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AN ECOLOGICAL AND TAXONOMIC REVIEW OF THE SWIFT FOX (*Vulpes velox*)

WITH SPECIAL REFERENCE TO MONTANA

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AN ECOLOGICAL AND TAXONOMIC REVIEW
OF THE SWIFT FOX (Vulpes velox)
WITH SPECIAL REFERENCE TO MONTANA

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8 January 1991

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INTRODUCTION

The swift fox (Vulpes velox) and its close relative, the kit fox (V. macrotis), represent the smallest North American members of the family Canidae. Weighing from 4 to 6 pounds and measuring just over 2 feet, the swift fox is a uniform buffy tan except for a black-tipped tail and dark patches on either side of its nose. The swift fox is a predator of small mammals, birds, and insects.

The swift fox is believed to have originally been abundant throughout its range on the Great Plains. It was extirpated early in this century from the northern portion of its range while remnant populations in the southern portion survived human settlement of the prairies. The original cause of this widespread extirpation is attributed to the ready acceptance of poisoned baits and traps placed for coyote (Canis latrans) and wolf (Canis lupus), extermination. Loss of habitat to dry land agriculture, a changing prey base, and increased interspecific competition from coyotes and red foxes (V. vulpes) may have also contributed to this decline.

The loss of the swift fox over such a broad area prior to the advent of quantitative ecological studies has resulted in a paucity of ecological information on this species. Virtually nothing is known about this species in Montana. Its small size and nocturnal habits have also contributed to this lack of even basic biological information. In recent years, swift foxes have increased in numbers and records of dispersing swift foxes have been reported in formerly unoccupied areas. As a result, there has been increased interest by state and provincial conservation agencies with regard to swift fox ecology and conservation.

The purpose of this paper is to review published information on the distribution, taxonomy, biology, ecological relationships, and food habits of the swift fox. Conservation issues and swift fox reintroduction programs are also reviewed. Special effort has been placed on reconstructing the original distribution of the swift fox in Montana, its prey base, and habitat use. This paper is designed to provide baseline biological information on the swift fox to aid in designing a cost effective and biologically sound swift fox reintroduction/management program for the state of Montana.

DISTRIBUTION AND STATUS

The swift fox originally occurred throughout the Great Plains from the southern portion of the Canadian prairie provinces south to central Texas (Figure 1) (Hall 1981). The swift fox ranged as far east as western Iowa and Minnesota, although there are no specimen records for verification (Allen 1870, Swanson et al. 1945, Bowles 1975). The Rocky Mountains represent the western margin of

Figure 1. Historic range of the swift and kit foxes.

its range. Hall and Kelson (1959) show the swift fox distribution crossing the mountains in northwest Montana and extending into southeast British Columbia but this is without factual basis (Hoffmann et al. 1969) and Soper (1964) does not list the swift fox as part of British Columbian mammalian fauna. The southwestern margin of the swift fox range in New Mexico and Texas abuts with the kit fox range (Hall and Kelson 1959, Rohwer and Kilgore 1973). The present range of the swift fox is much reduced from its historic range (Figure 2).

The red fox now occurs in many areas formerly occupied by the swift fox (Samuel and Nelson 1982) (Figure 3). There is some question whether the red fox is native to North America (Samuel and Nelson 1982), although Churcher (1959) believes it was native north of latitude 40° N. Red foxes are apparently native to Montana based on observations of them along the Missouri River by Lewis and Clark in 1805 (Burroughs 1961). Hoffmann et al. (1969) document the rapid increase in records of this species in Montana during the mid-1900's. The original red fox distribution is confounded by numerous introductions for sporting purposes as early as 1750 (Godin 1977). Existing swift fox populations tend to occur in geographic areas not inhabited by red foxes. A similar pattern is also present for kit foxes.

Other members of Canidae found within the historic swift fox range include the gray wolf, coyote, and gray fox (Urocyon cinereoargenteus). The former two species originally overlapped the swift fox in both range distribution and habitat use (Figures 4 and 5). Both of these species had larger ranges and occupied a greater diversity of habitats. The wolf has been eliminated from all areas of the present swift fox range. The coyote, on the other hand, has increased in numbers to partially fill the niche vacated by the wolf. The coyote does not compete well with the wolf (Mech 1966, 1974) and does not tolerate foxes (Vulpes sp. and Urocyon cinereoargenteus) (Young 1951, Deckker 1983, Voigt and Earle 1983).

Despite its nocturnal habits, the swift fox was considered common by naturalists and explorers in most areas of its original range (Coues 1893). Lewis and Clark reported observations of the swift fox along the Missouri River in Montana in 1805 (Burroughs 1961). Specific sightings were at the Great Falls of the Missouri and Two Medicine River above the mouth of the Marias River. Lewis' notes indicate that he had not seen the swift fox before the Great Falls. Bailey and Bailey (1918) reported the swift fox to be common over the plains along the eastern edge of Glacier National Park. Although no positive record existed, they thought the swift fox entered the Park at St. Mary's Lake and in the lower portions of the Swiftcurrent and Belly River Valleys.

One indicator of the original abundance of the swift fox comes from fur returns compiled by the American Fur Company and the

Figure 2. Probable present range of the swift fox.

Figure 3. Present range of the red fox.

Figure 4. Present range of the gray wolf.

Figure 5. Present range of the coyote.

Hudson Bay Company. Since the early 1800's, large numbers of furs have been traded annually. In the journals of Alexander Henry (Reid and Gannon 1928), 237 swift foxes were reported taken between 1800 - 1806 in northeastern North Dakota. Between 1835 and 1838, the American Fur Company traded 10,614 swift fox pelts at their upper Missouri and Sioux outfits (areas covering Montana and the Dakotas) while only 1989 red fox and 108 gray fox furs were traded (Johnson 1969). Grinnell (1914) comments that in addition to poisoning 750 wolves and 250 coyotes in Kansas during the winter of 1860 - 1861, several bales of yellow fox (V. velox) furs worth \$0.25 each were also taken. In the mid 1800's an average of 5,000 swift fox pelts per year over a 24 year period were traded in Canada (Rand 1948). As late as 1905, 5,000 "kits" were sold in a London auction (Seton 1929). In Canada, commercial trapping of swift foxes continued into the early 1900's. However, by 1925, only 508 pelts were sold from the Canadian prairie provinces (Carbyn and Killaby 1989) and after this date no records were kept on the species due to their insignificant role in the annual take of furs in Canada.

The swift fox was extirpated from vast areas of its range early in this century and was not considered abundant even in areas where it survived. Causes of the decline are attributed primarily to poison baits set for wolf and coyote control/extermination, and the ease with which swift foxes can be trapped. Choate (pers. comm.) now thinks that the early canid extermination efforts which eliminated the wolf and favored the coyote resulted in biotic communities with too much niche overlap between the swift fox and coyote. Robinson (1953) and (1961) and Linhart and Robinson (1972) present some data to suggest an inverse relationship between coyotes and kit/swift foxes. Coyotes are also a known predator of swift foxes (Herrero et al. 1990, Kilgore pers. comm., Choate pers. comm.) and are capable of causing substantial yearly mortality among swift fox populations. Also contributing to the decline in swift foxes was the influx of humans to the Great Plains and the conversion of native prairies to croplands.

The last of the original swift foxes recorded in Montana were those reported by Bailey and Bailey (1918). We sent letters of inquiries to 30 of the largest museums in the United States and Canada specifically requesting information on swift fox specimens collected in Montana. Our intent was to establish a historical distribution for the swift fox in Montana. Twenty-three responses (the American Museum of Natural History with 254,800 specimens - second largest in North America - did not respond to our inquiry) representing a survey of 1,764,590 mammal specimens (this figure includes collections at Montana's two universities) resulted in locating 44 swift fox specimens collected prior to 1910. (Yates et al. (1987) lists the total North American mammal collection at 2,823,129 specimens.) Montana swift fox specimens represent only 0.0025% of all mammal specimens surveyed. All located specimens belong to the National Museum of Natural History (two are on

indefinite loan - one of these resides at the University of Montana). Forty-three specimens were collected at Kipp and Blackfoot in upper Teton County, (now Glacier County) Montana between 1901 and 1906 for the National Museum of Natural History. One other specimen of a Montana swift fox, taken near Fort Benton in the late 1880's (USNH A04213), is housed in this same museum. Appendix A lists all known Montana swift fox specimens.

