum	Height of brain case at bullae
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29.5	22.4	52.7
28.7	21.7	50.6
27.0	21.5	52.9
24.5	19.6	48.6
26.6	21.8	52.0
25.4	19.9	49.0
24.2	20.5	51.5
25.2	17.9	47.2
25.7	21.0	48.8
26.9	21.0	50.3
24.7	18.2	48.2

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territory was inundated, the foxes visited the buttes, but they always went back to the lowlands as the water receded. The foxes occurred west of the river on the "Colusa plains," and east of the river on the plains "south of Marysville." Lamme believed they probably still (1923) existed in the latter area, and *knew* they did on the great tracts

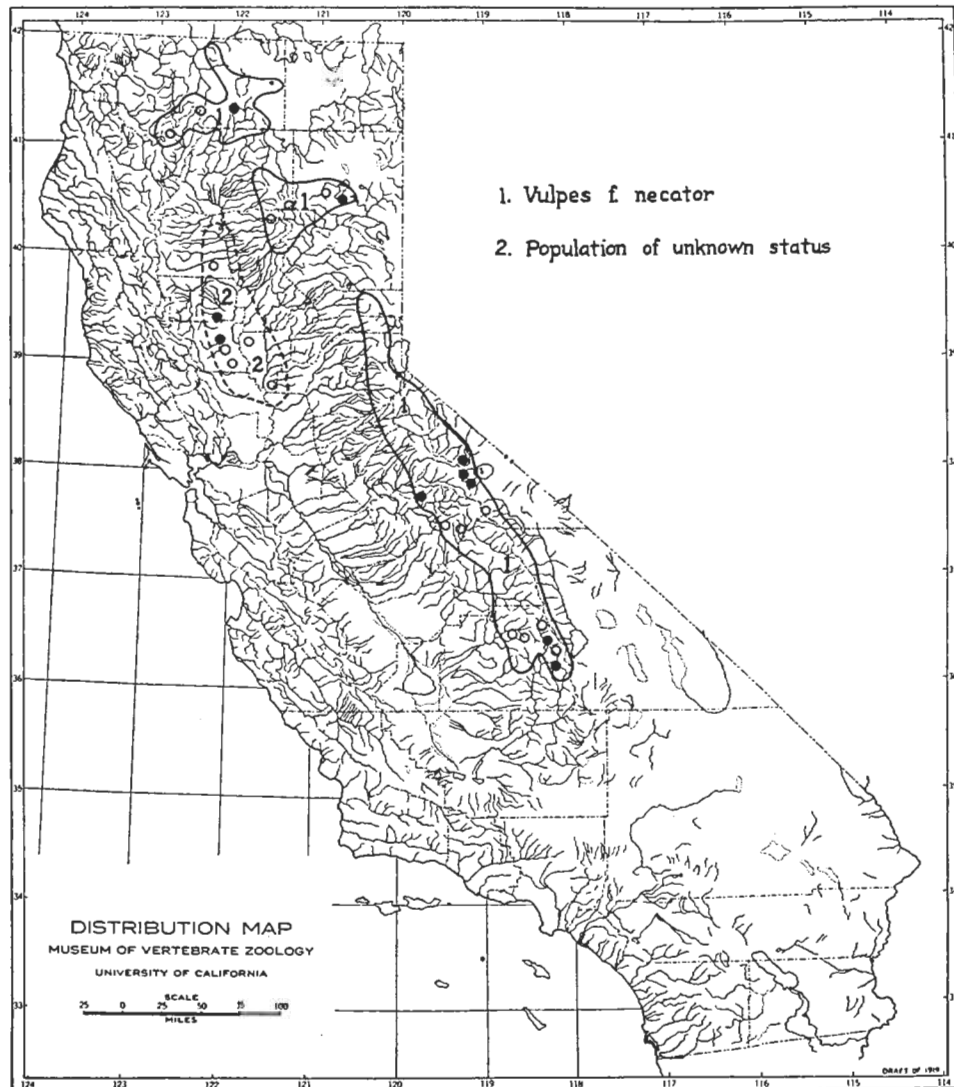


Fig. 144. Distribution of red foxes in California: Solid circles indicate localities from which specimens have been examined; open circles indicate localities of record otherwise. Solid outlines enclose assumed general range of the native Sierra Nevada red fox; broken line surrounds general range of the Sacramento Valley population of red foxes, the history and status of which are not known at this writing.

of uncultivated pasture land in the former territory. Trappers were still taking red foxes each year on the Colusa plains. They lived in big holes in high mounds which were not likely to be flooded by heavy rain. A litter of young was dug out in the spring of 1922.

Effort was made to convince Lamme of the importance of obtaining one or more specimens of this "valley" red fox. He agreed to do his best; and he made good. On

November 7, 1923, there was received from him at the Museum of Vertebrate Zoölogy, in-the-flesh, a specimen the history of which was as follows (quoted in substance from his letter of November 13, now filed in the Museum). A litter of nine pups was dug out in the spring of 1923 on land belonging to the Maxwell Irrigated Lands Company, seven miles northeast of Maxwell, Colusa County, "between the Thompson ranch and No. 2 pump house." The hole was in the ground of a gravel ridge "in the center of the plains" probably twenty miles long, running north and south, and so high as to be above water at all times. There are known to be "quite a number of red foxes" inhabiting that strip of country. A man by the name of Jack Gray dug the little foxes out and saved some of them to raise for pets. But as they grew up they began to kill poultry and Gray decided to get rid of them. A man named Buck Thomas acquired the foxes, and Lamme bought two of them from him, both "dogs." They were killed on November 5. One carcass was sent to the Museum fresh, and the pelt of the other was kept for fur.

