SPECIES ASSESSMENT FOR SWIFT FOX (*VULPES VELOX*) IN WYOMING

prepared by

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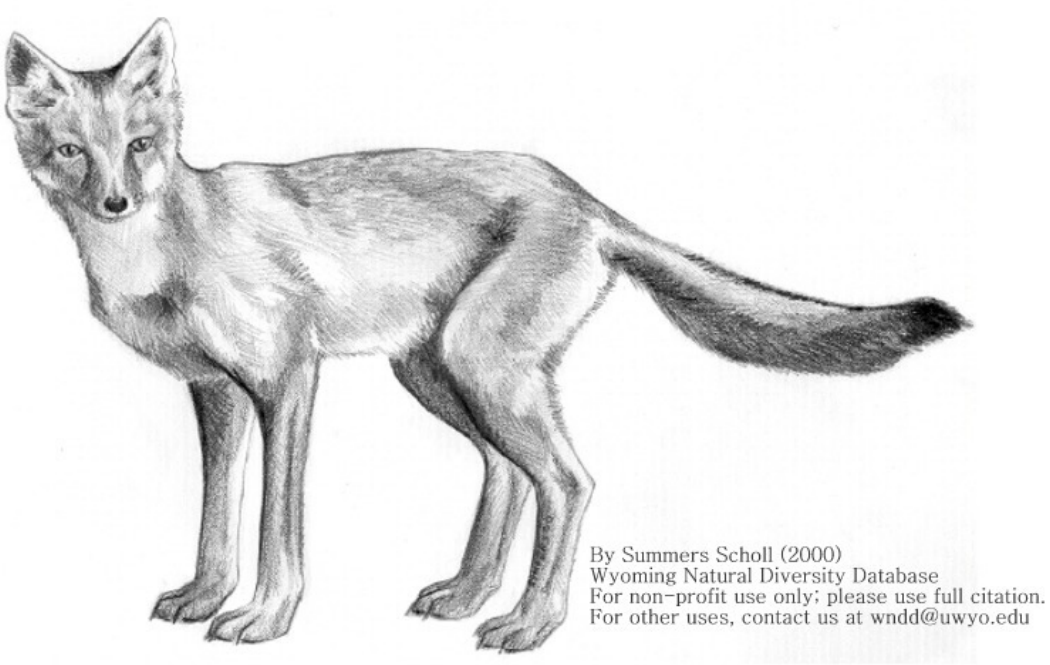

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Introduction

The swift fox (*Vulpes velox)* is the smallest of all canids (with adults reaching the size of a house cat) (Clark and Stromberg 1987), and is adapted to living in prairie regions (Egoscue 1979). These small and curious foxes get their name from their speed, which tops out around 25-35 miles per hour over short distances (Chambers 1978, Stewart 1999). Swift foxes are known to be naïve, and vulnerable to trapping, due to their curious nature (Stewart 1999). At one time the swift fox was common over most of the area that was then covered by short-grass and mid-grass prairies, and their range may have extended as far east as western Iowa (Allen, 1870-add) and Minnesota (Swanson *et al*. 1945). However, less than 50 years after settlement of the area began, conversion of the prairie to farmland, overgrazing by livestock, and poisoning campaigns aimed at wolves, had reduced swift fox numbers greatly (Egoscue, 1979). Then for reasons not fully understood, swift fox populations began to slowly recover in the mid 1950's in certain areas (Egoscue, 1979), and have since seemed to keep increasing slowly in most of the historical range.

The Wyoming Game and Fish Department feels the 1972 ban on the compound 1080 (sodium monofloroacetate) may be partly responsible for the rebounding swift fox population (Skinner 1986). The compound was used in large poisoning campaigns across the west and aimed at killing canids, especially coyotes. Skinner (1986) says that the recovery and expansion of swift fox in Wyoming first became obvious 8 years after 1080 was banned.

The swift fox is considered uncommon in Wyoming. However, since 1990 many surveys have shown them to be more common than previously thought. They can be found in the southeastern corner of the state where they are most common, as well as in areas of south-central and

southwestern Wyoming. They seem to be expanding in abundance and range, as populations recover from incidental poisonings in the mid 1900's.

Natural History

Morphological Description

The swift fox is the smallest of all canid species, as adults are only about the size of a house cat (Clark and Stromberg 1987). An adult male stands 30-32 cm at the shoulders and can range from 80-84 cm in length (Scott-Brown *et al*. 1987, Carbyn 1998). Other recorded swift fox measurements are 28 cm for length of the tail, 3 cm for length of hind foot, and 0.8 cm for length of ear (Carbyn 1998). Males are slightly larger than females weighing 2.4 kg (5.4 pounds) on average versus 2.3 kg (5.0 pounds) on average for females (Scott-Brown *et al*. 1987). Both sexes show the same pelage coloration. The winter coat of the swift fox is a dark buffy gray across the back extending into a yellow-tan coloration on the sides, legs, and ventral surface of the tail (Scott-Brown *et al*. 1987) (Figure 1). The posterior portion of the back appears to be grizzled due to the presence of conspicuous black and white guard hairs (Scott-Brown *et al*. 1987). The throat, chest, and belly are pale yellow to white (Clark and Stromberg 1987). The summer pelage is shorter and may be rufous in coloration (Scott-Brown *et al*. 1987). The swift fox has a black tip on its tail and black fur on the sides of its muzzle (Scott-Brown *et al*. 1987) (Figure 1).

The swift fox can be distinguished from all other North American foxes, except the kit fox, by its small size and black-tipped tail (Scott-Brown *et al*. 1987). The swift fox can be distinguished from the kit fox (*Vulpes macrotis*) by its shorter and more widely spaced ears, its shorter tail, and its more rounded and doglike head (compared with the broader head and narrower snout of the kit fox) (Egoscue 1979).

The diploid number of swift fox is 50, which includes 4 pairs of large metacentrics, 20 pairs of submetacentrics, and the sex chromosomes (Scott-Brown *et al*. 1987). The dental formula of the swift fox is: incisors, 3/3; canines, 1/1; premolars, 4/4; molars, 2/3; a total of 42 teeth (Scott-Brown *et al*. 1987). The swift fox has an elongated skull with small widely spaced teeth (Carbyn 1998). Skull sizes from male Colorado swift foxes were measured to be 112 m, zygomatic breadth (64mm) and interorbital constriction (24mm), post orbital constriction (23mm) (Carbyn 1998).

Taxonomy and Distribution

Taxonomy

There are 3 species in the genus *Vulpes*; *V. vulpes* (red fox), *V. macrotis* (kit fox), and *V. velox* (swift fox). The taxonomic status of the swift fox and the closely related kit fox has long been confused and under review (Scott-Brown *et al*. 1987, Dragoo *et al*. 1990, Mercure *et al*. 1993). Although taxonomic arguments still exist at this time, most systematists now agree in favor of separate specific status for the swift fox and kit fox (Thornton and Creel 1975, Egoscue 1979, Mercure *et al*. 1993). Electrophoretic studies of serum proteins and hemoglobin have shown that the swift fox is distinct from the kit fox (Thornton and Creel 1975). Mercure *et al.* (1993) conducted mitochondrial DNA tests and found that the genetic variation between the two foxes was large, and similar to that of small rodents with limited dispersal capabilities. They also found two distinct groupings of genotypes, separated by the Rocky Mountains and corresponding to the traditionally designated kit fox and swift fox populations (Mercure *et al.* 1993).

The swift fox is regarded as conspecific with the kit fox (*Vulpes macrotis*) by Dragoo *et al*. (1990). Dragoo *et al.* (1990) proposed reclassifying the swift and kit foxes as a single species (*Vulpes velox*) with two recognized subspecies (*Vulpes velox velox* – swift fox, and *Vulpes velox*

macrotis – kit fox). Dragoo et al. (1990) based their recommendations on morphometric findings and results from a protein-electrophoretic study that showed that genetic divergence was negligible with a high degree of genetic similarity among all subspecies examined. Jones *et al.* (1992, 1997) and Hall (1981) concurred in treating *V. velox* and *V. macrotis* as conspecific.

There is also some confusion regarding the separation of the swift fox into two subspecies, *Vulpes velox hebes* and *Vulpes velox velox* (Scott-Brown *et al*. 1987). *V. v. hebes*, the northern subspecies, was first described from 6 specimens collected near Calgary, Alberta (Merriam 1902). In 1979 the U.S. Fish and Wildlife Service listed this northern subspecies as an endangered species, but this only lasted until 1982, when it was delisted because it was determined by Stromberg and Boyce (1986) that valid subspecies variation did not exist. Stromberg and Boyce (1986) used multiple discriminant analyses of cranial and dental features, but could find no differences to warrant the subspecific status of *V. velox*, even though there is significant geographic variation between the northern and southern populations. Given the low numbers of swift foxes currently present in the United States, it may never be possible to resolve the status of these possible subspecies (Scott-Brown *et al*. 1987). The confidence for the subspecies designations of the swift fox and for the validity of the range boundaries between the southern and northern populations is moderate.

Both the swift fox and kit fox are native in Colorado, New Mexico, and Texas (Egoscue 1979). Kit foxes can be found in some western counties in Colorado while swift foxes are found over much of the central and eastern plains in the state (Eussen 1999). It is still in question if these foxes may be hybridizing in extreme western Colorado. Mercure *et al.* (1993) found locality-specific genotypes in the swift foxes from Colorado.