The lack of any confirmed records of swift foxes in Montana following Bailey and Bailey's (1918) report, prompted Hoffmann et al. (1969) to declare this species extinct in Montana. They based this conclusion on the absence of swift foxes from 16 years of fur harvest data. This trend continued until 1978 when a male swift fox was trapped in Custer County near the Tongue River on 5 March 1978 (T2N, R45E, Sec. 12) (Moore and Martin 1980). This specimen is now in the Montana State University vertebrate museum (#6240). In mid-January 1984, a female swift fox was captured north of Broadus (Henckel 1984). Little is known about this specimen other than it was shown to a taxidermist and was not surrendered to Montana Dept. of Fish, Wildlife and Parks as required by law. Its disposition and information concerning the exact location of capture are not known. Later in the same year, another specimen was captured on 15 November 1984 (T15N, R58E, Sec. 2) east of Glendive in Dawson County (Vallard 1985). This specimen was turned over to Montana Dept. Fish, Wildlife and Parks and later sent to a taxidermist to be mounted as a display specimen. The disposition of this specimen is unknown at present. Pacific Hide and Fur reported one swift fox fur traded at Havre in 1985-86 (Carbyn and Killaby 1989), this being caught along Sage Creek near Gilford, Montana. Additionally, during the same period, there was one sighting and one unconfirmed capture of a swift fox near Hogeland and Chinook, respectively. Presumably all three of these observations are of animals dispersing from the Canadian reintroduction program (Carbyn and Killaby 1989). At present, one radio-marked Canadian swift fox is living in this area of Montana (Dood pers. comm.). Figure 6 shows historic and recent swift fox records and observations for Montana. The three unconfirmed observations in southeast Montana are from Thompson (1982).

A similar trend has been noted in other states. No sightings of swift foxes were reported in North Dakota from 1915 to 1970 (Pfieffer and Hibbard 1970). Bailey's (1926) last record of a swift fox came in 1915 from northern Mckenzie County, North Dakota, where they were considered very scarce. The adult male specimen reported by Pfieffer and Hibbard (1970) was from southeastern Slope County, North Dakota about 161 km southeast of Glendive, Montana (Figure 7). Seabloom et al. (1978) report a swift fox sighting in southern Mercer County, North Dakota, in 1976. More recently, a swift fox was observed in May 1990 in northern Golden Valley County, North Dakota about 80 km east of Glendive, Montana (USFWS 1990).

Figure 6. Historic and present records of swift foxes in Montana.

Figure 7. Recent records (X) of the swift fox in North Dakota.

The last record of swift foxes in South Dakota was reported by Visher (1914) in Harding County where they were considered rare. There was a hiatus of 52 years until the next report of a swift fox in 1966 (McDaniel 1976). Additional records were reported by Van Ballenberghe (1975) which included two individuals from Fall River County in 1970, one animal from Tripp County in 1972, and another individual from Sulley County in 1974 (Figure 8). Subsequently, Sharps (1977) reported three established swift fox populations in South Dakota (Shannon, Haakon, and Perkins Counties). Hillman and Sharps (1978) provide additional data on the Shannon County population.

Likewise, swift foxes were not reported in Wyoming for many years (Long and Long 1964, Long 1965) until the Longs' report of one from Laramie county in 1958. Muchmore (1975), Floyd and Stromberg (1981), and Floyd (1983) provide additional details of swift fox records in this area and assume continuity between the 1958 record and their earliest record of 1976. Figure 9 shows the current range of the swift fox in Wyoming.

In Nebraska, no records of swift foxes exist from 1901 to 1953 (Jones 1964) when a female with two kits was taken. Bluss et al. (1967) report on a female swift fox taken in March 1966 in McPherson County, Nebraska. Hines (1980) presents a range map for Nebraska showing all verified swift fox sightings since 1950 and indicates that swift foxes range throughout most of western Nebraska.

The swift fox also vanished from its range in Canada. The last confirmed records of swift foxes in Saskatchewan were in 1927 and 1928 (Beck 1958) and 1938 for Alberta (Soper 1964). Swift foxes are now present in these two provinces due to reintroduction (Carbyn and Killaby 1989, Herrero et al. 1990) (Figure 10). Loomand (1972) reported on a possible swift fox sighting in Saskatchewan during the 1970's, but no established population was ever found.

In the southern portion of its range, the swift fox never disappeared, although it became very rare by the 1930's. Zumbaugh and Choate (1985) document the historical biogeography of the swift fox in Kansas. These authors present evidence to show the swift fox as being extremely abundant in the mid-1800's, declining rapidly by the late 1800's, becoming very rare and restricted in distribution by the 1930's, and a general population recovery starting in the 1950's (Martin and Sternberg 1955). The swift fox is presently considered the most abundant fox of the Kansas high plains (Zumbaugh and Choate 1985).

In Colorado, Lechleitner (1969) reported swift fox populations were reduced in size by 1900 and later extirpated from many areas. Bailey (1905) considered the swift fox in Texas to be scarcer than in former years. Glass (1959) reported a long absence of records

Figure 8. Established populations (P) and recent records (X) of the swift fox in South Dakota.

Figure 9. Current range of the swift fox in Wyoming.

Figure 10. General release sites of swift foxes in Alberta and Saskatchewan.

for the swift fox from the Oklahoma Panhandle until 1956 but by the mid-1960's the swift fox was considered abundant in this area (Kilgore 1969).

These records indicate that the swift fox became so scarce throughout its range that by the mid-1900's it was believed extirpated in most areas. This may have been an artifact of swift fox behavior, the nature of small isolated populations, and a lack of interest among conservation agencies. The net result was a series of state reports (cited above) of the swift fox returning to former habitat after being absent for an extended period. A careful look at these reports suggests that the swift fox was either never totally extirpated from many areas and/or it is a good colonizer. The timing of the reports detailing increased numbers of swift foxes in Oklahoma, Kansas, Nebraska, Wyoming, North Dakota, and South Dakota are so closely spaced that they suggest a response by several swift fox populations to a common variable. We now know that reports of swift foxes reappearing in Kansas, South Dakota, and Wyoming could be traced to pre-existing populations in those states (Zumbaugh and Choate 1985, Sharps 1977, and Floyd and Stromberg 1981, respectively).

The recovery of the swift fox starting in the 1950's has been attributed to a change in coyote control methods; specifically the substitution of compound 1080 (sodium monofluoroacetate) bait stations for strychnine and the use of "coyote getters" (Robinson 1953, Robinson 1961, Linhart and Robinson 1972). Egoscue (1956) concluded that these two methods of coyote control had no effect on kit fox populations in Utah. President Nixon's ban in 1972 on the use of chemical toxicants for predator control on Federal lands (Executive Order 11643) was undoubtedly a positive step in swift fox recovery. The recovery of the swift fox in many areas of its former range may not be so much a spread from south to north, as a general response of small, remnant populations scattered over a broad geographic area to changes in Federal policy and social-economic factors (Floyd and Stromberg 1981). This would illustrate the ability of the swift fox to exist in relative obscurity in small isolated populations and to avoid detection unless specific searches are made for this species.

The current distribution of the swift fox appears to be composed of several highly disjunct populations. Scattered populations exist from western South Dakota, south through eastern Wyoming and western Nebraska, into eastern Colorado and western Kansas, and on into New Mexico and Texas (Figure 2). Three known populations lie very close to Montana's borders. One population is located southwest of Gillette/southeast of Buffalo, Wyoming (Pallister, Boyce, and Stromberg pers. comm.) (Figure 9). The 1978 Montana record (Moore and Martin 1982) may have been a dispersing individual from this population. Reintroduced swift foxes are now present in southeastern Alberta and southwestern Saskatchewan (Carbyn and Killaby 1989, Herrero et al. 1990) (Figure 10) and

represent the closest known population to Montana. A few of these animals have turned up in Montana (Carbyn and Killaby 1989, Dood pers. comm.). An existing population of swift foxes in Perkins County, South Dakota, is another population very close to Montana (Figure 8) and may account for the two 1984 Montana records.

TAXONOMY

The first record of a swift fox comes from Alexander Henry's report of fur shipments from Pembina Post of the Northwest Company's Red River District in 1801. By 1805, 117 swift fox furs had been shipped (Burroughs 1961). Lewis indicates in his notes on July 1805 that the term "kit fox" was already in use by the fur traders of that period. However, it was not until 1823 that the swift fox was first described as a species by Thomas Say (Say 1823, Burroughs 1961). It is generally believed that the swift and kit fox are two separate species. So similar are the two species, however, that their common names have been used interchangeably (Miller and Kellogg 1955), and there has been considerable controversy over the specific status of the two species. Rohwer and Kilgore (1973) analyzed swift and kit fox specimens collected along, and on either side of, a zone of sympatry in eastern New Mexico and south-central Texas. These authors documented hybridization between the two species in the zone of overlap but felt that interspecific competition prevented either species from expanding into the other's range. Others (Creel and Thornton 1971, Snow 1973, Thornton and Creel 1975, McGrew 1979, Stromberg and Boyce 1986) present evidence supporting the swift fox and kit fox species designation.

Principle differences between the two species are longer ears and tail in the kit fox, and a larger body size and broader skull (Egoscue 1979) for the swift fox.