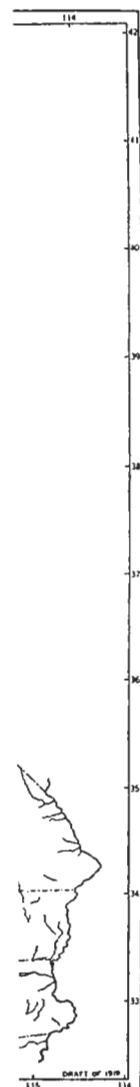
The carcass received at the Museum was prepared (D.) as a tanned skin with complete skeleton, and now bears the catalogue number 33550. The animal was fat,—“in excellent condition,”—so its life in captivity had at least not been one of privation. Although probably not more than seven months old, it was evidently almost full-grown. Its weight was $10\frac{3}{4}$ lb. Measurements: Total length, 1055 mm. ($41\frac{1}{2}$ in.); tail, 390 ($15\frac{3}{8}$); hind foot, 170 ($6\frac{3}{4}$); ear from crown, 104 ($4\frac{1}{8}$); hind foot, $1\frac{1}{4}$ in. wide, $1\frac{3}{4}$ in. long including toenails; front foot, $1\frac{5}{16}$ wide, $1\frac{3}{8}$ long including toenails. The pelt was not yet prime when the animal was killed, although the coat is full and good; the soles of the feet are well haired. In general tone of color this animal is slightly paler than the average Sierra Nevada red fox; indeed, it almost matches the palest example in our series of skins from the Mono Lake country. Most of the overhairs of the lower back and rump are terminated in white. The tip of the tail (brush) is solidly white for 5 in.—the longest tail tip in our series of Californian pelts. Nevertheless, there is the maximum amount of black on the tops of the feet and up the fronts of the fore and hind legs. The skull presents the following measurements (compare with those in table on p. 380): Greatest length of skull, 145 mm.; condylobasal length, 142.6; basilar length, 129.4; palatilar length, 66.4; zygomatic breadth, 71.4+; mastoid breadth, 45+; breadth across postorbital processes, 32.5; interorbital width, 27; width of rostrum, 21.3; height of brain case at bullae, 49+. (This skull is imperfect because the animal was killed by being shot through the head and then given a blow on the head!)

We made further efforts to procure specimens representative of the red fox population of the Sacramento Valley. From December 1 to 17, 1924, Mr. Adrey E. Borell, then of the Museum staff, scouted about Colusa County specifically for this purpose. Clues were found which led to the taking of specimens later, although none was obtained at this time, and general information was gathered which may be summarized as follows:

Everyone interviewed told of having seen foxes on the gravelly ridge referred to previously, which lies partly on the Gordon Ranch and partly on the Helphenstine place, northwest of Colusa. Several dens were seen on this ridge, all on little knolls. Each den was an enlarged part of a ground squirrel burrow and there were squirrel holes near it. Apparently these enlarged holes also were used by striped skunks and wild house cats, both of which were numerous in the region.

A Mr. Parker reported that in the spring of 1924 he dug out a litter of five young foxes on a high ditch bank on the Gordon Preserve. The hole was about 20 feet long and did not go far beneath the surface. It had two entrances. The young foxes were turned in to the County, and *coyote* bounty of \$5 each was collected on them. This was said to be a common practice in the community.

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Mr. Jack Gray said that he once saw a female fox in this locality with 10 pups, all of which appeared black. Another litter containing 11 young was found about April 1 and was thought to have been about ten days old at that time. A third litter contained 7 young. From another source it was learned that one den which was dug out yielded 2 young, and another 13. Mr. Ray Shelooe told of once digging out a female and 4 pups. On another ranch it was reported that four dens were found within a radius of two miles. Two that were excavated held 6 and 5 young, respectively.

An adult red fox which was seen by Mr. Borell on December 3 was trotting through grass and weeds only 200 yards from the observer. Its gait was much like that of a coyote. Its conspicuously bushy tail was white-tipped. Another fox, seen on December 16, was approached on foot. It permitted the observer to come within 150 yards of it; then it began sneaking along ahead, stopping on every levee and knoll to look back at its pursuer. Sometimes it sat on its haunches and waited. Finally it went into a tule patch and was next seen on a levee one-half mile away. Later this fox passed by some sheep dogs which chased it for three-fourths of a mile.

A rancher one mile west of Princeton reported that on December 11 he set a straw stack on fire and a red fox that had been concealed there ran out and was chased away by a dog. A local trapper said that he had seen foxes on clear days, usually in early morning or late afternoon, but never on a cloudy, foggy, or rainy day.

In April and May, 1926, there were sent to the Museum by Mr. H. G. Boyes, of Princeton, Colusa County, eleven red foxes in-the-flesh but "drawn." These had been captured, partly by digging, in a tract of territory seven to ten miles south or southwest of Princeton—ground that had been explored by Mr. Borell two years previously. On April 22, four young (nos. 36492, 36493, Mus. Vert. Zoöl.; nos. 2813, 2814, Ralph Ellis coll.), uniformly the smallest of the series, were dug out on the Moulton ranch; "there may have been more." On April 30 an adult female (no. 2816, Ralph Ellis coll., skull broken) was captured together with three young (nos. 36494, 36495, Mus. Vert. Zoöl.; no. 2815, Ralph Ellis coll.) three miles south of the Moulton ranch; they "had left their den and were taken in a heavy brush patch." About May 5, four young (nos. 36496, 36497, Mus. Vert. Zoöl.; nos. 2817, 2818, Ralph Ellis coll.) were captured "7 miles south of Princeton"; these specimens appear to represent three different litters, the individual last taken being the oldest. Our informant did not give specific information concerning the animals.