Swift fox in Wyoming are clearly *Vulpes velox*, and do not seem to be affected by genetic introgression with forms of *Vulpes macrotis* (Beauvais 2000). Mercure *et al.* (1993) found through mitochondrial DNA tests that the swift foxes from Wyoming had locality-specific genotypes that showed these foxes were specific to Wyoming locations.

North American Distribution

Originally the swift fox was found in the central plains of North America from southern Alberta and Saskatchewan to central Texas, and from the eastern edge of the Great Plains west to the Rocky Mountains (Egoscue 1979). Their present day range is much restricted and consists of various disjunct populations (Beauvais 2000) (Figure 2 – shows the historical range of the swift fox as a dashed green line). Kahn *et al.* (1997), estimated that based on vegetation mapping, the swift fox inhabits 40% of its former range in the U.S. Based on the current swift fox range-wide distribution information, the Fish and Wildlife Service (Federal Register 1995) estimates that the swift fox is extirpated from 80% of its historical range, and they estimate that of the remaining 20% of suitable range, they may only occupy half. The swift fox has been extirpated from Canada and appears to be absent from North Dakota, and remnant populations exist in Montana and western Nebraska (Carbyn 1998, Federal Register 1995). Populations of swift foxes can be found in western South Dakota, southern and eastern Wyoming, western Kansas, western Oklahoma, eastern and northern Colorado, and northwestern Texas, and eastern New Mexico (Federal Register 1995) (Figure 2). The best remaining populations are in southeastern Wyoming, eastern Colorado, and western Kansas (Beauvais 2000). Reintroduction programs in Canada and Montana have established wild populations, but the fate of these populations is still in question. Mercure *et al.* (1993) conducted mitochondrial DNA tests that confirmed the hypothesis that there is a zone of hybridization between *V. velox* and *V. macrotis* in the Pecos River drainage area of eastern New

Mexico and the western panhandle of Texas (Dragoo *et al*. 1990, Rowher and Kilgore 1973) (Figure 2 – this are of range overlap is shown in purple and green stripes).

Wyoming Distribution

Wyoming is on the western periphery of the swift fox's historical range. The swift fox's current distribution in Wyoming has changed little from historical times (Lindberg 1986). Swift fox in Wyoming are generally found in the southeastern corner and the south-central portion of the state (Clark and Stromberg 1987, Long 1965, Wooley *et al*. 1995) (Figure 3). They are occasionally documented in southwestern Wyoming as well (Wooley *et al*. 1995). Woolley *et al*. (1995) suggested that the current swift fox population in Wyoming occurs in primarily three geographic regions: the Laramie Valley and Shirley Basin in Albany and Carbon counties; the Southeastern Plains in parts of Laramie, Platte, and Goshen counties; and the Powder River Basin in parts of Converse, Natrona, Weston, and Niobrara counties. This distribution in the state reflects the areas of best swift fox habitat in the state.

WYNDD has a total of 213 swift fox records, and of these, 141 are considered to be current (less than 10 years old), and 72 are considered historical (Figure 3). There are a total of 71 breeding records for the state, 48 of which are current. There are 142 non-breeding records for the state, 93 of which are current. The increase in the number of swift fox records in the state within the last 10 years is likely due to the increased search efforts that occurred after the swift fox was proposed for listing in 1995.

Habitat Requirements

Year-round Habitat

The swift fox is native to the grassland prairies in the Great Plains region of North America (Kahn *et al.* 1997). The swift fox prefers open and flat prairies and arid plains with flat to rolling

terrain and sparse vegetation (Kilgore 1969, Banfield 1974, Hillman and Sharps 1978, Carbyn 1998). They sometimes inhabit plains and prairie areas that are intermixed with winter wheat fields (Banfield 1974). Some studies in Kansas have shown that although swift foxes will inhabit croplands, they seem to thrive better in rangelands. Matlack *et al.* (2000) found that swift foxes in Kansas that occupied rangelands were larger, and in better condition than those found in croplands. Current and historic swift fox range is dominated by short-grass prairie. On the western periphery of their range, swift fox occur in areas with substantially more shrubs, such as sagebrush, and greasewood (Kahn *et al*. 1997, Olson 1999). Swift fox have also been documented in areas that are considered to be non-typical habitat, such as Badland-like areas in Wyoming (Lindberg 1986), the sandhills of Nebraska (Blus *et al.* 1967), pinon-juniper habitat in Colorado (Covell 1992), and cultivated areas adjacent to shortgrass prairies (Floyd and Stromberg 1981). The swift fox likely chooses areas with long sight-lines, therefore avoiding vegetation and topographic features like canyons, steep hills, dense shrub, and forests (Carbyn 1998). The preferred habitat types and conditions appear to provide the best opportunities for avoidance from predators, or visibility and mobility from predators. The confidence rating for knowledge of habitat use by the swift fox rangewide is high.

In Canada and the northern United States, swift foxes seem to favor native grasslands over cultivated farmlands, possibly due to the availability of food (Carbyn 1998). The dominant vegetation in these northern areas are pasture sage (*Artemisia frigida*) and grasses, such as blue gramma *(Bouteloua gracilis*), spear grass (*Stipa comata*), and fescue (Festuca spp.) (Carbyn 1998).

Swift foxes live in the same habitat year-round, in underground burrows called dens. Swift foxes are the most den-dependent of all canids in North America (Carbyn 1998). They generally

place their burrows in sandy soil on areas of high ground (on top of hills) with good views of the surrounding landscape (Pruss 1999). Swift foxes generally prefer firm friable soils that are suitable for excavation of den sites (Hines and Case 1991, Kahn *et al.* 1997). During a study of selection of natal den sites by swift fox in Canada found that occupied den sites were predominantly on the tops of hills with a gradual slope, and that this variable may be a useful tool for selecting and modifying suitable release sites for swift foxes (Pruss 1999). Swift foxes can dig their own burrows, but they also use burrows made by other mammals (e.g., prairie dogs and badgers) (Hillman and Sharps 1978, Fitzgerald, *et al.* 1983, Uresk and Sharps 1986). During periods of inactivity swift fox usually stay in their burrows. Swift fox young are born in dens approximately 1 meter beneath the grounds surface (Banfield 1974). The swift fox is known to use multiple den sites throughout the year, and any disturbance can cause them to move to a new den (Carbyn 1998). Their dens range from a simple one-way tunnel to a complex of system of channels and chambers as deep as 4-6 feet with as many as 6 entrances (Kilgore 1969, Hillman and Sharps 1978, Fitzgerald *et al.* 1983). The swift fox prefers to den on top of hills to allow drainage, and place their entrances among tall grass or shrubs for screening cover and the high insect abundances there (Olson 1999, Pruss 1999). Den sites are generally placed in areas near a permanent water source and low predator abundance (Carbyn 1998). However, Pruss (1999) disagrees with this theory and suggests that swift foxes may select den sites farther away from water sources in order to minimize encounters with coyotes, which have a high physiological demand for water. A study of swift foxes in Nebraska showed that 68% of dens were located within 230 meters of a road, and swift foxes radio-located during the study were within 1 km of roads 66% of the time (Hines and Case 1991). An analysis of swift fox den sites conducted in New Mexico showed that swift foxes select den sites in close proximity to prairie dog towns, in areas devoid of residential structures, with predominantly loam or clay-loam soil texture, and

relatively high road densities (Kintigh 1999, Pruss 1999). Jackson and Choate (2000) studied den sites of the swift fox in rangelands and croplands in Kansas and they concluded that den sites in these two habitats were nearly identical. This led them to suggest that "the swift fox is capable of exploiting resources available in a patchwork environment of natural and cultivated habitats" (Jackson and Choate 2000).

Swift fox habitat in Wyoming is much the same as described above. Much of the swift fox's habitat in Wyoming has relatively high densities of shrubs such as sagebrush and greasewood, in comparison to the typical shortgrass prairie habitat found elsewhere (Wooley *et al*. 1995, Olson 1999). Olson and Lindzey (2002) investigated swift foxes in a transition zone between shortgrass prairie and sagebrush shrub steppe plant communities (non-typical swift fox habitat) in southeastern Wyoming. Plant communities at the site primarily consisted of graminoids, but were also interspersed with patches of big sagebrush (*Artemisia tridentata*), greasewood (*Sarcobatus vermiculatus*), and saltbush (*Atriplex gardneri*) (Olson and Lindzey 2002). The main grasses at the site were buffalograss (*Buchloe dactyloides*), blue gramma (*Bouteloua gracilis*), needle-and-thread (*Stipa comata*), western wheatgrass (*Agropyron smithii*), and prairie junegrass (*Koeleria macrantha*) (Olson and Lindzey 2002). The confidence rating for knowledge of habitat use by the swift fox in Wyoming is high.

Territoriality and Area Requirements

The swift fox is a prairie-dwelling species that requires 518 hectares to 1,296 hectares (1,280 – 2,300 acres) of short to midgrass prairie habitat with abundant prey to support a pair of foxes (Jones *et al.* 1997, Rongstad *et al.* 1989). Home ranges of seven adults in Nebraska averaged 32.3 km^2 (Hines and Case 1991), although this estimate is significantly larger than others found in the

literature. The mean overall home range size of 73 swift foxes trapped on the Pinon Canyon Maneuver Site in southeastern Colorado was 7.6 km^2 (Kitchen *et al.* 1999).