Merriam, an early taxonomist prone to excessive subspecies designations, described two subspecies of the swift fox, the northern swift fox (*Vulpes velox hebes*), and the southern swift fox (*Vulpes velox velox*) (Merriam 1902). This classification was the basis of a brief listing of the northern subspecies as an endangered species (U.S. Fish and Wildlife Service 1979 and 1982). The northern swift fox was delisted when it was decided that valid subspecies variation did not exist. Stromberg and Boyce (1986) examined swift fox specimens collected from throughout their range and concluded that subspecific status for a northern population as proposed by Merriam (1902) is not justified. However, these authors cautioned that there was significant geographic variation among the specimens examined and that this variation may reflect genetic differences. They advised that conservation efforts to restore swift foxes to former portions of their range consider this geographic variation as a preservation criteria. A similar study conducted by Dragoo et al. (1987) also concluded that the

subspecific designation as proposed by Merriam (1902) was not valid.

Hall (1981) suggests that the swift and kit foxes are conspecifics and may be only subspecifically distinct. Dragoo et al. (1990) present data to support this contention. They assessed the relationships of these two foxes by morphometric and protein-electrophoretic methods. In the latter case, they found genetic divergence to be negligible with a high degree of genetic similarity among all nominal subspecies examined. Morphometric analysis were only able to distinguish between the swift and kit fox and not between any of the previously proposed subspecies. Dragoo et al. (1990) propose to reclassify the swift and kit foxes as a single species - Vulpes velox - with only two recognized subspecies - the swift fox, Vulpes velox velox, and the kit fox, Vulpes velox macrotis.

Although the red fox (third North American member of the genus Vulpes) appears quite distinct from the swift and kit foxes, Thornton et al. (1971) and Creel and Thornton (1974) have documented hybridization between kit and red foxes in Texas. Based on this finding, and the report by Rohwer and Kilgore (1973), the possibility appears to exist for hybridization between the swift and red fox as well.

SPECIES DESCRIPTION

The swift fox averages about 2.4 kg body weight (range = 1.8 to 3.0 kg) and measures 70 - 85 cm for total length (Kilgore 1969). Tail length is 24 - 35 cm, hindfoot 11 - 14 cm, and ear length 56 - 75 mm. Although males tend to be 8% heavier than females (Egoscue 1979), skeletal sizes of the two sexes are similar (Dragoo et al. 1987). The cranium and rostrum of a swift fox skull is relatively short and broad (Figure 11) (condylobasal length 105-120 mm) which distinguishes it from the longer narrower red fox skull (condylobasal length 120-150 mm). The lyre-shaped sagittal crest of the gray fox distinguishes this species from the members of the genus Vulpes. The dental formula for the swift fox is $i\ 3/3$, $c\ 1/1$, $p\ 4/4$, $m\ 2/3$.

Pelage is a buffy tan above with a light tan to white below. A tinge of orange may be present on the sides, legs, and lower surface of the tail. The tail has a black tip and a dark patch is found on either side of the muzzle. Figure 12 shows the physical characteristics of the swift fox. The swift and kit foxes are distinguished from other North American foxes by their small size, black tip to the tail and tan fur (Figure 12). The foot pads of the kit and swift foxes are largely hidden by fur; some (Seton 1929) have speculated that this aids in travel over sandy country. Summer fur is short and coarse and winter fur is long, dense, and

Figure 11. Lateral, ventral, and dorsal views of a swift fox skull showing condylobasal measurement of 105 - 120 mm. (Modified from Egoscue (1979)).

Figure 12. Physical characteristics of the swift fox.

lighter in color. A full account of pelage characteristics is described by Audubon and Bachman (1854), Baird (1857), and Bailey (1926, 1931).

REPRODUCTION

Timing of breeding in the swift fox varies across its range. The swift fox breeds in December and early January in Oklahoma (Kilgore 1969), January and February in Colorado (Fitzgerald et al. 1983), and in February and early March in Nebraska (Hines 1980). The swift fox is believed to be monogamous (Kilgore 1969), however, Kilgore (1969) and Hines (1980) site examples of two males present at a den site during the breeding season. The swift fox is monoestrous (Asdell 1964). The gestation period is 52 - 53 days (Sharps 1984, Sharps and Witcher 1984), which is slightly longer than the 49 - 50 days for red foxes (Asdell 1964). Young are born in March and early April in the south, and April and early May in the north. Eyes and ears of young open at about 10 - 15 days. Young emerge from dens at three to four weeks of age (Hines 1980) and are weaned at 6 - 7 weeks (Kilgore 1969, Hines 1980). Pups weigh less than a 1/4 kg at birth but grow rapidly and obtain adult weight by early fall (Kilgore 1969). Dispersal of pups does not occur until late summer or early fall. Swift and kit fox pups stay with family groups and use their natal dens longer than most other North American canids.

Swift foxes are capable of breeding during their first year (Sharps 1984), but under natural conditions in Kansas only 10% of a sample of 100 juveniles showed evidence of breeding (Zumbaugh 1984). In the same study, 76% of the yearling females bred and 86% of the older females bred. Mean number of placental scars per pregnant female in this study was 2.3 for juveniles and 4.3 for yearlings and older. Other reports of litter size appear to be based on number of young observed at the den. Kilgore (1969) summarizes his data with other accounts (Seton 1929, Cutter 1958a, Glass 1956) of litter size ($N = 9$) and reports an average litter size of 4.8. Hines (1980) reports an average litter size of 4.25 for four litters and Fitzgerald et al. (1983) had an average litter size of 3.6 at 16 natal dens. Litter size in captive-raised swift foxes has ranged from 2 - 7 (Carbyn and Killaby 1989).

DENS

Swift and kit foxes are the most den dependent members of the North American canids (Egoscue 1979). Dens are used on a daily basis year long (Kilgore 1969). Swift foxes can construct their own dens (Kilgore 1969), or may make use of burrows dug by prairie dogs (Cynomys ludovicianus) or badgers (Taxidea taxus). Uresk and Sharps (1986) reported that swift foxes favored hilltops as den sites. Most dens were located in short to mid-grass prairies and

showed no selection for soil type. Over half of the 35 dens found by Kilgore (1969) were in cultivated fields or other man-made habitats (cemeteries). The remainder of his den sites were in short grass pastures. Dens were located in level areas or along blow-ridges. Dens in cultivated fields usually had only one opening, while in native habitat they had multiple openings (up to 9, mean 4). Fitzgerald et al. (1983) found the majority of their dens on flat areas along ridges or drainages dominated by short grasses. Eighty-five percent of their dens had only one or two openings. Fitzgerald et al. (1983) also reported dens to be clustered in groups of 3 to 13. They found natal dens to be used in consecutive or alternate years. Cutter (1958a) also reported dens to show a clumped distribution with three to six dens in a quarter of a section. Approximately 3/4 of his den sites were located in overgrazed pastures devoid of any shrubs. Other den sites included plowed fields and fence rows with wind-formed soil banks.

Hines (1980) gathered information on 40 dens used by radio-marked swift foxes. Numbers of dens used by marked animals over an extended period ranged from 2 to 11. Males and unmated females established non-natal dens throughout the year, and mated females established non-natal dens except during whelping. Mated females established natal dens from May through August. Hines (1980) reported dens within home ranges to show a clumped distribution. About half of his dens were located in flat terrain and the remainder in areas of gently rolling topography. All dens were located in short grass prairies and 68% were within 200 m of a road. Hillman and Sharps (1978) also comment that all of their den sites were within 1.6 km of a road. Hines (1980) found natal dens to average (3.1) more entrances than non-natal dens (1.4).

All accounts of excavated dens (Cutter 1958a, Kilgore 1969, Fitzgerald et al. 1983) suggest that swift fox dens are relatively shallow (around 1 m deep) and range in length from 2 - 5 m. Burrows used by swift foxes have been variously reported to be 13 - 20 cm in diameter.

POPULATION STRUCTURE

Reasonable information on age and sex structure of swift fox populations come from two studies (Zumbaugh 1984, Fitzgerald et al. 1983). Both of these studies show that the juvenile age class dominates. Sixty-three percent of 298 foxes taken over two trapping seasons in Kansas were under one year of age. Yearlings accounted for 16% of the harvest and animals 2 - 4 years of age accounted for 18% of the harvest. None of the swift foxes examined were judged to be over 5 years of age. Hines (1980) sectioned canines and looked at dental cementum annuli for eight foxes and found all to be under three years of age. Fitzgerald et al. (1983)

reported 45% of 66 swift foxes trapped and marked on his study area as juveniles.

Sex composition of swift fox populations appear to approximate an equal number of males and females. In Kansas, 46% of 296 swift fox carcasses were determined to be males and 54% were females. In Fitzgerald et al.'s (1983) study, 53% of the animals marked were males and 47% were females.