All these specimens are in the red phase of coloration. The pelage of the adult female, however, is in such faded and abraded condition as to make it almost useless for color comparison. In contrast with our winter-taken pelt (no. 33550) already described, this adult shows but a trace of white tail-tipping, and the whole throat and front of the neck are dull brown instead of gray; such differences are scarcely to be accounted for by the wearing down of the overhair, although these features are equally variable in red foxes from the Sierra.

The young of the three litters show progressively more overhair in the dorsum. The middle group approximates very closely in dimensions and color our young red fox from Mount Shasta (no. 3296), described above in detail. The only conspicuous difference is the entire lack of white on the tip of the tail in these as in all other Colusa-taken young. Instead of white at the tail tip, each has a terminal tuft of crinkly hair that is more yellowish brown than the next proximal part of the tail. The youngest, of date of April 22, shows the most completely "woolly" stage of pelage.

One other specimen from the Sacramento Valley is at hand: a skeleton with perfect skull (no. 44095, Mus. Vert. Zoöl.) received through the kind offices of Mr. James Moffitt and Mr. Howell Joseph. The animal represented was obtained about the middle

of October, 1929, at a point on the Spalding ranch three miles north of Norman, Glenn County. From features of the skull we judge this to have been an adult male. Its measurements are: Greatest length of skull, 159.1 mm.; condylobasal length, 151.4; basilar length, 142.6; palatilar length, 78.7; zygomatic breadth, 80.3; mastoid breadth, 49.2; breadth across postorbital processes, 36.6; interorbital width, 29.9; width of rostrum, 22.3; height of brain case at bullae, 51.8. Comparison of these figures with those given in the table on page 380 shows that this skull exceeds in most dimensions that of any of our Sierra-taken red foxes, but the amount of difference is not great.

EXTERNAL MEASUREMENTS (IN INCHES) AND WEIGHTS (IN POUNDS) OF ADULT OR SUBADULT
Vulpes fulva necator FROM CALIFORNIA

No. M.V.Z.	Sex	Age	Locality	Date	Total length	Tail vertebrae	Hind foot	Ear from crown	Weight
33382	♂	adult	Saddlebag Lake.....	Nov. 7, 1922	40 $\frac{1}{4}$	14 $\frac{3}{8}$	6 $\frac{1}{2}$	3 $\frac{3}{8}$	8
33381	♂	subad.	Saddlebag Lake.....	Nov. 6, 1922	40 $\frac{3}{8}$	14 $\frac{1}{2}$	6 $\frac{3}{4}$	4 $\frac{1}{8}$	9
33474	♂	subad.	Ellery Lake.....	Dec. 14, 1922	36.9	13 $\frac{3}{4}$	6 $\frac{3}{8}$	3 $\frac{3}{8}$	9
32809	♀	adult	Virginia Lakes.....	Feb. 2, 1922	38 $\frac{3}{8}$	14	6 $\frac{1}{4}$	3 $\frac{3}{8}$
33473	♀	adult	Saddlebag Lake.....	Jan. 14, 1923	39 $\frac{1}{2}$	14.3	6 $\frac{3}{8}$	4 $\frac{1}{8}$	8
33472	♀	subad.	Saddlebag Lake.....	Jan. 9, 1923	34 $\frac{3}{4}$	12 $\frac{1}{4}$	5 $\frac{3}{4}$	3 $\frac{3}{8}$	6 $\frac{1}{2}$
16251	♀	adult	Whitney Meadow.....	Aug. 9, 1911	37 $\frac{1}{4}$	13 $\frac{3}{4}$	5 $\frac{3}{4}$	7
16252	♀	subad.	Whitney Meadow.....	Aug. 25, 1911	36 $\frac{3}{4}$ [945]* [933]	14 $\frac{3}{8}$ [350] [373]	6 $\frac{1}{4}$ [145] [160]	4 [100]

* The original measurements, recorded in millimeters, are given in brackets.

In respect to geographical distribution, the existence of red foxes on the floor of the Sacramento Valley is altogether anomalous. The group is essentially northern, in other words Boreal, in its predilections, and normally we should not expect any representation in the hot lowlands of California. The "colony" there is very restricted, evidently wholly cut off from the population on the Sierra Nevada (see map, fig. 144). The possibility suggests itself that the animals in the valley were "planted" there by man. It is known that red foxes have been transplanted in the East to new localities for running with hounds, and thus have become established beyond the limits of their natural range or in territory from which the original stock had disappeared. But we have been unable to get any evidence that would support this explanation of the occurrence of red foxes in the Sacramento Valley. It will have been noted that the one specimen we have in full winter coat is a subadult, reared in captivity. It therefore cannot be relied upon to show subspecific characters of such diagnostic value as to permit its positive identification with the Sierran race or an eastern race, or its determination as a representative of a separate, as yet unnamed, subspecies occupying the very small territory indicated, *unless* such characters be outstanding and unequivocal. The pelt is somewhat paler, less brightly red, than two pelts of eastern red foxes in the Museum collection from Maine; it is more nearly like certain examples from the Sierra. We have studied the three full-grown skulls available with some care, comparing them with our series of red fox skulls from elsewhere. There is appreciable variation among members of the latter, irrespective of locality, in size of teeth and the other features mentioned by Merriam (1900, pp. 665, 666) in his descriptions of the forms newly named by him;

so that again we find ourselves unable definitely to allocate the Sacramento Valley animals to a subspecies by means of skull characters.