In Wyoming, home-ranges (x $\pm$ SE, n=10) averaged 11.7$\pm$1.3 and 7.7$\pm$1.1 km^2 using the 95% adaptive kernel method and the 100% minimum convex polygon, respectively (Pechacek *et al*. 2000). The home-ranges of males seemed about 25% larger than that of females, and core areas (50% utilization distribution) consisted of 1 or 2 polygons and averaged 19.0$\pm$2.6% of the total home-range area (Pechacek *et al*. 2000). Home-range overlap of paired foxes was significantly greater than range overlap of unpaired animals, and paired foxes shared more than 70% of their dens (Pechacek *et al*. 2000). 75% of one foxes total number of dens, were located within that individual's core area (Pechacek *et al*. 2000). In a study done near Medicine Bow, swift fox pairs occupied nearly exclusive home ranges, indicating territorial behavior (Olson 2000b).

Landscape Pattern

Swift fox habitat is comprised of level to gently sloping topography containing an open view of the surrounding landscape (< 15% slope), abundant prey, and lack of predators and competitors (Cutter 1958, Hillman and Sharps 1978, Hines 1980, Lindberg 1986, Carbyn *et al.* 1993). The key to a healthy landscape pattern is to provide suitable habitats where swift fox can obtain prey, while avoiding predators (Kahn *et al.* 1997). Management agencies need to provide a large enough area (1,280 – 2,300 acres) of suitable habitat to provide a good prey base, within a close proximity to den sites, in order for the foxes to avoid predation. A good landscape mosaic would have several suitable den sites in open, prairie habitat. Swift foxes are known to avoid creek drainages, greasewood vegetation, bare/rocky terrain, and clayey-sandy soils in southeast Wyoming (Olson 2000b).

Movement and Activity Patterns

Migration, Dispersal, and Home Range

The swift fox does not migrate per se. Swift fox are considered good dispersers although quite little is known concerning natal dispersal activities (Kahn *et al.* 1997) and home range fidelity (Brown et al. 1987). In one study, dispersal distances for adult swift foxes averaged 11 km, with an observed maximum distance of 64 km (Mercure *et al*. 1993). Although swift foxes are large enough to overcome most barriers to dispersal, Mercure *et al.* (1993) suggest that their relatively low dispersal distances may be a result of their high habitat specificity. This habitat specificity may restrict their dispersal relative to slightly larger, fox-like canids that are habitat generalists (Mercure *et al*. 1993). Swift fox may range over several square kilometers during a single night, while foraging. In Laramie County, Wyoming, Clark and Stromberg (1987) noted that swift foxes covered 8-10 square km during a night and moved at a speed of 3-4 km/hour.

Phenology

Swift fox are nocturnal, although they may rest in the sun outside their burrows during the day (Clark and Stromberg 1987). Swift foxes are crepuscular and generally hunt at sunrise and sunset (Carbyn 1998). Activity periods commenced between 6 and 10 PM and ceased between 3 and 6 AM (Hines and Case 1991). Hines and Case (1991) found that swift fox traveled an average of 13.1 km for each of 47 nights that they were radio-tracked. The hourly distance traveled averaged 1.2 km during activity periods (Hines and Case 1991). Covell *et al.* (1996) determined that swift fox traveled an average of 18.5 km/day during their nighttime activity periods in winter. The also found that locomotion costs accounted for at least 21% of a swift foxes total daily energy expenditure (Covell *et al.* 1996). Hines and Case (1991) determined that swift foxes are more active at night and that only females with pups moved during daytime hours. Kintigh (1999) suggested that roads may be important travel routes for swift fox.

Reproduction and Survivorship

Breeding Behavior

Swift foxes usually mate for life in a monogamous relationship, and form pair bonds in early winter (Kahn *et al.* 1997, Carbyn 1998). However, there have been numerous observations of den sharing, and burrows containing one male and two females (Kilgore 1969, Covell 1992, Carbyn 1998). Foxes are considered a mated pair when a male and female were found using the same dens and home range (Olson and Lindzey 2002). Sex ratios are not known for certain, but are thought to be 1:1. Production of young in swift foxes is likely related to prey abundance, as it is with the kit fox (Olson and Lindzey 2002). Parental care is overseen by both parent's, and the male swift fox is extremely important in raising the pups (Stewart 1999). Stewart (1999) documented several cases where the female died and the male partner continued to raise the pups.

Swift foxes do not necessarily require undisturbed breeding sites, however they probably benefit from having breeding sites that remain undisturbed. Swift foxes are known to have multiple den sites that they use on a regular basis (Carbyn 1998), and if one den is disturbed the swift fox will move their young to another den (Carbyn 1998). Disturbances to breeding sites can cause swift foxes to move to new den and this puts them at risk of predation, so undisturbed breeding sites are best.

Breeding Phenology

Female swift foxes area monestrous, with estrous occurring from late December to February depending on latitude (Kilgore 1969, Hines 1980, Carbyn 1998). The gestation period lasts 7 to 8 weeks (approx. 55 days), and most litters are born in February or March in southern portions of the range (Egoscue 1979), and from mid April to June in Canada and northern portions of the range (Carbyn 1998). At about 2 weeks of age the pups weigh 200 grams and their eyes and ears are open (Carbyn 1998), and the pups emerge from the den when they are 4 weeks old. Pups are

usually fully weaned by 6 weeks, and they reach their adult weight by mid-summer (Carbyn 1998). Young usually remain with the family group until late August and dispersal begins in September and October (Kahn *et al.* 1997).

The year can be divided into 3 biological periods corresponding to the reproductive biology of adult swift foxes (Kitchen *et al*. 1999): pup-rearing (May-August), dispersal (September-November), and pair formation (December-March). This information may prove beneficial for managers planning monitoring actions in swift fox habitats because it would allow them to know when the best time is to survey swift fox populations. It is likely that the best time to survey swift fox populations would be from May through August, during the pup-rearing phase.

In Wyoming swift foxes appear to mate in April or May, and pups begin to emerge from the den from mid-June through July (Olson and Lindzey 2002). The mean minimum litter size in a study done near Medicine Bow, was 4.6 foxes (for 19 litters) (Olson and Lindzey 2002).

Fecundity and Survivorship

The swift fox produces one litter of pups per year (Kilgore 1969). Litter size usually ranges from 3-6 pups (Egoscue 1979), but Olson *et al*. (1997) observed litters ranging from 3-10 pups in southeastern Wyoming. However, this upper limit may have been 1 adult female tending to 2 litters (Olson *et al*. 1997). The mean minimum number of young observed by Olson during his study was 4.6 young per litter (Olson 2000b). Parturition (the act of giving birth) occurs from March to May (Kilgore 1969, Pruss 1994) and is likely influenced by latitude (Hillman and Sharps 1978). Pups first emerge from the den at about 1 month of age. Pups first emerge from the den around June 1 in Wyoming (Olson *et al*. 1997). The young are tended by both sexes, and disperse in late summer or early fall. Swift fox are considered adults by their first December (Kitchen *et al*. 1999), and are able to breed in their first year of life. However, not all first year vixens will breed

(Kahn *et al.* 1997, Carbyn 1998). A documented annual mortality rate for juveniles in western Kansas was found to be 0.67 (Sovada *et al.* 1998). Estimates of offspring survivorship are not well known at this time.

Average documented litter sizes: Colorado 2.9 (Covell 1992), 1.6 (Fitzgerald and Roell 1995), 3.4 (Kahn and Beck 1996), and 3.4 (O. J. Rongstad *et al*. 1989); South Dakota 4 (Hillman and Sharps 1978); Canada 3.9 (Brechtel *et al*. 1993).

At the Medicine Bow study site, the mean minimum number of young observed per litter for 19 swift fox pairs, plus an additional 6 litters observed outside the study area, was 4.6$\pm$ 0.4 SE (95% CI = 3.8-5.3, n = 25) (Olson and Lindzey 2002). Mean annual survival rate of adult foxes at this site for 3 years was 0.58. The annual mortality rate at this study site ranged from 0.31 to 06.60 and predation by coyotes accounted for 73% of known mortalities (Olson 2000b). 79% of fox pairs in this study produced young (Olson and Lindzey 2002).

A swift fox in captivity can live up to 14 years, but in the wild they are lucky to survive half that long (Stewart 1999).

Documented annual survival rates: Pinyon Canyon Maneuver Site, Colorado 0.52 for adults and 0.05 for pups (Rongstad *et al.* 1989), and Covell (1992) for pups and adults (including yearlings) was 0.53, and for adult foxes was 0.64 (Kitchen *et al*. 1999); Kansas 0.43 for adults (Sovada *et al*. 1998); Montana 0.46 for adults (Zimmerman 1998).

Documented annual mortality rates: western Kansas, 0.55 for adults and 0.67 for juveniles (Sovada *et al.* 1998); Colorado 0.47 for adults and pups (Covell 1992), 0.43 for adults (Roell 1999).

Population Demographics

Limiting Factors

There are some factors that may limit population growth of the swift fox. The availability of adequate den sites may be a primary factor limiting swift fox distribution and population growth (Kintigh 1999). The abundance of prey items is also a major factor that contributes to swift fox survival and overall health (Kintigh 1999). Perhaps the most significant factor that may limit swift fox population growth is high mortality rates from predation, or competition by coyotes.