MORTALITY

Swift fox populations are characterized by high annual mortality. Human related activity appears to be one of the most common causes of mortality. This includes being struck by vehicles, shot, and trapped (Hines 1980, Sharps and Whitcher 1984 Fitzgerald et al. 1983). Coyote predation is frequently cited as a common form of natural mortality (Kilgore 1969, Carbyn and Killaby 1989, Herrero et al. 1990) although there is little evidence of such. Many authors have noted the dependency of swift foxes on dens and interpreted this as an indication of swift fox vulnerability to predation (Egoscue 1979). Golden eagles (Aquila chrysaetos) and other raptors have been found to feed on swift fox but in many cases it is not known if they had killed the animals or if they were scavenging (Pfeifer and Hibbard 1970, Hines 1980, Fitzgerald et al. 1983). Sharps (1989) observed an unsuccessful attack on a swift fox by a great-horned owl (Bubo virginianus).

Sharps and Whitcher (1984) radio-marked 14 swift foxes and, over a one year period, found 50% of the marked animals dead and were unable to account for another 27%. Hines (1980) radio-marked seven adult swift foxes and was able to follow these up to six months. Three of these were known to have died and the fates of the other four were unknown at the end of the study. He also reported 46% mortality of juvenile swift foxes within the first four months of post emergence from the den. Fitzgerald et al. (1983) reported a minimum of 17% mortality of marked pups within their first year. This was based on tag returns and actual mortality was probably much higher. Swift fox harvest data obtained over a two year period in Kansas would indicate almost 75% mortality among juveniles and 50% mortality among adults (Zumbaugh 1984).

HABITAT USE

Although no quantitative analysis of swift fox habitat selection has been undertaken, numerous studies indicate that swift foxes use, and prefer, short to mid-grass prairies (Cutter 1958a, Kilgore 1969, Hillman and Sharps 1978, Hines 1980, Fitzgerald et al. 1983). Prairie habitats dominated by buffalo grass (Buchloe dactyloides) or blue grama grass (Bouteloua gracilis) appear to be

the areas where the highest densities of swift foxes are found in the southern portion of their range (Kilgore 1969, Hillman and Sharps 1978, Fitzgerald et al. 1983). Dense shrub layers are not reported as being part of swift fox habitat. In fact, most studies report few, if any, shrubs in areas used by swift foxes. However, this may be an artifact of surviving swift fox populations being in geographic regions devoid of shrubs. Fitzgerald et al. (1983) found swift fox densities in their better habitat to range from 0.8 to 1.1 animals per 100 ha and to range from 0.2 to 0.4 in poorer habitat.

The swift fox is known to inhabit areas of mixed agricultural use. Stromberg (pers. comm.) stated that swift foxes can be found in these areas but in lower densities. Kilgore (1969), Fitzgerald et al. (1983), and Hines (1980) reported similar results. The lower densities of swift fox in agricultural areas may be due to increased human caused mortality in these areas. The San Joaquin kit fox appears to be very adaptable to substantial modification of its habitat provided the prey base remains, and adjusts to human presence to the point of being habituated to people (personal observations).

The swift fox is a prairie dwelling animal and most topographic situations reported used by this species are either level or gently rolling hills with slopes under 15% (Hillman and Sharps 1978, Hines 1980, Fitzgerald et al. 1983). However, Hillman and Sharps (1978) reported swift foxes to den within 1.6 km of the White River in South Dakota. Original accounts of swift foxes indicate that they also frequented the footslopes of the northern Rockies in Montana and Alberta (Bailey and Bailey 1918, Soper 1964)

Sharps and Whitcher (1984) considered the presence of water in swift fox home ranges as an important habitat factor. Hines (1980) found no obvious relationship of swift foxes to water sources. All dens located by Hines were greater than 4 km from a water source. Hines (1980) points out that studies on the red fox show their den sites to be closely tied to water sources, usually within 1 km of water. This factor may provide some niche separation between swift and red foxes in areas where they coexist.

Hines (1980) located radio-marked swift foxes and dens disproportionately close to roads. Sixty-eight percent of his dens were located under 200 yards from a road. Hillman and Sharps (1978) reported all their dens to be located less than 1.6 km from roads. Roads and trails may be used as travel routes for swift foxes. This may also explain the high incident of traffic mortalities in many studies. Madson (1990) reported that Canadian Wildlife Service personnel successfully trapped swift foxes by setting traps along fences which served as travel ways. One factor which may favor the use of roadsides as swift fox den sites is that larger predators such as coyotes may avoid (or are selectively removed from) these areas. Some other wildlife species which may

serve as swift fox prey are associated with roads and trails. In Montana, prairie dogs have been noted to disperse along roads and prairie dog colonies frequently have roads or cow trails running through them (Knowles 1984).

HOME RANGE AND DISPERSAL

Home range size of resident swift foxes has only been investigated in one study in Nebraska (Hines 1980). Additionally, radio collars have also been placed on swift foxes in two reintroduction programs (Herrero 1984, Sharps and Whitcher 1984, Herrero et al. 1990). Average home range size for seven radio-marked swift foxes reported by Hines (1980) was 15.22 (range 6.66 - 28.80) km². Males had larger home ranges than females (males $\bar{X}$ = 17.33, range 6.66 - 28.80 km²; females $\bar{X}$ = 12.41, range 9.14 - 14.3 km²). Average distance traveled over 47 nights for the seven radio-marked foxes was 13.06 km. Sharps and Whitcher (1984) comment that swift fox home ranges during spring ranged from 1.6 to 3.2 km² and increased to 11.2 to 12.8 km² during the remainder of the year. However, details of these data are not provided in the paper.

Juvenile swift foxes disperse during late summer and early fall. Several studies report dispersal distances for marked animals. Dispersal distances bear direct relevance to the recent Montana swift fox records. Sharps and Whitcher (1984) reported dispersal distances of reintroduced swift foxes to range from 6 to 252 km (average distance; males 51.4 km, females 76.5 km) over approximately a two year period. This would represent a minimum since some of the released foxes died early in the study or radio contact was lost. Fitzgerald et al. (1983) reported dispersal distances for two foxes at 40 and 70 km. Carbyn and Killaby (1989) monitored the movements of a released fox that traveled 50 km before mating and establishing a den.

FOOD HABITS

Swift fox food habits probably have been investigated more thoroughly than other aspects of their ecology. In general, swift foxes appear to be opportunistic feeders (Loy and Fitzgerald 1980) taking small mammals, birds, and insects depending on availability. Mammals are the major component of the swift fox diet and lagomorphs are consistently represented in food habit studies (Cutter 1958b, Kilgore 1969, Hillman and Sharps 1978, Hines 1980, Choate and Fox 1985, and Uresk and Sharps 1986). Lagomorphs taken by swift foxes include the genus Lepus and Sylvilagus. Jackrabbits appear to be the largest prey taken by swift foxes although they are known to scavenge on dead ungulates including domestic cattle (Hines 1980, Uresk and Sharps 1986). Hines (1980) considered

carion to be an important component of the swift fox diet with road-killed animals a readily available source.

Uresk and Sharps' (1986) study is the only investigation where prairie dogs were the major prey item and rabbits did not comprise the bulk of the diet. This can be related to the abundance of prairie dogs on their study area and the fact that two dens were located in prairie dog colonies. Prairie dogs appear in the swift fox diet in other studies where prairie dogs were present on the study area (Kilgore 1969, Hillman and Sharps 1978, Hines 1980, Choate and Fox 1985). Ground squirrels, primarily thirteen-lined ground squirrels (Spermophilus tridecemlineatus), are also taken by swift foxes (Cutter 1958b, Kilgore 1969, Hillman and Sharps 1978, Hines 1980, Uresk and Sharps 1986). The presence of prairie dogs and ground squirrels, two strictly diurnal genera, in the swift fox diet implies that swift foxes are capable of diurnal hunting.

Sharps (1989) was able to return to his former study area and conduct swift fox surveys following a 92% reduction in black-tailed prairie dog colonies. Sharps noted a wide-scale reduction of swift fox population densities over the survey area. During 102 days of survey time, he was unable to locate swift foxes in the remaining prairie dog colonies. These colonies were located in rough topographic situations which tend to favor coyotes and bobcats (Lynx rufus). Preliminary observations of swift fox scats from the survey area in 1989 indicated that small mammals, insects, and ground roosting birds comprised the primary food base. These data (Uresk and Sharps 1986, Sharps 1989) suggest that prairie dogs play an important role in swift fox ecology.

Egoscue (1975) reported kit fox welfare to be tied directly to jackrabbit populations. Declining rabbit numbers resulted in non-breeding and smaller litter sizes among kit foxes. He stated that kit foxes were incapable of altering their predatory habits to take advantage of diurnal prey species. Our observations of the kit fox in southern California and Nevada indicate that this species is indeed highly nocturnal. In addition, Egoscue found that the lack of rabbits in the kit fox diet was not compensated for by nocturnal small mammals such as kangaroo rats (Dipodomys sp.). Because of its dependence on rabbits, Egoscue (pers. comm.) recommends that reintroduction efforts for the swift fox be keyed to peaks of rabbit cycles.