To sum up, then, there is a well-established population of red foxes at an unexpectedly low altitude, less than 350 ft. above sea level, in the upper Sacramento Valley. These foxes have been there at least forty years; but whether they are thoroughly native or were introduced by the white man is not known. The latter is the more likely surmise. The material so far available for determination is not satisfactory, so that subspecific identity is uncertain. Therefore, we are including the Sacramento Valley red fox under the same heading with the Sierra Nevada red fox only tentatively, chiefly as a matter of convenience.



Fig. 145. Habitat of Sierra Nevada red fox, on Wallace Creek, 11,300 feet altitude, Sequoia National Park, as it appeared on June 9, 1934.

Photograph by Wildlife Division; courtesy of the National Park Service, Department of the Interior.

Unlike the red fox of eastern North America, the red fox of California is rarely found in well-settled country or even anywhere near cultivated lands. Our animal, the Sierra Nevada red fox, constitutes a slightly different race from the eastern animal, and it is restricted (save for a colony of as yet unknown status in the Sacramento Valley) to the highest timbered peaks and ridges of the main Sierra Nevada from the vicinity of Mount Shasta south to the vicinity of Mount Whitney.

Almost every person has become acquainted with this type of fur bearer through books or stories. Because of this popular knowledge, the animal

is usually called by its proper vernacular name, red fox. Sometimes the gray fox (a very distinct species) having reddish under parts, is confused with the red fox. But the red fox is much larger and heavier than the gray, has black feet and backs of ears, and a white-tipped tail. Pelts of these two species can be readily separated. The tail of the red fox is circular in cross section, averages more than 5 inches in diameter, and has a *white* tip. The tail of the gray fox is triangular in cross section, averages 3½ inches in diameter,

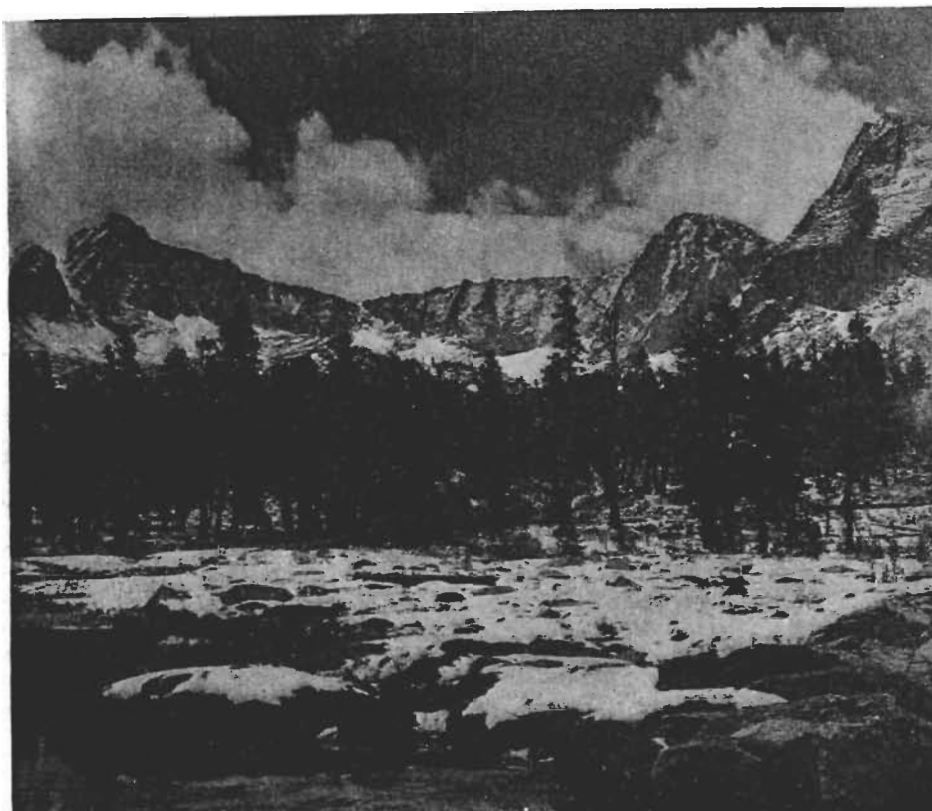


Fig. 146. Wallace Creek at 11,000 feet altitude, Sequoia National Park. Six sets of tracks found here on June 9, 1934, indicated that red foxes in this vicinity had been hunting white-tailed jack rabbits. Here snow lies on the ground more than half the year.

Photograph by Wildlife Division; courtesy of the National Park Service, Department of the Interior.

and has a *black* tip. See Plate IX. The fur, particularly the overhair, on the back and rump of the gray fox is harsh in texture and iron gray in color, having none of the softness or rusty tinge found in the fur of the red fox.

Red foxes are unknown from the Coast Ranges either north or south of San Francisco Bay, and the species has never been recorded from anywhere in southern California, even from the highest peaks there. Within recent years there have been three main centers of population in California: around Mount Shasta and Lassen Peak in the north, the high Sierra near Mono

Lake in the central part of the State, and the region about Mount Whitney in the south. At least toward the south there is a marked tendency for certain individuals of this species to descend to middle altitudes for the winter season; this is indicated by a number of winter records from stations between altitudes of 4500 and 6500 feet. One or more red foxes are trapped



Fig. 147. Lake South America, Sequoia National Park, where tracks were found on June 11, 1934, showing location of capture of a white-tailed jack rabbit by two red foxes.