Metapopulation Dynamics

Given the somewhat patchy distribution of the swift fox and the isolated populations that are being reintroduced in Canada, Montana, and South Dakota, it is possible that a metapopulation structure exists within the greater North American population. However, we are aware of no studies investigating the possible metapopulation dynamics of swift fox populations, so there is no information on what geographic or temporal parameters might define such a system.

Genetic Concerns

Mercure *et al.* (1993) conducted mitochondrial DNA tests that confirmed the hypothesis that there is a zone of hybridization between *V. velox* and *V. macrotis* in the Pecos River drainage area of eastern New Mexico and the western panhandle of Texas (Dragoo *et al*. 1990, Rowher and Kilgore 1973). There may also be hybridization in other areas where the two species' ranges overlap, such as in Colorado, but this is still in question at this time. The primary barrier obstructing gene flow in kit-swift foxes is the Rocky Mountains (Mercure *et al.* 1993). The Colorado River may also be an important barrier to gene flow between these two species (Mercure *et al.* 1993). Because of low population numbers in some areas, inbreeding depression was a concern at one point, but does not seem to be an issue any longer. There were also some concerns during the captive breeding program in Canada because foxes from as far south as Colorado were

being used in the captive breeding programs, and some researchers felt that interbreeding these foxes with the northern foxes may cause the loss of genetic adaptation to the rigors of northern environments (Stromberg and Boyce 1986).

The Swift Fox Conservation Team has an ongoing plan in which members on a technical committee are to investigate the genetic integrity of the U. S. swift fox population by 2005 (Kahn *et al.* 1997). The committee is conducting periodic testing and analysis of genetic variation among the state populations. This effort will validate the basis of the metapopulation concept to ensure species persistence.

Food Habits

Food items

The swift fox diet includes various small mammals (e.g., jackrabbits, cottontails, ground squirrels, prairie dogs, mice), birds, invertebrates, and small amounts of vegetable matter such as grasses and berries (Cutter 1958, Kilgore 1969, Hines and Case 1991, Carbyn 1998, Sovada *et al.* 2001, Zumbaugh *et al.* 1985). Small mammals (especially *Sylvilagus* spp.) and insects seem to comprise the bulk of the swift fox's diet, but they opportunistically prey on a variety of food sources (Cutter 1958, Scott-Brown et al. 1987, Carbyn 1998, Sovada *et al.* 2001, Zumbaugh *et al.* 1985). Mammals and insects comprised the bulk of prey items found in swift foxes from Nebraska (Hines and Case 1991). Jack rabbits (*Lepus townsendii*) are the largest prey species in Canada, where black-tailed prairie dog (*Cynomys ludovicianus*) distribution is very limited (Carbyn 1998). Ground squirrels (*Spermophilus* spp.) are likely an important seasonal prey item in Canada, and may be elsewhere as well (Carbyn 1998). A number of studies (Cutter 1958, Egoscue 1962, Kilgore 1969, Zumbaugh *et al.* 1985) support the importance of lagomorphs in the diet of the swift fox.

In a study done near Medicine Bow, Wyoming, diet differed with respect to prey availability and among fox pairs, indicating that the foxes have an "opportunistic predatory" behavior (Olson 2000b). Clark and Stromberg (1987) noted that swift foxes in Laramie County, Wyoming ate horned larks, jack rabbits, and deer mice during winter months, ground squirrels in the spring when they emerge from their dens, and beetles, small mammals, and grasshoppers during the summer and fall. Floyd (1983) speculated that swift fox in Wyoming also eat cottontail rabbits and ground dwelling birds such as lark buntings and western meadowlarks.

Foraging Strategy

"Predation by swift foxes seems to be random and non-selective" (Kilgore 1969). Swift foxes are opportunistic, solitary predators and eat a variety of prey items, including carrion when it is available (Egoscue 1979). The swift fox is known to cache excess food under snow during the winter (Banfield 1974). Much work needs to be done on the foraging behavior of swift foxes, especially in northern portions of their ranges. Swift foxes are primarily nocturnal, and are nocturnal to a higher degree during winter months (Carbyn 1998). The onset of activity for swift foxes appears to be correlated with light (sunrise and sunset), but it varies with temperature. Swift foxes likely travel along predictable routes, such as fence lines, ridges, cattle trails, and roads in foraging trips through their home ranges (Carbyn 1998). Pruss (1994) found that during the spring and summer months, swift foxes are active over extended periods during both the day and night. Swift foxes in Canada and northern portions of their range switch their food requirements from winter to summer based on the availability of prey (Carbyn 1998). Young foxes are also known to forage more on readily accessible prey items, such as insects (Carbyn 1998).

Foraging Variation

Swift fox are opportunistic and therefore will eat whatever they can find. During winter months foxes probably seek out appropriate microenvironments with high concentrations of voles, mice, and insects within the prairie ecosystem (Carbyn 1998). Sovada *et al.* (2001) conducted a study of seasonal food habits of swift foxes in cropland and rangeland landscapes in western Kansas and found that variation in diet between the two areas was most likely due to the opportunistic foraging behavior of the swift fox, resulting in a diet that closely links prey use with availability. This study showed no differences between the two landscapes for occurrences of mammals, arthropods, or carrion in the diet in any season (Sovada *et al.* 2001). However, Hines and Case (1980) suggested that swift foxes in Nebraska consume more carrion, especially road-kills, during the winter months. Cutter (1958) also concluded that the swift fox diet varies seasonally with the availability of food. The diet of whelps does not seem to vary from the diet of adults, except that they may consume more insects that can be found in and around the den (Cutter 1958). Zumbaugh *et al.* (1985) found that there was no significant relationship between sex or age of swift foxes and foods consumed. Their study also showed that mammals were the most frequently taken prey item during winters in Kansas (Zumbaugh *et al.* 1985). This does not differ from the primary prey source of swift foxes during other seasons throughout the year. Eussen (1999) found that insects were an important dietary component for swift foxes in Colorado during winter and spring months when mammalian prey can be scarce.

Community Ecology

Predation

Swift foxes are small and vulnerable to several predators, and because of this predation is currently the most common mortality factor for swift fox (Covell 1992, Carbyn *et al.* 1993). The primary cause of swift fox mortality is predation by coyotes (*Canis latrans*) (Covell 1992, Sovada

et al. 1998; Matlack *et al.* 2000). Wolves (*Canis lupus*) used to account for some mortality of swift foxes as well (Egoscue 1979, Kahn *et al*. 1997). Interestingly enough, coyotes do not always eat the swift foxes that they kill (Stewart 1999). Other causes of death include predation by large raptors such as golden eagles (*Aquila chrysaetos*) and ferruginous hawks (*Buteo regalis*), and predation by badgers (*Taxidea taxus*) (Olson and Lindzey 2002). A new threat to swift foxes may be the spread of red foxes into areas occupied by the swift fox causing an increase in competition for food and space (Carbyn 1998; Sovada *et al.* 1998). Some degree of mortality also results from collisions with vehicles on roadways (Lindzey and Olson 2002; Carbyn 1998).

In a study done near Medicine Bow, Wyoming, 46% of swift fox deaths resulted from coyote predation, 6% from predation by raptors, and 3% from predation by badgers (Olson and Lindzey 2002).

Interspecific interactions

Coyotes (*Canis latrans*) and red foxes (*Vulpes vulpes*) are significant competitors in some areas where both species occur together. Interspecific competition with red foxes may be substantial in areas where cultivation has improved habitat quality for red foxes (Sovada *et al.* 1998). Kitchen *et al.* (1999) found that a high degree of interspecies spatial overlap occurred between coyotes and swift foxes at the Pinyon Canyon Maneuver Site in southeastern Colorado. Their study also showed that there was not any evidence of temporal avoidance of coyotes in swift fox movement patterns at this site, although interference competition between the two canids resulted in 48% (12/25) of swift fox mortalities (Kitchen *et al.* 1999). In each case of a coyote related mortality the death occurred outside the fox's home range or the 85% isopleth of that range, indicating that coyotes are more likely to attack a fox successfully when it was a substantial

distance from its den (Kitchen *et al.* 1999). Kitchen *et al.* (1999) concluded that swift foxes are able to coexist with coyotes because of year-round den use and a degree of dietary partitioning.

Parasites and Disease

In a study done in northern Texas to determine the food habits of swift fox, parasitic worms were found in all stomachs examined (Cutter 1958). The worms were identified to be from the *Physaloptera* spp. and *Dipylidium caninum* (Cutter 1958). Miller *et al.* (1998) conducted a study of the parasites of swift foxes in southeastern Colorado and found one coccidian, six nematode, and one cestode species. Two tick species (*Ixodes* spp.) and one flea species (*Pulex irritans*) were also collected from the foxes (Miller *et al.* 1998). Heavy burdens of coccidian, ascarids, hookworms, shipworms, and tapeworms are capable of causing pathology of the gastrointestinal tract and debilitating swift foxes, especially juveniles (Miller *et al.* 1998).