Swift foxes are also reported to eat a variety of mouse species. These include deer mouse (Peromyscus maniculatus), northern grasshopper mouse (Onychomys leucogaster), Ord's kangaroo rat (Dipodomys ordii), pocket mice (Perognathus sp.), harvest mice (Rythronomys sp.), prairie vole (Microtus orchogaster), and cotton rat, (Sigmodon hispidus). Insects, when seasonably available, may be an important prey item. A variety of insects may be taken, but grasshoppers tend to dominate in the diet (Cutter 1958b, Kilgore 1969, Hines 1980). Grasses and other plants are

also eaten by swift foxes and compose an important portion of their diet even in the winter (Cutter 1958b, Kilgore 1969, Uresk and Sharps 1986, Hines 1980, Zumbaugh et al. 1985)

BEHAVIOR

Little is known of swift fox behavior. Swift foxes are primarily nocturnal and are only rarely seen abroad during daylight hours. This may be a contributing factor for the paucity of behavioral information. It may also result in small, isolated populations going undetected unless specific surveys by experienced biologists are employed. Hines (1980) noted swift foxes to cease their nocturnal activity period well before sunrise and not to begin nightly activities until nearly dark. Swift fox activity increased after sunset and reached a plateau between 0200 and 0300 hrs. Average distance traveled during this time period ranged from 1.22 to 1.30 km per hour. Hines (1980) considered the swift fox to rest only during the day. The activity patterns of swift foxes may be very similar to that of the black-footed ferret (Mustela nigripes).

Like black-footed ferrets, young swift foxes may be seen playing during daylight hours at den openings (Kilgore 1969, Chambers 1978, Hines 1980). Females with pups were noted to make short daytime forays for food (Hines 1980). Kilgore (1969) considered swift foxes to pair for life but lacked any hard evidence for this statement. He cites an example of one male being observed at a den with at least three different females (the first two females were killed at the den) over a two month period. This may be taken as an example of serial monogamy or a polygamous breeding unit (Egoscue 1962). Hines (1980) had an observation of two males at a den with one female. Males participate in the rearing of young swift foxes (Hines 1980). However, information gathered by Hines (1980) would indicate that participation by males is variable and often minimal.

Shortly after swift foxes are weaned, the family unit may move from the natal den to a nearby den. This may be due to a build up of ectoparasites in the den or exhaustion of the forage base near the den (Jon Sharps, pers comm.). Family units split up and dispersal of pups begins in late August. At this time, pups resemble adults in pelage, and weigh about 2/3 of the adult weight. In addition to the lighter weight, young during the fall may be distinguished from adults by shorter fur on the tail, and lack of tooth wear (Hines 1980).

MANAGEMENT AND ECONOMIC VALUE

Swift fox fur is not particularly valuable and is dyed to be used as an imitation for more expensive fox fur (Arnold 1925). Its

lack of value, however, has not stopped the trade in swift fox furs. As a result of its low economic value and relative scarcity, state conservation agencies have made little effort on managing swift fox populations.

Classification of the swift fox varies by state. Wyoming and New Mexico have no restrictions on the harvest of swift fox. The swift fox is considered a furbearer in Colorado, Kansas, Montana, and Texas. These states have regulated trapping seasons, although Montana's season is closed year long. In North Dakota, South Dakota and Nebraska, the swift fox is classified as either threatened or endangered and are fully protected.

Kansas took advantage of a newly instigated trapping season in the fall and winter of 1982-1983 to gather age structure, sex ratio, and food habits information on the swift fox (Zumbaugh 1984, Zumbaugh et al. 1985). The first two seasons of data collection resulted in 83 and 215 swift fox carcasses being turned over for research purposes. Hines (1980) summarizes harvest data from the late 1970's for four states (Wyoming, Colorado, New Mexico, and Texas). The greatest number of animals harvested was in Colorado where 1499 were taken in 1978-79. Wyoming reported the smallest harvest with their largest being 14 in 1977. The other two states were intermediate to these extremes.

In the United States, the swift fox is presently listed as a category II species (Fish and Wildlife Service 1989) and has no legal Federal protection. The northern swift fox was briefly listed as an endangered species in 1979 but was quickly delisted when it was determined that there was no basis for the subspecies designation. Depending on the outcome of the present debate over taxonomic classification of the swift and kit foxes, additional changes in Federal classification of the swift fox may be needed to reflect the latest scientific evidence.

The swift fox is listed in Appendix 1 of the CITES agreement, and it is listed in the IUCN red data book (Schroeder undated). The Committee On the Status of Endangered Wildlife In Canada lists the swift fox in Canada as an extirpated species (Carbyn and Killaby 1989).

PARASITES AND DISEASES

Relatively little work has been done on the parasites and diseases of swift fox. Swift foxes have been noted by several researchers to host a large number of ectoparasites (Kilgore 1969, Hillman and Sharps 1978, Hines 1980). Kilgore noted the only swift foxes he examined to be free of fleas were three whelps less than 10 days old. Common flea species found on the swift fox include Pulex irritans and P. simulans (Jordan and Rothschild 1908, Holland

1949, Rapp 1962, Kilgore 1969). Kilgore also found the flea Opisocrostitis hirsutus, which normally infests black-tailed prairie dogs, at swift fox dens. Kilgore reported large numbers of fleas present in swift fox dens and suggested that flea infestations may partially account for the frequent changes in den sites.

Kilgore (1969), Hillman and Sharps (1978), and Hines (1980) all report ticks (Acarina) on swift foxes. Kilgore (1969) and Hines (1980) both identified the ticks as (Ixodes kingi). Hillman and Sharps (1978) noted ticks to be attached to the ears of swift foxes.

Cutter (1958b), Kilgore (1969), and Hines (1980) identified several endoparasites. These included the Cestodes Taenia multiceps and Dipylidium caninum and the Nematodes Toxocara canis and Pysaloptera sp.. Stiles and Baker (1935) and Erickson (1944) also found Ancylostoma caninum in swift foxes. In addition, three species of parasitic protozoans have been reported in swift foxes. These are Coccidium bigeminum (Weidman 1915), Isopora bigmina (Becker 1934, Stiles and Baker 1935), and I. felis (Stiles and Baker 1935). Kilgore (1969) notes that most of the ecto- and endoparasites are also found in other wild canids and dogs.

The occurrence of infectious diseases of wild and domestic canids in swift foxes is not well known. However, it is reasonable to suspect that the swift fox is susceptible to most diseases which plague other canids. Disease should not be overlooked as an important factor limiting swift fox populations and slowing the return of the species to unoccupied habitat.

The San Joaquin kit fox has been surveyed for selected diseases (McCue and O'Farrell 1988). Canine parvovirus was the major disease of the kit fox and may well be the most important disease among wild canids (Johnson pers. comm.). McCue and O'Farrell (1988) found antibodies against this pathogen in all animals examined in one collection period and in 67% of the animals tested in a later collection period. Other diseases with a high incidence of occurrence were canine distemper virus (0 - 14%), infectious canine hepatitis virus (6 - 21%), tularemia (Francisella tularensis) (8 - 31%), brucellosis (Brucella abortis and B. canis) (3 - 8% and 0 - 14%, respectively), toxoplasmosis (Toxoplasma gondii) (6%), and coccidioidomycosis (Coccidioides immitis) (3%).

Rabies is a virus which is known to impact wild and domestic canids and could potentially affect swift fox populations. Fitzgerald (pers. comm.) believes rabies may influence swift fox numbers in northeastern Colorado. Canine distemper could also potentially impact swift fox populations in a manner similar to that seen in black-footed ferrets (Thorne and Williams 1988), although there are no documented accounts of distemper decimating a swift fox population. Johnson (pers. comm.) considers lyme disease as another potential disease of the swift fox.

PREDATION

The small size of the swift fox makes it vulnerable to other predators. Many researchers have commented that the swift and kit fox are the most den dependent members of the North American canids. Escape from predation is frequently cited as the cause of this den dependency. Wild predators of the swift fox include the coyote, red fox, bobcat, badger, and golden eagle. Herrero et al. (1990) states that coyotes are a major cause of death among radio-marked reintroduced swift foxes in Alberta. Golden eagles have been found on swift fox carcasses on at least two occasions (Pfieffer and Hibbard 1970, Fitzgerald et al. 1983) and noted to kill reintroduced swift foxes in Canada (Herrero et al. 1990). Hines (1980) reported finding unidentified raptor pellets at the remains of a dead swift fox but the cause of death was not determined.