Photograph by Wildlife Division; courtesy of the National Park Service, Department of the Interior.

nearly every winter near Buck Meadow, at a 4500-foot altitude, between Hetch Hetchy and Yosemite. In the early part of January, 1920, Joseph Kinsman caught a red fox at an altitude of less than 5000 feet, near Chiquito Basin, one mile north of Fuller's Meadows, Madera County. Red foxes are reported nearly every winter from the Giant Forest, 6400 feet, in the Sequoia National Park.

The southernmost known station of occurrence is vouched for by Henry W. Ross, of Bodfish, Kern County, who says that about 1900 he and his brother caught two red foxes on the summit of the Piute Mountains, Kern County. This is across the Kern "gap" from the main southern Sierra, at least thirty miles south from territory at all likely to be inhabited regularly by the species. This of course may be merely an outpost of casual wandering.

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The following list of red foxes caught by trappers in the winter of 1922-23 gives a fair idea of the distribution and also of the relative numbers of this animal. Elbert Nicholson, Coffee, Trinity County, 1 red fox (the westernmost record for the State); John S. Hale, United States Forest Service Look-out, Mount Eddy, Siskiyou County, 4 red foxes; A. J. Gardisky, Mono Lake,



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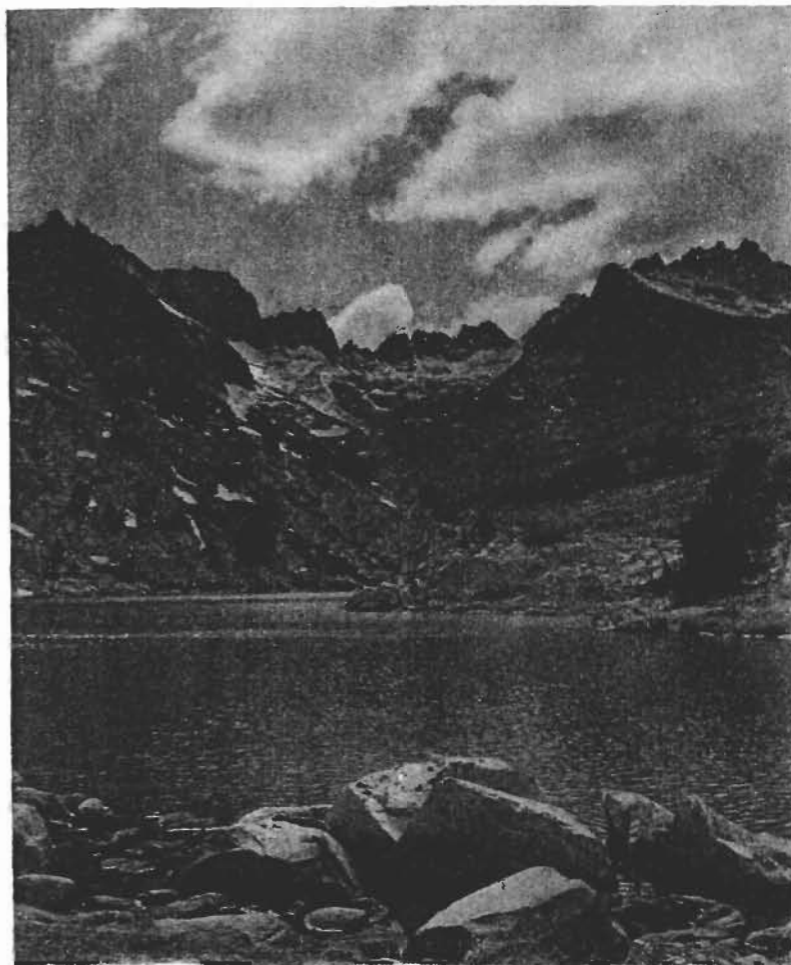


Fig. 148. Habitat of Sierra Nevada red fox at the head of the Kern River in Sequoia National Park, June 11, 1934.

Photograph by Wildlife Division; courtesy of the National Park Service, Department of the Interior.

Mono County, 4 cross, 9 red, foxes; Charles Rouse, Buck Meadows, Tuolumne County, 2 cross foxes; C. R. Adams, Bishop, Inyo County, 1 cross fox. The total of 21 is probably near the average annual catch.

The Sierra Nevada red fox is a Boreal species, inhabiting for the most part the Canadian and Hudsonian life zones. It is thus to be found at much higher altitudes in the southern part of its range than in the northern parts of the State. On August 6, 1911, one of us (G.) found numerous red fox

of the pine thicket and raced for the shelter of a granite boulder that rested 25 feet distant in the open meadow. The squirrel was closely pursued by the red fox and would have been overtaken except for its clever dodging. As it was, it managed to reach a burrow under the boulder barely 6 inches ahead of the fox's jaws, which clicked audibly at its heels."

One possible function of the large bushy tail of the fox was suggested by this incident: It was observed that the fox, in making a quick turn, used its tail to maintain balance in somewhat the same manner as a tight-wire walker uses a balancing pole. It seems (to D.) fairly safe to conclude that a fox without a tail would not be equally able to make sudden turns and thus follow the zigzag course of a fleeing ground squirrel.

"This fox made no attempt to dig out the squirrel, although the soil under the granite boulder was loose and thus provided easy digging. Instead, he slipped around the boulder and stood with ear cocked and forefoot poised, watching quietly to see if, by any chance, the squirrel might run out on that side to gain its permanent burrow, which was under another boulder some 20 feet away. So intent was the fox upon getting a meal that he had not seen the observer who stood motionless within 50 feet during the entire performance. After watching for 3½ minutes and finding that the squirrel did not come out, the fox drooped its tail and trotted off."