Thirteen of 16 foxes (81%) at the Medicine Bow study site had been exposed to canine distemper virus (Olson and Lindzey 2002). Two swift foxes at this site died from the virus and, and these were the first documented deaths of a swift fox due to the virus (Olson and Lindzey 2002). Swift foxes are known to carry antibodies for canine distemper virus (Miller *et al*. 2000). Canine distemper is endemic and common in the Intermountain West (Thorne and Williams 1988), and the virus is spread through direct contact. Animals in poor physical condition are more susceptible to the disease, and impacts on small carnivore populations can be significant (Monson and Stone 1976). Olson and Lindzey (2002) found that persistence at the Medicine Bow study site, large litter sizes, and high antibody prevalence rates in the foxes tested, suggested that canine distemper probably did not have a major impact on that particular swift fox population.

Symbiotic and Mutualistic Interactions

Historically, the range of the swift fox and the prairie dog overlapped extensively (Sharps 1984). There is some evidence to make a point for a strong link between swift foxes and the prairie dog ecosystem. Kintigh (1999) found that swift fox dens in New Mexico were distributed significantly closer to prairie dog towns, than were random points. The research community has

suggested that swift fox are highly associated with the black-tailed prairie dog ecosystem, however, the nature of this association is not fully understood (Kintigh 1999). Most likely the association is the result of overlapping habitat requirements such as dennable soils, and not a predator-prey relationship (Kintigh 1999).

Conservation

Conservation Status

Federal Endangered Species Act

The U.S. Fish and Wildlife Service proposed the swift fox for listing as endangered in 1992, but in 1995 they determined that the listing was "warranted but precluded" by other actions of higher priority (Federal Register 1995). Recently, the Fish and Wildlife Service (Federal Register 2001) removed the swift fox from its warranted list, and it is no longer being considered for listing at this time. However, the Canadian population of the northern swift fox (*Vulpes velox hebes*), was declared endangered by the U.S. Fish and Wildlife Service on June 2, 1970 (U.S. Fish and Wildlife Service Endangered Species Home Page 2002). As an endangered species this population is protected wherever it occurs and federal agencies are required to consult with the Fish and Wildlife Service on any actions taken that may affect this population.

Bureau of Land Management

The Wyoming BLM developed their sensitive species list in 2001, and the swift fox was assigned to that list. The BLM developed the list to "ensure that any actions on public lands consider the overall welfare of these sensitive species and do not contribute to their decline." The BLM's sensitive species management will include: determining the distribution and current habitat needs of each species; incorporating sensitive species in land use and activity plans; developing

conservation strategies; ensuring that sensitive species are considered in NEPA analysis; and prioritizing what conservation work is needed (BLM Wyoming 2001).

Forest Service

Region 2 of the U.S. Forest Service includes the swift fox on its sensitive species list. Sensitive species are defined by the Forest Service as "those animal species identified by the Regional Forester for which population viability is a concern as evidenced by: (a) significant current of predicted downward trends in population numbers or density, and/or (b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution" (USDA Forest Service 1994). The Region 2 area in Wyoming includes the Bighorn, Black Hills, Medicine Bow, and Shoshone National forests and Thunder Basin National Grassland.

State Wildlife Agencies

The Wyoming Game & Fish Department classifies the swift fox as a NSS3-Species. This ranking means that habitat is restricted or vulnerable (but no recent or significant loss has occurred); populations are declining or restricted in numbers and or distribution (but extirpation is not imminent); the species may be sensitive to human disturbance (Oakleaf *et al.* 2002). Management decisions should be based on the above ranking and all available information on the species.

Heritage Ranks and WYNDD's Wyoming Contribution Rank

The swift fox has been assigned a rank of G3/S2 by the Wyoming Natural Diversity Database. The G3 rank refers to the global security of the swift fox, and it means that it is rare or local throughout its range, or found locally in a restricted range (usually known from 21-100 occurrences). The swift fox was given a ranking of S2 because it is considered to be imperiled in

Wyoming due to its rarity and several factors demonstrably making it vulnerable to extinction (see Biological Conservation Factors). The swift fox is facing habitat loss and degradation, anthropogenic impacts, and interspecific competition in much of its range, including Wyoming.

The Wyoming contribution rank for the swift fox is High. This ranking is based on a decision ranking tree developed by the Wyoming Natural Diversity Database (Keinath and Beauvais 2003), and it is designed to consider how Wyoming contributes to the range-wide persistence of a species. The swift fox is considered a native species to Wyoming, and it is a resident because it has been reliably encountered in Wyoming at multiple locations during the last 10 years. Wyoming encompasses a medium/low percentage of the swift fox's continental range, and the swift fox is a regional endemic to the Great Plains states. The current swift fox population is somewhat patchy, especially in the far northern portion of its range. Finally, the Wyoming population of the swift fox is probably more secure than other state's populations elsewhere within the species' range. This is due to several factors including large areas of potential habitat that remain undisturbed and known, persistent populations in the state. Olson and Lindzey (2002) found higher mean litter sizes at their study site near Medicine Bow, Wyoming, and survival rates similar to those documented in other literature. The Swift Fox Conservation Team has reported in several of their annual reports that Wyoming's swift fox population is one of the most secure, along with populations in Kansas and Colorado.

Biological Conservation Issues

Abundance

Rangewide the swift fox has been extirpated or reduced in numbers over much of their historic range (Clark and Stromberg 1987); (Table 1 – provides a list of the population status of the swift fox in each state within its range). Swift foxes were extirpated from Canada, but have recently

been reintroduced and a small wild population of approximately 600 individuals does exist (Carbyn, 2002, pers. comm.). A recent increase in the frequency and intensity of swift fox occurrence reports and collected specimens in Montana suggest that a resident population is established in at least 3 northern counties in the state (Giddings and Knowles 1996). The swift fox may exist at extremely low densities, if at all, in the southwestern counties of North Dakota, and in South Dakota swift fox can be found in the southwestern counties (Kahn *et al.* 1997). Swift fox are known to occur in very limited numbers in the panhandle and southwestern Nebraska (Kahn *et al.* 1997). Recent status information indicates the species is well distributed in eastern Colorado, and the mean number of foxes captured in one study was estimated to be one fox per 5.3 km^2 (Roell 1999). Swift fox are currently present throughout most of their historic range in Kansas and have maintained a stable population for the past 20 years, with densities estimated at 1 fox per 2.0 km^2 (Fox and Roy 1996). Recent status information indicates swift fox occur at low densities in a four to six county area in the panhandle and northwestern portion of Oklahoma (Kahn *et al.* 1997). Densities and distribution of swift fox in Texas and New Mexico are not well known at this time, but populations do occur in eastern New Mexico and western Texas (Kahn *et al.* 1997).

Current distributions and associated densities of swift fox appear to be highly variable among the occupied range (Kahn *et al.* 1997). The current population status of the swift fox in many occupied areas has yet to be fully investigated. However, recent increased survey efforts in several areas such as Montana, Colorado, and Kansas have resulted in estimates of greater abundances than had been previously thought. In most of the states within the swift fox's range, several studies using a variety of survey methods were used to estimate abundances. There are some potential biases in these estimates depending on the survey methods used. Scented track plate stations seem to be the most effective method for detecting swift foxes, but they probably result in higher abundance estimates than actually exist. Live trapping of swift foxes with some

form of mark and recapture is probably the best way to accurately estimate population abundances.

In Wyoming the swift fox is generally uncommon (Beauvais 2000), but has been found to be locally common in a few areas of the state. It was thought to be very rare as recently as 1990, but recent surveys have shown the swift fox to be common in parts of south-central and southeastern Wyoming (Luce *et al*. 1997). However, current abundance of the swift fox is less than what it once was in the state. Although the swift fox is considered rare to uncommon, densities of 1 pair per 5-8 km^2 were documented in Laramie County during a scent post survey in the 1980's (Clark and Stromberg 1987). WYNDD categorizes the abundance of swift fox within Wyoming as uncommon with a high degree of confidence.

Trends

Abundance Trends

Swift foxes were once very abundant on the Great Plains, but once settlers began to arrive in the area, their numbers began to decline sharply. By 1900 the species was rare in the northernmost part of their range (Hillman and Sharps 1978). Rangewide abundance has decreased from historical levels, but the swift fox may be recovering from massive mortalities from incidental poisoning suffered in the early to mid 1900's. In 1972 there was a ban on the compound 1080 (sodium monofloroacetate), which had been used to poison canids for years prior to this time (Skinner 1986). The swift fox population seems as though it may be increasing slowly over most of its range. The Montana Fish and Wildlife and Parks Department believe that evidence shows that swift fox numbers in Montana have increased in the last 10-15 years (Titus 1995). A Kansas researcher noted that the swift fox population there was good and had been holding strong for quite awhile (Titus 1995). Kansas, Colorado, and Wyoming presented evidence

indicating that swift foxes have reoccupied former prairie habitats in those states (Federal Register 1995).