Nearly all researchers comment that human related mortality is the principal cause of death among swift foxes. Swift fox behavior seems to contribute to their susceptibility to humans. Swift foxes are readily trapped (Bailey 1926), easily shot at den sites (Hines 1980), and occur in areas inhabited and traveled by humans (Cutter 1958a, Hines 1980). Sharps and Whitcher (1984) found 50% annual mortality among radio-marked captive-released and wild swift foxes. The four documented mortalities among the captive-releases were human caused (two road kills, one trapped, one shot). Hines (1980) found road kills accounted for four of the 11 mortalities he documented, three were shot, and cause of death was not determined for four others. Carbyn and Killaby (1988) report similar findings for captive-released foxes in Saskatchewan. Road kills, shootings, and trappings seem to account for most of the known mortality. Kleiman and Brady (1978) considered canid populations with a high juvenile proportion to be indicative of heavy human exploitation. They theorized the juvenile segment of an unexploited canid population should be under 50%.

SURVEY TECHNIQUES

With the increased interest in the swift fox over the past two decades, techniques have been developed to locate and survey swift fox populations. These methods include fur harvest surveys, scent post and tracking surveys, spotlight surveys, and live-trapping.

Fur harvest surveys are dependent upon having an open, legal trapping season on swift foxes. Colorado, Kansas, New Mexico, Texas, and Wyoming have obtained distributional information on swift fox by tallying harvests by counties. Kansas conducted a fur harvest survey prior to, and after, an open season on swift fox (Zumbaugh 1984). They found that all reports of pelts traded prior to the open season were supposedly taken in Colorado which had an

open season on swift fox trapping. With the initiation of an open, legal trapping season, number of pelts reported went up and they were all taken within Kansas. Occasionally, fur dealers may report a swift fox record even during a closed season (Carbyn and Killaby 1989). However, when swift foxes were afforded legal protection in South Dakota, Sharps (pers. comm.) found fur dealers very reluctant to disclose information concerning the take of this species. Government trappers have proved valuable in locating small isolated populations of kit fox in Utah (Egoscue pers. comm.).

Scent post (Linhart and Knowlton 1975) and tracking surveys (Sharps pers. comm.) may disclose locations of swift fox populations. Zegers (1976), in developing survey techniques for swift foxes, reported that the scent post survey was the most effective method tested, and that swift foxes were readily attracted to a scent station. The scent post survey may provide presence/absence data on the swift fox and give some indication of abundance relative to other wild canids. Muchmore (1975), reporting on the results of two scent post surveys conducted in an area of southeast Wyoming where a swift fox was observed in 1972, stated that there were 13 swift fox visits, 23 red fox visits, and 41 coyote visits at 100 stations over a 5 day period. Results of this survey may indicate that these three canid species are capable of coexisting in a limited geographic area. Scent post surveys have also been successfully used to census kit foxes in Oregon (D. Edge pers. comm.)

Sharps (pers. comm.) stated that looking for swift fox tracks around stock ponds, on cattle trails, or during periods of winter snow cover, may also be useful. Pallister (pers. comm.) cautioned that swift fox tracks may easily be mistaken for jackrabbit tracks. Snow-tracking techniques developed for black-footed ferret surveys (Richardson et al. 1984) may be a useful method of locating swift fox populations. Both these techniques require that field personnel have prior experience in discerning track sign of red fox, gray fox, and coyotes from swift fox. Separation of sign of these species can be accomplished with some training and practice (Sharps pers. comm.). The tracks, trail and scat of the swift fox is illustrated in Figure 13. This technique represents a low cost survey method which can be applied to a broad region.

Spotlight surveys are also useful in locating and observing the primarily nocturnal swift fox. Spotlighting as a technique developed for locating black-footed ferrets (Campbell et al. 1985) may be applied to locating swift fox populations. Hines (1980) reported swift fox dens to be located disproportionately close to roads which facilitates this technique. The habitat preference of the swift fox for short and mid-grass prairies also makes this technique highly useful. Hillman and Sharps (1978) used this technique to locate swift foxes on their study area. Spotlighting is conducted from a vehicle while driving roads and trails at night and using a 200,000 candle power spotlight for illumination. Swift

Figure 13. Tracks, trail and scat of the swift fox. (Modified from Murie (1975)).

fox eyes reflect a blue-white light (Sharps and Whitcher 1984). An advantage of this technique is that an observation of a swift fox results in a positive record and little prior experience is needed to identify a swift fox. Lack of a swift fox sighting using this technique does not mean swift foxes are absent, because only a small area either side of a road is sampled. Sharps (pers. comm.) considered late May to late July as the best time to conduct spotlight surveys for the swift fox. Swift fox family units were present around their dens at this time and were highly visible. Foxes may be pressured into revealing their den site at night by following them with a vehicle. If this cannot be done, the location of the observation can be flagged and a 0.5 to 1 km area around the observation site can be intensively searched the next day. Spotlighting during the fall dispersal may also be a useful time period to make observations.

Live-trapping can also be used as a sample method (Stromberg pers. comm.). Stromberg recommended spacing live-traps at 1.6 km intervals and baiting with bacon. Live-traps combine the greater survey area of scent stations, and the positive record value of spotlight surveys. However, live traps are expensive, hard to transport, and require monitoring. Absence of a swift fox capture can be considered as lack of swift foxes in the area (Stromberg pers. comm.).

REINTRODUCTION

Reintroduction of swift foxes as a means to hasten recovery of extirpated populations has been attempted in two separate areas. The largest and longest running reintroduction program is in Canada. A total of 284 swift foxes have been released in the southern prairies of Alberta and Saskatchewan with releases occurring every year since 1983 (Herrero 1984, Carbyn and Killaby 1989, Herrero et al. 1990). South Dakota conducted the first, but smaller, reintroduction program with the releases taking place in 1980. The initial Canadian effort was patterned after the South Dakota release.

Two basic methods of release have been employed in these reintroduction efforts. The first method used was termed a "soft release" where swift foxes are paired and held in a pen at the release site for an extended period prior to release. In this method, foxes must be supplied with food and water while held captive. The pair may be held on the site long enough to breed and rear pups. After the release, pens are kept in place and are available to the foxes as a den site. In some cases, food is made available at the pen following the release. Many of the animals used in this method have been born and raised in captivity. This method is very labor intensive, requires considerable materials, and has a high cost per fox released.

The other method used for reintroduction is the "hard release" where swift foxes are captured from existing populations in one area, transported to the reintroduction site and released. The animals are handled as little as possible and held a minimum of time with this technique. Labor and material costs per fox released are considerably lower with this technique, but foxes may not stay at the release site.

Survival rate of reintroduced foxes has been low. Sharps and Whitcher (1984) used both captive-raised and wild-trapped foxes for their reintroduction program. Known mortality was 67% for the three captive raised foxes and 50% for the five wild-trapped foxes (fate of one was not determined) within the first year of release. Only one pair remained in the release area indefinitely and raised eight pups the following spring. Both individuals of this pair were wild-trapped. All captive-born and captive-raised animals left the release area within one month, and one moved 203 km before establishing a home range. Sharps and Whitcher (1984) used juvenile foxes for their release and held them in pens up to 1.5 months.

The Canadian reintroduction effort has employed both soft and hard releases. Animals for the soft releases have been both captive-raised and wild-trapped, while those for the hard releases were wild-trapped. Animals used for the soft releases have generally been paired and placed in pens at the release site during winter and released the following spring or summer. In some cases, the pair bred and pups were raised and also released. In the Alberta program, animals were fed at the pen site even after the pens were open. In the Saskatchewan program, animals were not supplied with supplemental food after they were released.

Three of the 17 soft release foxes released in 1984 in Saskatchewan died within 3 weeks of release. It is believed that starvation contributed to their death (Carbyn and Killaby 1989). Road kills, trapping, and shooting were other documented mortalities. By the spring of 1987, only 22% of the 39 soft released swift foxes were known to still be alive. Initial survival of the hard release animals appears to be better than the soft release, however, record mild winter weather may have contributed to this higher survival rate (Carbyn and Killaby 1989). Some reintroduced foxes were known to over-winter and produce pups.

Of the 25 foxes initially released in Alberta in September 1984, 17 were radio-marked, and seven of these died within 9 months, three were missing and seven were grouped in three pairs. Each pair produced a litter (5, 4, and 3) even though they were only one year old. Predation by coyotes and bobcats were the causes of death in six of the seven confirmed mortalities (Herrero pers. comm.).

In the Alberta reintroduction project, the majority (52 of 83) of the soft released foxes stayed in the vicinity of their pens (Herrero et al. 1990). In fact, 52% of the relocations of radio-marked animals were at the release site. In contrast, hard release swift foxes tended to establish a den site away from the release site. The distances, however, were not great. In 1987, radio-marked foxes moved an average distance of 4.5 km before establishing a den. One fox moved 50 km in 13 days before it was shot. Arid conditions existed at the Alberta release site in 1988, and only 4 of 12 radio-marked foxes remained on the study area. These animals moved an average of 8 km before establishing a den site. Herrero et al. (1990) concluded that under favorable climatic conditions with an ample prey base, translocated swift foxes tend to remain in the vicinity of the release site for both soft and hard releases.