Red foxes were seen in the wild on several occasions by the late W. H. Parkinson. One of these chance meetings occurred in late September, 1910, when Parkinson was camped at about a 7200-foot altitude on Hall Meadow between Deer Creek and North Fork of Kings River, in Fresno County. When crossing the meadow for his horses early one morning, he caught sight of two cross foxes near a patch of willows. The smaller one smelled here and there along the ground while the larger one stood still and looked sharply in the direction of the camp, which was out of sight from that point.

The observer stood perfectly still and watched the foxes, which were within 100 yards of him. The smaller animal, with head and tail held on a level with its back, stepped carefully along in a stiff-legged manner. Suddenly it arched its back, made a short dive ahead, and began digging rapidly in the ground. In about two seconds it grabbed something in its mouth and then pointed its muzzle straight up. The larger fox made a quick lunge and took the game from the other's mouth and ate it. Twice more within the next two or three minutes was this performance repeated. Finally the small fox obtained a catch and ate it before the other one could reach it, whereupon the big fox started to do its own hunting while the small one stood guard.

In the next ten minutes the big fox managed to catch two mice for itself. Then the two animals came together and, after looking about nervously, started trotting side by side across 400 yards of open meadow. They soon broke into a long lope which had developed into a fast run by the time they reached the shelter of the timber on the other side of the meadow. Parkinson remarked in his notes: "In running, as in all other movements, they were

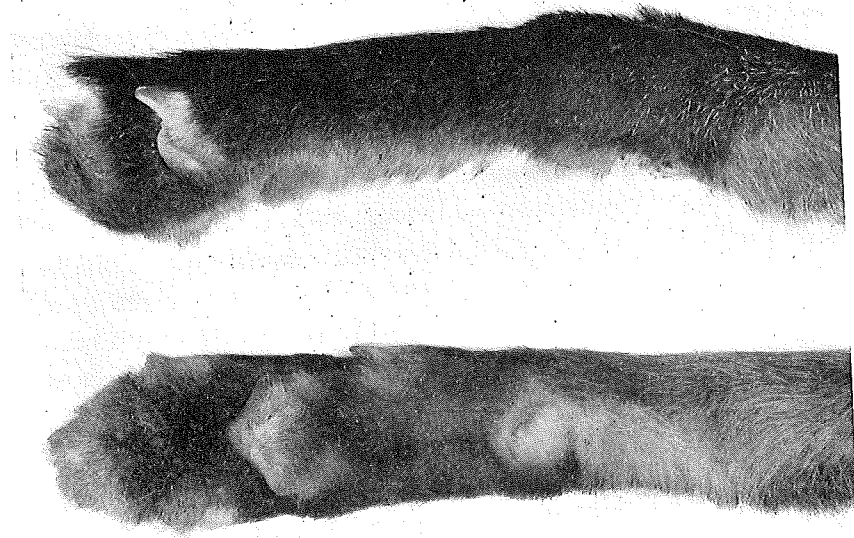


Fig. 149. Front foot of red fox, side and ventral views. Specimen obtained in November, 1923, from Butte Creek Basin, Sacramento Valley. Mus. Vert. Zool., no. 4043. About $\times \frac{3}{4}$.

most graceful, seeming to be composed of some light material little heavier than air."

An examination of the ground over which the foxes had hunted revealed that they had been after meadow mice, which they caught by digging out the nests lodged just beneath the surface of some of the higher ground of the meadow.

Parkinson said that the Sierran red fox was the "wildest wild creature" he knew of, and that it had a "greater fear of man and his scent than all the other fur bearers combined." One individual that he trapped showed more absolute fear at his approach than any other animal he had seen in a trap. It gave not the least sign of anger nor even of "bluff."

Footprints and feces are the main evidence of the presence of a red fox in a locality. Such "sign" is so inconspicuous as to be easily overlooked. An examination of the feet of red foxes taken in early winter (see figs. 149, 150)

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reveals that during the winter season the toe and heel pads of each foot are concealed and protected by a cover of hair borne on the bottom of the foot between the pads. This protective growth keeps the toes from direct contact with the snow, and makes the prints of the pads, at best, blurred and indistinct. Where there is a crust on the snow, even a slight one, a red fox may travel without leaving any visible trail. In a way, he is provided with