In Wyoming the swift fox experienced historic declines as well, but they now appear to be expanding into formerly occupied range and increasing in abundance (Beauvais 2000). Their distribution in Wyoming has remained fairly constant over time. Presence/absence surveys for swift foxes in various parts of Wyoming began being conducted in 1999 and 2000 by the Wyoming Game and Fish Department (Luce *et al*. 2000). In 2001 the Game and Fish Department conducted a survey for monitoring swift fox population trends and this survey will be repeated in 2006 in order to document the long-term trend for the species (Luce *et al*. 2000). Until the Game and Fish concludes their population surveys it is hard to know the exact abundance, distribution, and trend rates of swift fox populations in Wyoming. Olson (2000b) conducted a study near Medicine Bow, Wyoming in the late 1990's and determined that the population there was not declining, despite the high mortality rates that they found. Although the range of the swift fox seems to be expanding in Wyoming, this does not give any indication of current or historical abundance. Bob Luce, of the Wyoming Game and Fish Department said that "there was not any evidence to show that the Wyoming swift fox population had suffered a decline" (Madson 1987). WYNDD categorizes the abundance trends of swift fox within Wyoming as fairly uncertain due to the short time the population has been monitored and the mobility of the species. The confidence in this rank is moderate, since much available information is anecdotal, or the result of surveys begun only in recent years.

Population Extent and Connectivity Trends

Current range is much less than what it once was, but more recent data shows that the swift fox may be making a comeback, and expanding out into what was formerly their historic range. Records from Wyoming, Colorado, and South Dakota within the last 10-15 years show this

expansion into former range. However, in Nebraska and Kansas this does not seem to be the case. The Kansas swift fox population seems to be doing well, but it mainly encompasses only the western half of the state, and does not extend east, into what was once historical range. Within the remaining historical swift fox range, populations exist in scattered and isolated pockets of remnant short to midgrass prairie habitat (Federal Register 1995).

In Wyoming their distribution has changed little (Lindberg 1986). Woolley *et al.* (1995) found swift foxes in eight Wyoming counties, as far north as the Powder River Basin and as far west as the Red Desert in Sweetwater County (Madson 2001). Survey efforts in Wyoming were increased in 1995 after the swift fox was proposed for the endangered species list, and the Wyoming Game and Fish Department found that swift foxes were much more widely distributed than had been previously thought (Madsdon 2001). While it appears that the swift fox is expanding its range in Wyoming and increasing in number, Game and Fish officials still believe the population is relatively small.

Trends in Available Habitat

Rangewide, swift fox habitat is decreasing. Habitat loss and fragmentation has resulted from agricultural conversion and mineral extraction. Roadways also alter available habitat and result in fragmentation that exposes the swift fox to traffic, trapping, and shooting (Federal Register 1995). Stewart (1999) declared that "habitat loss remains the chief threat to the swift fox's survival" and scientists estimate that as much as 50% of the species' historical range has been converted to cropland.

In Wyoming, Olson and Lindzey (2002) reported that extensive areas of sagebrush interspersed with short bunchgrasses exist throughout much of Wyoming (Risser *et al*. 1981). A great deal of this type of habitat has not been impacted by large-scale habitat modifications such as

dry land farming, and the vegetation remains largely unchanged from its condition in the 1800's (Knight 1994). This habitat in Wyoming supplies important potential habitat for the swift fox (Olson and Lindzey 2002). Based on this information, habitat trends for swift fox in Wyoming are probably stable.

Range Context

Although Wyoming plays an important role in the recovery of the current swift fox population, much of the swift foxes' range occurs outside of Wyoming. There are a total of 9 states and also Canada that are included in the swift foxes current continental range. Wyoming, Kansas, and Colorado together comprise a large portion of the best swift fox range in the U. S. The suitable range in Wyoming has valuable habitat for the swift fox and is an important part of the current range of the swift fox. WYNDD categorizes the range context of swift fox within Wyoming as moderate (Wyoming encompasses between 5% and 20% of the species North American range), with a high degree of confidence.

Extrinsic Threats and Reasons for Decline

Anthropogenic Impacts

The swift fox is extremely vulnerable to human activities such as trapping, hunting, automobiles, agricultural conversion of habitat, and prey reduction from rodent control programs (Federal Register 1995). Although hunting and trapping used to be a serious problem for swift fox throughout their range, this is less of an issue today. There are still poisoning campaigns to eradicate coyotes in some areas, and this can lead to accidental deaths of swift fox. The greatest human threat to swift fox populations is loss of habitat due to new agricultural cultivation and urban, suburban expansion. However, the larger geographic areas within current swift fox range where the land use pattern has not been altered significantly for decades (rangeland and farmland) are not likely to change in the foreseeable future (Kahn *et al*. 1997). Vehicle collisions can be a

problem, and may limit the growth of small and isolated populations. Prairie dog colonies are high quality habitats for the swift fox, due to their high densities of prey items and burrows, but elimination of prairie dog colonies continues to reduce quality habitat for the swift fox rangewide (Beauvais 2000). The swift fox is legally harvested in Colorado, New Mexico, Kansas, and Texas (Federal Register 1995), but is protected in the remaining states in which it is found. With more attention being paid to the swift fox in recent years, anthropogenic impacts on this canid species have decreased lately.

Invasive Species

Invasive species are not considered to be a problem for swift fox per se, but coyotes and red foxes do pose a threat to swift fox populations. These other canid species compete with the swift fox for habitat and prey items. Therefore, they can affect populations by predation, and competition for food and habitat.

Genetic Factors

The current genetic status of the swift fox population is still in question at this time (Kahn *et al.* 1997). The Swift Fox Conservation Team has an ongoing plan in which members on a technical committee are to investigate the genetic integrity of the U. S. swift fox population by 2005 (Kahn *et al.* 1997). The committee is conducting periodic testing and analysis of genetic variation among the state populations. At that time more will be known in regards to the genetic status of the swift fox population.

Stochastic Factors (e.g., weather events)

Swift fox ecology is linked to environmental conditions because they in turn influence the availability of prey and can cause increased stress upon the foxes. In the northern portions of the swift foxes range, severe winters, droughts, and the icing over of ranges can be very detrimental to

survival (Carbyn 1998). Droughts can be extremely detrimental, as they lead to a reduction in populations of prey species (Carbyn 1998).

Natural Predation

The most significant source of mortality is predation by coyotes and raptors (Kahn *et al*. 1997, Olson *et al*. 1997, Sovada *et al*. 1998). Swift fox are susceptible to death and predation year-round (Olson and Lindzey 2002). Mortality rates for swift fox have been documented to be high in several areas of their range, as mentioned earlier in the assessment (Titus 1995, Sovada *et al*. 1998). Being the smallest canid species, they suffer a high degree of predation and competition from larger canid species.

WYNDD Extrinsic Threat Rank

WYNDD categorizes the swift fox within Wyoming as being slightly threatened by extrinsic factors, with a moderate level of confidence. Many of these issues are noted below.

Intrinsic Vulnerability

Habitat Specificity

Habitat specificity is a concern for swift fox populations because they require open expanses of prairie and grassland habitats. This type of habitat has diminished greatly over the past 100 years and now there is much less of it in the United States. The areas of prairie that do exist, need to protected in order to sustain swift fox populations, and other populations of prairie dwelling species.

Territoriality and Area Requirements

The swift fox is a prairie-dwelling species that requires 518 hectares to 1,296 hectares (1,280 – 2,300 acres) of short to midgrass prairie habitat with abundant prey to support a pair of foxes (Jones *et al.* 1997, Rongstad *et al.* 1989). Territorial and area requirements are an important factor in recovering and sustaining swift fox populations. They require large areas of prairie and

grassland habitats to support them. Prey abundance and low numbers of competitors are also an issue in regards to area requirements for swift fox.

Susceptibility to Disease

The effects of infectious disease in swift fox are relatively unknown, but they are susceptible to most diseases that plague canids (FaunaWest 1991). Swift fox are susceptible to canine distemper virus. Thirteen of 16 foxes (81%) captured near Medicine Bow, Wyoming had been exposed to canine distemper virus, and 2 foxes died from the virus before the end of the study (Olson and Lindzey 2002). Other diseases documented in swift fox are canine parvovirus, canine hepatitis, tularemia, brucellosis, toxoplasmosis, and coccidiomycosis (FaunaWest 1991). Of these known diseases, canine parvovirus is a major disease in kit foxes in California (FuanaWest 1991).

Dispersal Capability and Site Fidelity

Dispersal capability and site fidelity are not a big problem for swift fox populations. Swift fox are large enough that they do not have any problems dispersing, and they do not exhibit site fidelity. They establish territories with their mates, but they seek out areas that other foxes do not occupy.

Reproductive Capacity

The reproductive capacity of swift foxes can vary to a degree, depending on several factors. Production of swift fox young is likely related to prey abundances, as has been demonstrated in the kit fox (Cypher et al. 2000). Swift fox only have one litter of pups per year and litters range from 3-6 pups (Egoscue 1979). Swift fox are considered adults by their first December (Kitchen *et al*. 1999), and are able to breed in their first year of life. However, not all first year vixens will breed (Kahn *et al.* 1997, Carbyn 1998). Although swift fox reproductive capacity is fairly high, swift fox also experience high mortality rates, so their reproductive capacity is an important factor to sustaining swift fox populations.

Sensitivity to Disturbance

Swift fox are somewhat vulnerable to disturbance, depending on what the disturbance is. They are most vulnerable to disturbance during the breeding and whelping phases, and are especially vulnerable to any disturbances of their dens (Carbyn 1998). Disturbance at den sites can cause the mother to relocate her pups to another den, and this is risky for them. If the disturbance is severe, swift foxes will abandon their den and territory completely and will have to relocate to a new area.

WYNDD Intrinsic Threat Rank

WYNDD categorizes the intrinsic vulnerability of the swift fox within Wyoming as moderate due to their habitat specificity, sensitivity to disturbance, and high mortality rates.