In the Alberta release, the mean number of days that radio-marked foxes survived was 273. Thirty-seven foxes survived more than 200 days. Predation was the principal cause of mortality (63%) among recovered swift foxes and coyotes accounted for 63% of the known predation. Golden eagles, bobcats, and undetermined predators accounted for the remainder of the predation (Herrero et al. 1990).

The swift fox is not yet considered established in Canada despite known reproduction, survival of the young, and documented breeding by these wild born foxes (Carbyn and Killaby 1989, Herrero et al. 1990). The Canadian reintroduction program has demonstrated that swift foxes can be successfully released into former range under favorable climatic conditions and with an adequate prey base. The drought of 1988 resulted in dispersal of swift foxes away from the release sites, and increased mortality. This was attributed to a declining prey base. As of yet, the release program has not been tested with a severe winter.

Both Carbyn and Killaby (1989) and Herrero et al. (1990) caution that the prairie biome has been significantly altered and that habitat conditions may no longer favor swift fox survival. The loss of the bison (Bison bison) and wolf from the North American prairie may have been a contributing factor in the loss of the swift fox from its northern range. Bison may have been a constant source of carrion for swift foxes, and wolves selectively preyed upon coyotes keeping their numbers below present day levels. Carbyn (1986) and Herrero et al. (1990) speculate that the swift fox scavenged food at wolf kill sites, much as the arctic fox (Alopex lagopus) does at polar bear (Urus maritimus) kill sites.

Both the South Dakota and Canadian reintroduction efforts involved a pre-reintroduction survey of potential release sites. This consisted of two Master level theses on the part of the Canadians (Carlington 1980, and Reynolds 1983). Sharps and Whitcher (1984) list eight criteria for reintroduction sites used

in their program. These are: 1) available suitable habitat; 2) an adequate food source, preferably prairie dogs; 3) a permanent water source; 4) the absence of a predator poisoning program on, and adjacent to, the ranch chosen as a release site; 5) restriction of any furbearer or predator trapping; 6) release sites a minimum distance of 24.0 km from major roads; 7) hunters having access to the reintroduction area be made aware of the swift fox and be instructed not to shoot them; and 8) coyote or red fox dens in the immediate area would have to be eliminated prior to reintroduction.

Egoscue's (pers. comm.) recommendations concerning a reintroduction were to release swift foxes in the vicinity of recent sightings, release animals only when rabbits are abundant, and control coyotes for several years until the swift fox are established. Research conducted in South Dakota (Hillman and Sharps 1978, Uresk and Sharps 1986, Sharps 1977, Sharps 1989) indicates that black-tailed prairie dogs can serve as a constant prey base. Swift foxes having access to prairie dogs would not face the cyclic phenomenon of a lagomorph prey base, and would not be limited by the lack of carrion as speculated by Herrero et al. (1990). Areas with extensive prairie dog colonies may serve as indicators of suitable habitat for swift foxes.

Sharps (1977) estimated the operating expense of his 5 year swift fox reintroduction/ecology program at \$30,000. Twenty-five percent was provided by the state of South Dakota and 75% by the Federal government. The budget for a similar 5 year swift fox reintroduction/ecology program in Alberta, Canada for the release of 25 foxes was estimated at \$140,000. To date, over \$500,000 have been spent on swift fox reintroduction in Canada.

Swift fox reintroduction is not an inexpensive program. The South Dakota and Canadian experience shows that costs per released animal may exceed \$5,000, require that the program function for up to a decade, and that survival of the swift foxes is low despite the best efforts to assure success.

POTENTIAL MONTANA REINTRODUCTION SITES

Swift fox reintroduction, as evidenced by the Canadian program, may be a long and expensive project with no guarantee of establishing a population. The Montana prairie environment is much changed from pre-historic times in which the swift fox evolved. Species composition and numbers of the original ungulate population is very different and both domestic and wild ungulates are now closely managed with only minimal opportunity for carrion. Large areas of prairie have been converted to small grain agriculture. The gray wolf is gone and the coyote appears to have partly filled its niche. The red fox is now abundant in what was formerly swift fox range. Thus, the prey base, the habitat, and competition are

all much different now than a little more than 100 years ago. All these factors may influence a reintroduction program.

A swift fox reintroduction into Montana is dependent upon determining potential swift fox habitat. Although the original distribution of the swift fox in Montana may never be known, it can be surmised that swift foxes occurred in those regions of the state where short and mid-grass prairies existed east of the continental divide. Historical notes on swift fox distribution in Montana, and its present range distribution would indicate that prairie country with dense sagebrush or irregular topography may be marginal habitat for swift fox. In addition, areas with extensive small grain agriculture tend to support relatively few swift foxes as opposed to native habitat in range areas where the swift fox is still present (Fitzgerald et al. 1983, Stromberg pers. comm.). Thus, agricultural areas may be eliminated as potential reintroduction sites.

Habitat preference of the swift fox may overlap with other prairie wildlife species. These more resilient species which have persisted in Montana may serve as markers of what might be potential swift fox habitat. Rabbits and hares (Sylvilagus sp., Lepus townsendii, and L. californicus) figure significantly in swift fox food habit studies and their presence would be a prerequisite prior to any reintroduction. However, these species may be more widely distributed in habitat preference than the swift fox and could potentially occur in habitats unsuitable for the swift fox.

Further refinement of potential swift fox habitat may be judged by additional associated wildlife species. Fitzgerald et al. (1983) reported the swift fox in northeastern Colorado to use areas frequented by mountain plovers (Charadrius montanus). Mountain plovers select those habitats with level topography and the shortest of short grasses (Knowles et al. 1982). Similarly, swift foxes are documented to feed on black-tailed prairie dogs and den in their colonies (Hillman and Sharps 1978). In general, prairie dogs select for areas with little topographic relief, short grasses, and a sparse shrub layer. Areas with extensive complexes of black-tailed prairie dog colonies (Clark et al. 1987) may be good indicators of potential swift fox habitat.

We know that the swift fox historically existed in the Great Falls - Fort Benton area, and the Blackfoot Indian Reservation. The former area is primarily private land and has been extensively converted to small grain agriculture. The modification of the habitat makes this area undesirable for a swift fox reintroduction. The land ownership pattern also would not be desirable for a reintroduction. The habitat in the latter area is still largely intact and appears to be suitable for a reintroduction. However, the Reservation would present seemingly unique jurisdictional

situations which would add considerably to the complexity of a reintroduction program.

Several other areas within the State may present favorable situations for a swift fox reintroduction and should be considered further. These are: 1) The UL Bend National Wildlife Refuge represents an area of extensive Federal land ownership with no legal trapping on Refuge lands. The habitat in this area appears suitable with the prey base including prairie dogs and rabbits (For additional information on this potential release site see FaunaWest Wildlife Consultants (1986) and U.S. Fish and Wildlife Service (1988).). 2) Areas of recent swift fox sightings (south of Miles City, east of Glendive, and north of Broadus) should be evaluated as possible reintroduction sites. The swift foxes captured at these locations may have come from existing, nearby populations in South Dakota and Wyoming. 3) Although the habitat in the area immediately south of the Alberta/Saskatchewan reintroduction site is largely disturbed by agriculture, the presence of swift foxes immediately north of Montana and the recent observations of swift foxes south of the border suggests that this area should be evaluated for a reintroduction.

A considerable amount of work has been done on laying the ground work for a black-footed ferret reintroduction in Montana. Much of the data collected from this work would be useful baseline information for a swift fox reintroduction program. Moreover, the concepts being developed for the black-footed ferret reintroduction may be directly applicable to a swift fox reintroduction. In all likelihood, the two reintroduction programs would be so similar that they could be managed as sibling programs even though the reintroductions may be temporally and spatially separated.

RECOMMENDATIONS

Two existing swift fox populations (one in South Dakota and one in Wyoming) lie very close to Montana. A third population is in the process of being established immediately north of Montana in Alberta/Saskatchewan. Over the past 12 years, at least four swift foxes have been trapped in Montana. These four records are spatially close to the existing out-of-state populations and could represent dispersing animals or small resident populations. There have also been several unconfirmed sightings which correspond closely to the trapping records. This information provides a basis from which to initiate a Montana swift fox investigation.

It is recommended that before any reintroduction program is started, an effort be made to conduct an intensive survey for swift foxes. This survey effort should be concentrated in those areas of recent swift fox records and sightings. It is possible that one or more existing small populations are already present in the State.

Jerry Choate (pers. comm.), based on his experience with swift foxes and work in Montana, believes that it is highly likely that a swift fox population is already established in Montana south and east of the Yellowstone River. Three prime survey areas fitting Choates' description and corresponding to recent records would be east of Glendive, north of Broadus, and south of Miles City. A fourth area warranting a swift fox survey would be north of Havre adjacent to the area of the Canadian releases.