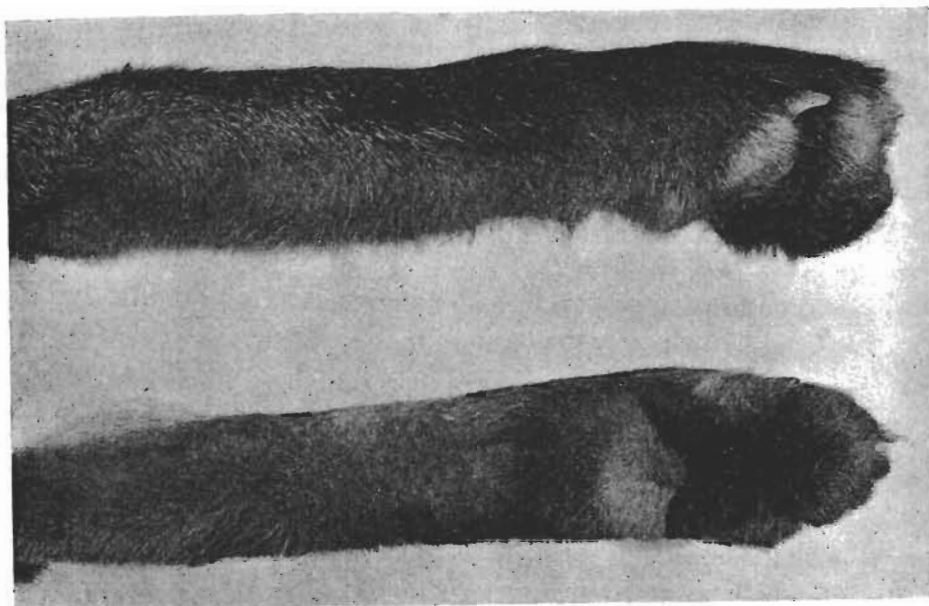


Fig. 150. Hind foot of red fox, side and ventral views. Specimen obtained in November, 1923, from Butte Creek Basin, Sacramento Valley. Mus. Vert. Zoöl., no. 4044. About $\times \frac{3}{4}$.

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"snowshoes," as is the white-tailed jack rabbit of the same altitudes. In the summer the hairs which protect the toe pads become worn down from contact with rocks and earth so that much more distinct tracks are left. At the east base of Lassen Peak on September 23, 1923, one of us (D.) measured and photographed unthawed tracks made in freshly fallen snow. The tracks of the front feet were $1\frac{1}{2}$ inches in width and 2 inches in length. The tracks made by the hind feet were $1\frac{1}{4}$ inches wide and 2 inches long. A red fox's tracks are thus intermediate in size between those of a gray fox and a coyote.

At one point where this red fox had walked at normal gait across a level patch of snow, a photograph was taken of the resulting trail. The tracks were 8 inches apart. By measuring the distances between a number of tracks it was found that the stride varied from 6 to 14 inches, with an average of 10 inches. At times the straddle was as much as 2 inches. When the fox was trotting, the tracks formed a single straight line of impressions in the snow.

The impressions made by the toenails showed distinctly in all deep tracks but not in shallow ones. Nail marks show most plainly in summer.

Feces of the red fox can nearly always be distinguished from coyote droppings by their smaller diameter. Examination of droppings of this fox showed them to contain hair and bones of mice, bushy-tailed wood rat, chickaree, chipmunk, and white-tailed jack rabbit.

D. C. Sample, Jr., 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 on Patterson Mountain, in Fresno County (Parkinson, MS).

A. J. Gardisky reports having found, in the Mono country, several old dens of red foxes, but he has never yet found a used den in solid earth. It is his belief that the Sierran red fox normally does not use earthen dens, but chooses to live in natural cavities in the huge rock slides and talus slopes prevalent in its domain; these cavities provide a multiplicity of compartments and passageways. Decided preference is shown for rock slides which face south or east. There rodents are probably most plentiful. The red fox remains active all winter, even at the highest altitudes; but Gardisky has found that on any especially cold night the foxes den up and remain more or less inactive until about noon of the following day, when the temperature has risen.

The "running" (rutting) season begins about February 15 in California. This is demonstrated by tracks in the snow which show that foxes have associated in pairs. Elsewhere, the period of gestation in the red fox is known to vary only a few hours from fifty-one days. The number of young in a litter in California averages six. Nine is the largest number we know of in any litter observed in this State. Three, the smallest number, was reported for a litter one-third grown, though casualty may have caused reduction from an originally larger number. Data for the Sacramento Valley "colony" are of course excluded here. (See p. 381.)

The golden eagle has shown itself to be an enemy of the red fox in California. A fox trapped February 10, 1916, at Buck Meadows, Tuolumne County, in Yosemite National Park, was badly damaged while held fast in a trap. The skin and flesh about the fox's shoulders were torn to ribbons, the pelt being left attached to the body by a mere thread of skin. Tracks and feathers about the scene indicated that a golden eagle had been the perpetrator.

In the first week in January, 1923, one of the best foxes that A. J. Gardisky had ever trapped was torn to pieces while it was fast in a trap. It was evident from the marks in the snow that an eagle had done the killing. The

fox was badly cut in the back, and had a hole about four inches in diameter on one side, where the bird had been feeding. A steel trap was set beside the mutilated remains of the animal and the next day an eagle, presumed to be the one that had killed the fox, was in the trap. In May, 1916, a pair of golden eagles was found (D.) hunting regularly over the territory where Gardisky later trapped thirteen foxes in a single season. Gardisky says that eagles hunt over this territory the year round; his long experience leads him to believe that the golden eagle is the most important single competitor of the trapper of red foxes in California. This is particularly true in midwinter, when food is extremely scarce and the dark-colored bodies of the foxes are in sharp contrast with the white snow.

It is reliably reported that large wildcats, when hard pressed for food in winter, sometimes kill both red and gray foxes. It is probable that they do kill young red foxes, but doubtful that they kill adult red foxes unless the latter are cripples, trapped, or otherwise incapable of defending themselves. Mountain coyotes are known to have killed gray foxes which they have found trapped or injured, and they may kill an occasional red fox in similar condition.

In winter, when food is scarce, red foxes will feed readily upon such carrion as a horse or cow long dead. This has been proved time and again by Gardisky's trapping of foxes at or near such carcasses. This may partly account for the fact that many red foxes taken in California in the middle of winter are notably fat. Birds which Gardisky has found in the Sierra at an altitude of 10,000 feet in midwinter, and which he believes to be part of the food of red foxes, are the hairy woodpecker, Williamson sapsucker, Clark nutcracker, and mountain chickadee. Many chickadees feed on the baits used to lure fur bearers into the traps, as do also nutcrackers, the latter being frequently caught in traps set for pine marten. A few Sierra grouse, found at lower altitudes, complete the list of birds. Of mammals, there are pine squirrels (chickarees), flying squirrels, several kinds of mice, conies, bushy-tailed wood rats, weasels, and white-tailed jack rabbits. During the summer, Belding ground squirrels and alpine chipmunks are abundant in or about the grassy meadows at timber line, and from droppings left by red foxes we learn that these rodents also are accepted as food at that season.