Protected Areas

The swift fox is classified as endangered or threatened in Nebraska and South Dakota; is a furbearer in seven other states; and is a nongame wildlife species in Wyoming (Kahn *et al.* 1997). Seventy to seventy-five percent of the known swift fox populations are believed to reside on private lands, with the remaining populations occurring on various federal lands (Federal Register 1995). The species receives a low level of protection on scattered parcels of land managed by the USDI Bureau of Land Management and USDA Forest Service National Grasslands. There are also a few USDI National Parks and USDI National Wildlife Refuges that support a limited number of swift fox (Beauvais 2000).

In Wyoming, much of the swift fox habitat is on private land, but there are also protected areas that are known to support swift fox as well. Swift fox have been documented on Thunder Basin National Grasslands and on various BLM lands as well. Since several swift foxes have been documented on private lands, it may be possible that they are doing well and thriving on these lands.

WYNDD Protected Areas Rank

With moderate confidence, WYNDD categorizes the protected areas of the swift fox within Wyoming as being fairly good since at least some of the known breeding sites within the state are protected.

Population Viability Analyses (PVAs)

This author is not aware of any formal population viability analyses studies that have been conducted for the swift fox.

Conservation Action

Existing or Future Conservation Plans

The Swift Fox Conservation Team (SFCT) was formed in 1994 to develop management strategies for the swift fox. This team consists10 states that comprise the historic range of the swift fox and includes Wyoming, Colorado, South Dakota, North Dakota, Montana, Kansas, Oklahoma, Texas, Nebraska, and New Mexico (Schmitt and Oakleaf 2001). The SFCT puts out an annual report that contains the survey efforts and research and management activities of all the states that comprise the conservation team. Despite the removal of the swift fox from the candidate list, the SFCT remains committed to their original objectives and continues to work towards these goals.

The Conservation Assessment and Conservation Strategy (CACS) for the swift fox in the United States was developed to provide a framework for conservation of the species as an alternative to a federally mandated recovery effort (Kahn *et al*. 1997). The primary objectives of the conservation team from (Kahn *et al*. 1997) are as follows:

- To maintain and protect existing areas of species abundance while expanding the distribution of swift fox where ecologically and politically feasible.

- Develop methods to monitor population status and species distribution.
- Identify, manage and protect suitable swift fox habitat.
- Implement cooperative efforts with private landowners and conservation agreements with federal land management agencies to maintain and manage habitat for swift fox.
- Elevate state legal status and/or management priority of the species throughout its range.
- Although not necessarily provide a geographically continuous population, it is essential to maintain a genetically connected continental population.

Success of the conservation program will be evaluated by the following criteria; 1) the ability to maintain local self-sustaining populations which are geographically distributed throughout each state or large blocks of contiguous prairie and 2) that the United States population occupies a minimum of 50% of the suitable habitat that is available. Attainment of the conservation goals are hoped to be reached by 2015 if adequate funding and resources are available (Kahn *et al*. 1997).

Inventory and Monitoring

All of the states that encompass current swift fox range have some type of plan for inventory and monitoring of swift fox populations. This varies greatly depending on the state, but some methods include scented track-plate stations or scent post surveys, scat DNA analysis procedures, spotlighting, live-trapping, and infrared triggered cameras (Schmitt and Oakleaf 2001). Schmitt and Oakleaf (2001) stated that track plate stations seemed to be the most effective method for detecting swift foxes in Wyoming. Canada also monitors the reintroduced swift fox population to determine how it is doing. Due to money limitations, most states can only afford to inventory swift fox populations every 3 to 5 years.

Habitat Preservation and Restoration

Preserving large chunks of native prairie grasslands is one of the most important factors in establishing successful swift fox populations (Carbyn 1998). In the ten states that encompass

swift fox range, the BLM controls over 36,000,000 acres, of which a large portion is managed as prairie rangeland (Kahn *et al*. 1997). Range quality enhancement, directed at water quality and increasing vegetative productivity, could benefit swift fox (Kahn *et al*. 1997). These may include and increased vegetative composition that would provide more productive small mammal and lagomorph populations and greater stability in soil conditions for den sites (Kahn *et al*. 1997). Maintenance and enhancement of large colonies of prairie dogs will likely increase habitat quality for swift fox (B. Luce, Wyoming Game and Fish Department, personal communication *in* Beauvais 2000, Stapp 1998). Work needs to be done in conjunction with private landowners in order to implement successful swift fox conservation practices on these lands.

Captive Propagation and Reintroduction

Reintroduction efforts have been undertaken in several areas of the swift fox's historical distribution. Canada began reintroduction efforts in 1976 and these are still ongoing. There have also been efforts to reintroduce the swift fox on the Blackfeet Indian Reservation in northwestern Montana by the Defenders of Wildlife (Schmitt and Oakleaf 2001). The efforts in Montana began in 1998 and to this point have been very successful. Releases on the Blackfeet Reservation will continue for at least 2 more years (Schmitt and Oakleaf 2001). The Turner Endangered Species Fund began reintroducing swift foxes in 2001 on their Bad River Ranch in Shannon and Fall River counties of South Dakota (Schmitt and Oakleaf 2001). In conjunction with these efforts the Turner Fund is working with the National Park Service in efforts to reintroduce swift fox in the Badlands of South Dakota, which are only 1 hour from the Bad River reintroduction site (Schmitt and Oakleaf 2001).

The most extensive reintroduction program thus far has been the one initiated in Canada. The swift fox was once abundant in Canada, but numbers have declined greatly in the last one hundred

years (Herrerro *et al*. 1991). The last acceptable swift fox sighting in Canada was in 1938 (Herrerro *et al*. 1991) and the Canadian population was listed as endangered in 1970 (Federal Register 1970). Reintroduction plans were began in 1976 by the Canadian Wildlife Service and actual reintroductions of animals started in 1983 (Herrerro *et al*. 1991). From 1983 to 1997 a total of 841 captive-raised foxes and 91 translocated foxes were released into Canada (Carbyn 1998). Several foxes were taken from Wyoming, Colorado and South Dakota and used in the translocation to Canada. From 1990 to 1996 a total of 88 swift foxes were taken from Laramie county, Wyoming and used in the captive breeding and release program (Carbyn 1998). A survey conducted from 1996-1997 showed the Canadian swift fox population to be in excess of 289 individuals (95% confidence interval: 179-412), 80% of which were thought to be wild born (Carbyn 1998). The target number of 420 foxes had not been reached when funding ran out in 1997. However, reintroduction efforts were successful to some degree as a population of approximately 600 foxes is established and breeding near the border area of southeast Alberta and southwest Saskatchewan (Carbyn, 2002, pers. comm.). A current estimate of the swift fox population in the entire region, including northern Montana, is approximately 900 individuals (Carbyn, 2002, pers. comm.). Although funding was discontinued in 1997, the reintroduction committee is currently looking at further issues in regards to the swift fox reintroductions in Canada, and new funding is being obtained (Carbyn, 2002, pers. comm.). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as of 1998 listed the swift fox as extirpated in Canada, but Carbyn (1998) recommended changing this status to endangered.

Information Needs

Rangewide Needs

Basic life history, distribution, habitat use, and population information are needed rangewide (Kahn *et al*. 1997). The ability of swift fox to persist in human-modified habitats also needs to be explored (Beauvais 2000). This includes studies that relate swift fox productivity to landscape-scale patterns of cultivation and urban/ suburban development that are needed to guide management (Beauvais 2000).

Hillman and Sharps (1978) made species and habitat management recommendations including the surveying of BLM lands to determine presence and numbers of kit and swift foxes, habitat requirements, home ranges, and population dynamics so that adequate management plans can be made.

Wyoming Needs

Studies need to be done on swift fox habitat selection in order to determine habitat attributes that swift foxes select for (Olson 2000b). A better understanding of the habitat factors that swift fox require or select for, will help managers identify limiting factors for potential swift fox habitat in the state (Olson 2000b). Considering the high mortality rates that swift foxes incur due to coyotes, studies need to be done to compare how swift foxes utilize habitats and home ranges, with respect to prey acquisition and predator avoidance (Olson 2000b). Wyoming needs to continue to monitor the swift fox population and distribution in the state in order to help maintain and protect it.

Tables and Figures

Table 1: Population Status of the Swift Fox in its Historical Range. Information taken from: The 1996 Swift Fox Conservation Team Annual Report (Luce and Lindsey 1996); The 1998 Swift Fox Conservation Team Annual Report (Roy 1998); The 2001 Swift Fox Conservation Team Annual Report (Schmitt and Oakleaf 2001); The Turner Endangered Species Website (Turner Endangered Species Fund Website 2002); The Update COSEWIC Status Report on Swift Fox (Carbyn 1998); and The Conservation Assessment and Strategy for Swift Fox in the United States (Kahn *et al.* 1997).