It is recommended that a survey for swift foxes consist of a modified scent post survey (Linhart and Knowlton 1975). The survey should consist of 50 scent stations checked for 5 nights. Rather than spacing the scent stations at 0.5 km intervals over a 24 km course, they should be selectively placed along gravel and dirt roads at about 1.6 km intervals. The scent stations would only be placed in habitats that appear to be high potential for swift foxes. The actual route for this survey would be established only after making a cursory search of the survey area making note of habitat, roads, and feasibility of the road for inclusion into the route. One survey would be conducted in each of the four geographic regions cited above as potentially containing swift foxes. Late summer-early fall would be the best time period to conduct this survey, both from a biological and meteorological basis. Additional survey work could be conducted concurrent with the scent post survey. This should include interviews with residents of the area, and night-time spotlight surveys along the scent post survey routes.

Prior to conducting scent post surveys for swift fox presence or absence data, Montana Dept. of Fish Wildlife and Parks should consult with their own biologists, Bureau of Land Management, and other interested parties on potential reintroduction sites. Criteria established by Sharps and Whitcher (1984) should be used as a guide for identifying potential reintroduction sites. Available suitable habitat should be considered as two or more townships of prairie habitat with less than 10% of the area disturbed by agriculture. Landform should be level to gently rolling. The area should be dominated by short grasses with only a sparse shrub layer. Habitat suitability for swift foxes at candidate release sites could be evaluated at the same time the scent post surveys are run.

Legalizing the trapping harvest of swift fox in Montana for one or more years would be an inexpensive means of gaining presence/absence data on the swift fox in Montana. With a legal harvest season, fur dealers would be more likely to report swift foxes and incidents such as happened in 1984 (Henckel 1984) would be avoided. With or without the legalization of trapping for swift foxes, fur dealers within the potential range of the swift fox should be questioned annually for the next five years about swift fox furs being bought or sold. Local, state, and Federal animal damage control personnel in this region should also be questioned

concerning their knowledge of swift foxes, and be advised of the importance of reporting sightings and records.

It is recommended that the Dept. of Fish Wildlife and Parks establish a swift fox reporting system similar to that instigated for the gray wolf (Flath 1979, USFWS 1980, Day 1981). Collection and tabulation of these data over a period of years may result in locating isolated populations and document the range expansion of swift foxes in Montana.

ACKNOWLEDGMENTS

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APPENDIX A

LIST OF MONTANA SWIFT FOX SPECIMENS HELD IN MUSEUMS

USNM Number: 108260

Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 24 MAR 1901
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Loc Modifier: KIPP POST OFFICE
Collector: DAWSON, J.
Field Number: NO NUMBER
Remarks: 2905 X
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 108318

Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 08 APR 1901
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Loc Modifier: KIPP POST OFFICE
Collector: DAWSON, J.
Field Number: NO NUMBER
Remarks: 2909 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 108319

Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 28 MAR 1901
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: SKIN GIVEN AS INDEFINITE LOAN TO MAMMAL
CONTROL SUPERVISOR, AMHERST, MASS.
Sex: ♀
Preparation: SKULL ONLY

USNM Number: 116560

Locator: FRV
Bldg / Area: FUR VAULT
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: -- MAR 1901
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Loc Modifier: KIPP POST OFFICE
Collector: DAWSON, J.
Field Number: NO NUMBER
Remarks: 3502 X
Sex: ?
Preparation: SKIN ONLY

USNM Number: 116561

Locator: FRV
Bldg / Area: FUR VAULT
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX

Date Coll: -- MAR 1901
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Loc Modifier: KIPP POST OFFICE
Collector: DAWSON, J.
Field Number: NO NUMBER
Remarks: 3503 X
Sex: ?
Preparation: SKIN AND SKULL

USNM Number: 145874

Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 20 NOV 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 5690 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 145875

Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 20 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MUNROE, G. J.
Field Number: NO NUMBER
Remarks: 5619 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 145877

Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 23 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MUNROE, J. K.
Field Number: NO NUMBER
Remarks: 5693 X
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 146311

Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 17 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 1
Remarks: 5761 X
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 146312

Family Code: 6010

Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 28 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 2
Remarks: 5762
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 146313
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 24 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 161
Remarks: 5766 X
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 146315
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 06 JAN 1906
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 11
Remarks: 5771 X
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 146316
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 10 JAN 1906
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 14
Remarks: 5774 X
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 146317
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 15 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 3
Remarks: 5763 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 146318
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 30 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 4
Remarks: 5764 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 146319
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 31 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 5
Remarks: 5765 X SKULL MISSING
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 146320
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: -- -- -- --
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, G. G.
Field Number: 7
Remarks: 5767 X SKULL MISSING
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 146321
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 23 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 9
Remarks: 5769 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 146322
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 07 JAN 1906
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 10

Remarks: 5770 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 146323
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 14 JAN 1906
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: BLACKFOOT
Collector: MONROE, J. B.
Field Number: 12
Remarks: 5772 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: A04213
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: -- -- -- --
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
Specific Loc: FORT BENTON
Collector: MULLAR
Field Number: 1056
Sex: ?
Preparation: SKULL ONLY

USNM Number: 130059
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 20 OCT 1903
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 4656 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 133091
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 18 JUN 1904
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 4633 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 133092
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 19 JUN 1904
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.

Field Number: 2
Remarks: 4634 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 133093
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 20 JUN 1904
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.
Field Number: 3
Remarks: 4635 X
Sex: ?
Preparation: SKIN AND SKULL

USNM Number: 133094
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 20 JUN 1904
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.
Field Number: 4
Remarks: 4636 X
Sex: ?
Preparation: SKIN AND SKULL

USNM Number: 135129
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 20 OCT 1904
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 4985 X
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 136566
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 17 MAR 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 5192 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: 139185
Family Code: 6010
Family: CANIDAE
Genus: VULPES
Species: VELOX
Subspecies: VELOX
Date Coll: 01 AUG 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA

3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 5612 X
Sex: ♀
Preparation: SKIN ONLY

USNM Number: 139186
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: 27 AUG 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 5613 X
Sex: ♂
Preparation: SKIN ONLY

USNM Number: 139187
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: 03 AUG 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 5615 X
Sex: ♂
Preparation: SKIN ONLY

USNM Number: 145876
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: 22 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MUNROE, M.
Field Number: NO NUMBER
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 146226
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: 04 NOV 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MUNROE, J. K.
Field Number: NO NUMBER
Remarks: 5681 X
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 146227
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: 07 NOV 1905

1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MUNROE, J. K.
Field Number: NO NUMBER
Remarks: 5682 X
Sex: ♂
Preparation: SKIN AND SKULL

USNM Number: 146228
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: -- WIN 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP
Collector: MUNROE, J. K.
Field Number: NO NUMBER
Remarks: 5559 X
Sex: ?
Preparation: SKIN AND SKULL

USNM Number: 146564
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: -- --- 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: UPPER TETON COUNTY
Specific Loc: KIPP
Collector: LANTZ, D. E.
Field Number: NO NUMBER
Remarks: 5784 X
Sex: ?
Preparation: SKULL ONLY

USNM Number: 146373
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: -- MAY 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP, [UPPER TETON COUNTY]
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 5556 X
Sex: ?
Preparation: SKIN ONLY

USNM Number: 146563
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: -- --- 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP, [UPPER TETON COUNTY]
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 5783 X
Sex: ?
Preparation: SKULL ONLY

USNM Number: 147597
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*

Species: *VELOX*
Subspecies: *VELOX*
Date Coll: -- MAY 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP, [UPPER TETON COUNTY]
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 5556 X
Sex: ?
Preparation: SKIN ONLY

USNM Number: **147767**
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: -- --- 1904
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: KIPP, [UPPER TETON COUNTY]
Collector: MONROE, J. B.
Field Number: NO NUMBER
Remarks: 5558 X
Sex: ?
Preparation: SKIN AND SKULL

USNM Number: **146324**
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: 20 DEC 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: UPPER TETON COUNTY
Collector: MONROE, J. B.
Field Number: 13
Remarks: 5773 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: **146325**
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: 25 JAN 1906
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: UPPER TETON COUNTY
Collector: MONROE, J. B.
Field Number: 15
Remarks: 5775 X
Sex: ♀
Preparation: SKIN AND SKULL

USNM Number: **146372**
Family Code: 6010
Family: CANIDAE
Genus: *VULPES*
Species: *VELOX*
Subspecies: *VELOX*
Date Coll: 28 JUN 1905
1st Geo Div: UNITED STATES
2nd Geo Div: MONTANA
3rd Geo Div: TETON COUNTY
Specific Loc: UPPER TETON COUNTY
Collector: MONROE, J. B.
Field Number: 1
Remarks: 5555 X
Sex: ♀
Preparation: SKIN ONLY