Some red foxes appear to concentrate their energies upon capturing the large "snowshoe" or white-tailed jack rabbit. This hare attains a weight of seven or eight pounds, being much larger than the black-tailed jack rabbit of the lowlands. In deep loose snow a fox, when it jumps a hare, gives chase at once. At every leap the fox lands exactly in the trail that has been broken

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by the fleeing rabbit. The tracks of the fox and the hare register so perfectly that an observer would think that but one animal had gone by. Gardisky has on several occasions followed a fox's trail just before and just after it entered upon a rabbit's trail. The country where the hares take refuge when pursued is so rough and steep that a person rarely can follow the trail to the finish. In deep, loose snow the chances are all in favor of the fox's having rabbit for dinner, but when the footing is good the fox is likely to fail unless the hare has been caught napping and has got no start at all. There are many foxes in places where no sign of hares can be found in midwinter. The number of hares in any one region varies greatly; in some winters they are plentiful and in others there will be scarcely any sign of them.

Sierra Nevada red foxes are not really numerous anywhere. Gardisky, after trapping for many seasons in the best of the red fox country, thinks that on the average there is about one fox to each square mile. Under favorable circumstances, three or even four foxes may be trapped in a single square mile. In certain parts of their range red foxes appear to be decreasing in numbers, whereas at other points they may be getting more numerous. (This estimate was made prior to 1924.) The change in local population seems to be entirely natural; similar changes may always have been characteristic of the species in California. Gardisky believed that within the 7-year period known to him, red foxes were becoming more plentiful in his territory.

In the winter of 1913 the late W. H. Parkinson caught eight red foxes within five miles of a cabin at Redtop Meadow, in Fresno County. After these had been taken, tracks in the snow indicated that several more foxes were present within that territory. Parkinson considered this fox to be more plentiful all along the high Sierra than is generally supposed. He also thought that there had been a steady increase in numbers since the United States Forest Service began to regulate sheep grazing in the high mountains. Formerly the sheep were herded all through 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."

With the possible exception of sea otter skins, select pelts (namely, "silver") of the red fox are the most valuable furs produced in California. Trappers report that prior to 1922 they sold fox pelts taken in California at the following prices:

Black fox.....	\$350 to \$1000
Silver fox.....	80 to 350
Cross fox.....	35 to 80
Red fox.....	12 to 30

These were the prices actually received by the trappers, not merely those quoted by fur buyers. Because of successful imitation by dyeing, black fox pelts declined greatly in value until in 1924 they sold for less than the better grades of silver fox pelts. Successful farming of foxes has also had effect in lowering the market prices.

Mr. Gardisky has found that the fur of red foxes which live in heavy timber is sometimes 50 per cent better in quality than that of foxes which inhabit open country. A possible reason for this is that pelts are less faded and abraded in the woods; in other words, they are less subject to the destructive effects of brilliant sunlight. One feature of the Sierran red fox is the large number of the "cross" phase which occur in that race. Of 59 foxes trapped over a period of seven years in one locality, 25 were red, 28 were cross, 5 were silver, and 1 was black. W. H. Parkinson informed us that in his experience nearly four-fifths of the foxes in the central Sierra were cross. He had found about one in each 75 to be silver or black. Gardisky says that in cross fox pelts the color varies greatly. Some of the better ones tend toward the light silver phase, whereas among the less desirable skins a light brown phase and a grizzled phase are found. It is to be emphasized that none of these phases is sharply set off; there are all sorts of blends from straight red to nearly pure black.

To our knowledge, the Sierra grouse is the only game bird which lives even partly within the habitat of the Sierra Nevada red fox, and all the nests of this bird of which we have record have been well below the red fox's summer range. There is an upmountain movement of grouse in late summer and fall, yet we have no record of any grouse killed by a red fox. Stockmen, at least, favor this fox because it destroys such rodents as the Belding ground squirrel and Sierra marmot, both of which eat much grass and other vegetation in our alpine meadows. As a matter of fact, the Sierran red fox is present in such small aggregate numbers, and lives so far removed from human settlements, that it rarely if ever comes into conflict with man's activities; on the contrary it benefits man by producing a very valuable pelt.

It is difficult to say just how the red fox in the wild could best be conserved. At present there is more or less of a bag limit or closed season *in effect*. When the fox trapper, who usually is a specialist in his line, finds that a certain territory no longer produces a sufficient number of fox pelts to make trapping pay, he abandons that field until such time as the foxes breed up and again become numerous enough to make his efforts worth while. The heavy snowfall, the low temperature, and the remoteness from civilization of the habitat of the Sierra Nevada red fox are factors which

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prevent any great number of trappers from invading the habitat in the proper trapping season and wiping out the species.

In our estimation (in 1924), the greatest menace to the productivity of this fur bearer is the intensive grazing of our alpine meadows by domestic sheep. The Sierran red fox is dependent for food upon certain rodents and rabbits, and these mammals in turn depend upon the available forage. Much of this forage, outside of national parks, is consumed by sheep. The sheep thus become an indirect but very vital check upon the natural production of fox furs in California.