State/Country	Occurrence	Comments
Canada	Yes	Reintroduced into Alberta and Saskatchewan beginning in 1983; efforts tapered off in 1997 but the population is doing well.
Colorado	Yes	Found throughout most of their historical range. Populations seem to be doing well and are viable.
Iowa	No	Historic range maps include extreme western Iowa, but no specimens were collected to verify this.
Kansas	Yes	Found throughout most of their historical range. Populations seem to be doing well and are viable.
Minnesota	No	Historic range maps include extreme western Minnesota, but no specimens were collected to verify this.
Montana	Yes	Small numbers occurring in 4 north-central counties. Defenders of Wildlife began reintroductions on the Blackfeet Indian Reservation in northwestern Montana in 1998.
Nebraska	Yes	Very limited numbers in the western counties. Only a limited amount of work has been done recently with very little data available.
New Mexico	Yes	Presence known. Work is in progress to document occurrence by county. A total of 32 foxes have been captured and collared on the Kiowa National Grasslands in Harding and Colfax counties.
North Dakota	No	Since 1970, 4 confirmed observations with the last recorded specimen taken in 1994.
Oklahoma	Yes	Found in 4-5 counties in the western panhandle region. Just finished 3 years of a tracking study to determine presence/absence of swift fox in several areas.
South Dakota	Yes	Small numbers in southwestern counties. The Turner Endangered Species Fund is beginning to release swift foxes on the Bad River Ranch in west-central South Dakota and will continue to do so for the next 6-10 years.
Texas	Yes	As of 1996 their presence is documented in 2 counties. Recent spot-lighting surveys and trapping have been conducted in Dallam and Sherman Counties, resulting in 22 and 27 swift fox captures, respectively.
Wyoming	Yes	Found throughout most of their historical range and in greater numbers than had been previously known. Population is doing well and is viable.

Figure 1: Photo of an adult swift fox (© Lu Carbyn, Canadian Wildlife Service).

Figure 2: Rangewide distribution map for the swift fox (green) and kit fox (purple); area of overlap (striped); historic range (dashed).

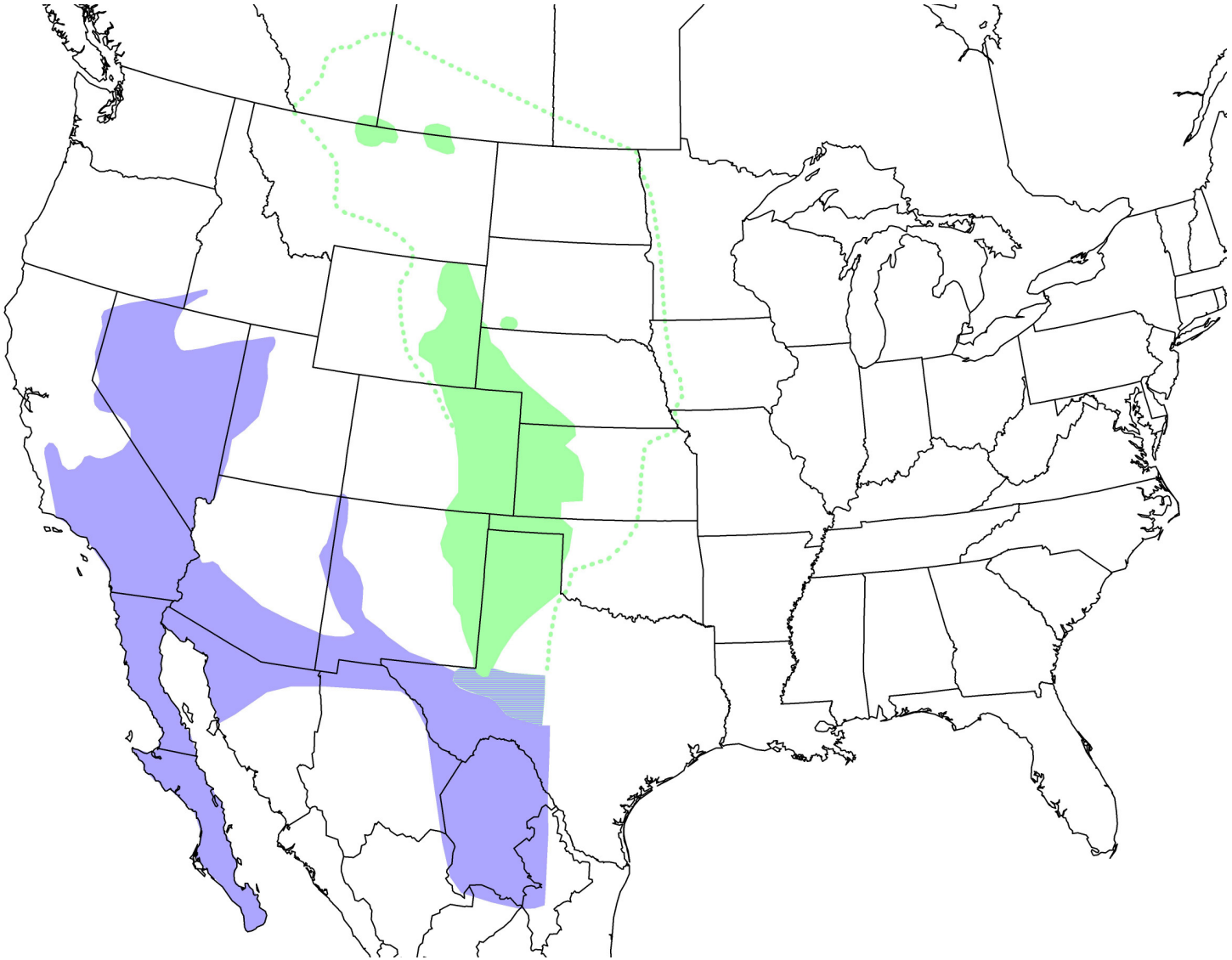
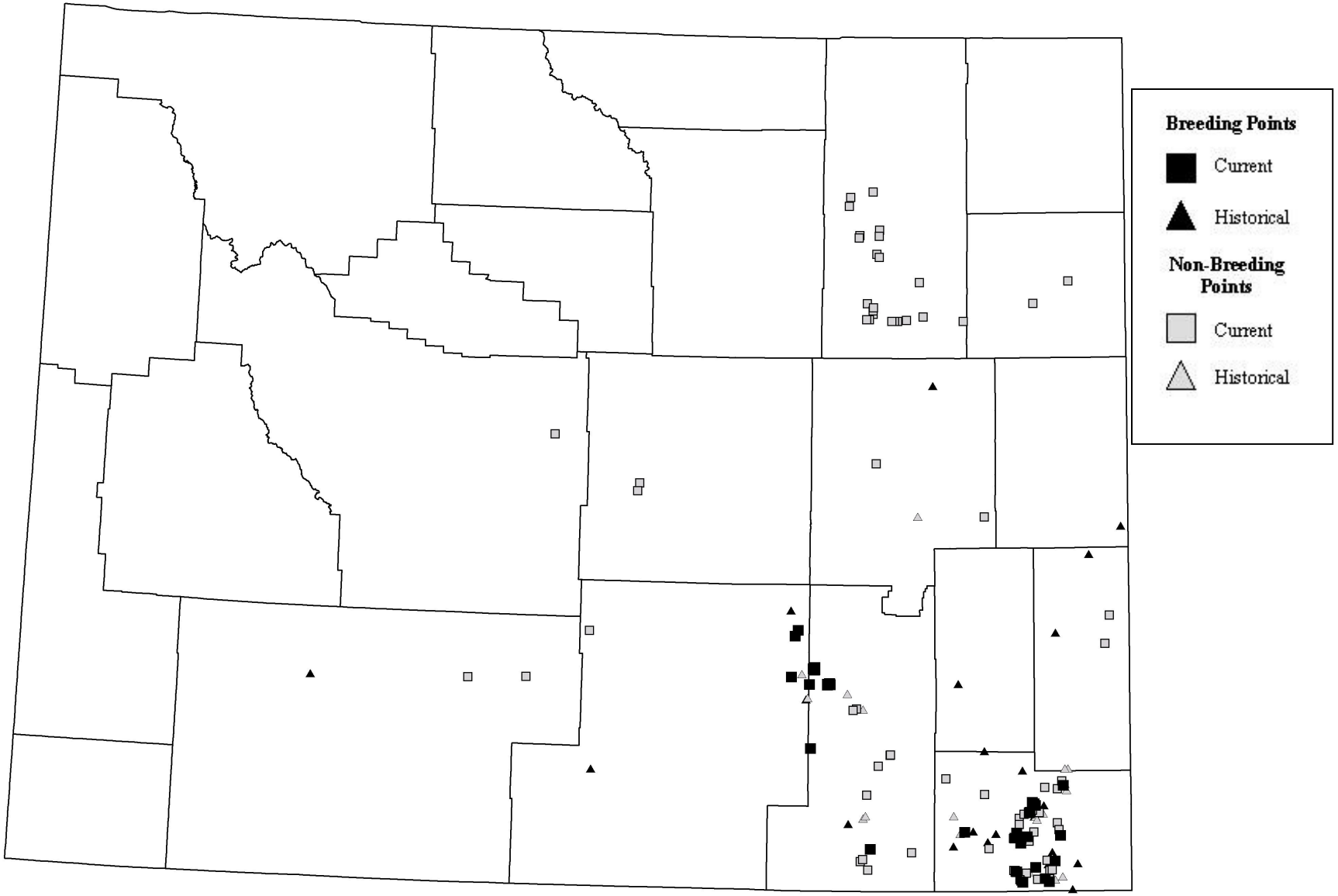


Figure 3: Reported occurrences (breeding and non-breeding) in Wyoming.



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