

Swift Fox
(Vulpes velox)

A Species Conservation Assessment
for the
Nebraska Natural Legacy Project



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The mission of the Nebraska Natural Legacy Project is to implement a blueprint for conserving Nebraska's flora, fauna, and natural habitats through the proactive, voluntary conservation actions of partners, communities, and individuals.

Purpose

The primary goal in the development of at-risk species conservation assessments is to compile biological and ecological information that may assist conservation practitioners in making decisions regarding the conservation of species of interest. The Nebraska Natural Legacy Project recognizes the swift fox (*Vulpes velox*) as a Tier I at-risk species (Schneider et al. 2011, Schneider et al. 2018). Provided here are general management recommendations regarding the swift fox. Conservation practitioners will need to use their professional judgment for management decisions based on objectives, location, and site-specific conditions. Based on the body of literature and available data, this particular species conservation assessment provides an overview of our current knowledge of swift foxes and may aid in decision-making for their conservation or in identifying research needs for the benefit of the species. Species conservation assessments will need to be updated as new scientific information becomes available. The Nebraska Natural Legacy Project focuses efforts in the state's Biologically Unique Landscapes (BULs), but it is also recommended that whenever possible, people make considerations for a species throughout its range in order to increase the success of conservation efforts.

<u>Common Name</u>	Swift Fox	<u>Scientific Name</u>	<i>Vulpes velox</i>
<u>Order</u>	Carnivora	<u>Family</u>	Canidae
<u>G-Rank</u>	G3	<u>S-Rank</u>	S2
		<u>Goal</u>	10
		<u>Distribution</u>	Limited
<u>Criteria for selection as Tier I</u>	State listed, G3		
<u>Estimated population in NE</u>	< 1,000	<u>Estimate based on</u>	Expert opinion
<u>Trends since 2005 in NE</u>	Stable		
<u>Range in NE</u>	Panhandle and Southwest Nebraska		
<u>Habitat</u>	Short-grass prairie, western mixed-grass prairie		
<u>Threats</u>	Conversion to cropland, fragmentation of habitat, loss of prairie dog colonies and effects of sylvatic plague, disjunct and fragmented populations, incidental take		
	Climate change Vulnerability Index: Not Vulnerable, Increase Likely		
<u>Research/Inventory</u>	Conduct surveys to assess effects of habitat management on distribution and abundance; conduct population monitoring (genetic diversity and connectivity), monitor dens for reproduction and collar foxes for life history and spatial data, investigate public perceptions, conserve and manage habitat		
<u>Landscapes</u>	Likely: Oglala Grasslands, Panhandle Prairies, Kimball Grasslands Less Likely: Pine Ridge, Upper Niobrara River, North Platte River, Wildcat Hills, Sandsage Prairies		

Status

The swift fox is a Tier 1 at-risk species according to the Nebraska Natural Legacy Project, the state wildlife action plan, and has been listed as an endangered species in the state of Nebraska since 1977. The species has a state Heritage rank of S2 (imperiled) and a global rank of G3 (vulnerable), and is protected under the Nebraska Nongame and Endangered Species Conservation Act. The species was petitioned for federal listing on the Endangered Species Act in 1970 and 1992, and was warranted but precluded by the U.S. Fish and Wildlife Service (USFWS) in 1994 and later placed on the federal candidate species list. At that time, the Swift Fox Conservation Team was formed to cooperatively work on management and conservation between state, federal, and tribal agencies, conservation organizations, and researchers in the United States and Canada. The species was removed from the USFWS candidate species list in 2001, but is considered a threatened species in Canada. The species has a harvest season with varying limits in Colorado, Kansas, Montana, New Mexico, and Texas, and is not harvestable in Nebraska, North Dakota, Oklahoma, South Dakota, and Wyoming.

The species was once abundant throughout the Great Plains from Canada to Texas in short and mixed grass prairies, but was nearly extirpated in the early 1900's after habitat conversion, unregulated trapping, and poisoning programs aimed at larger predators. Swift foxes currently inhabit less than half of their historical range, often in remnant short-grass prairie in fragmented conditions (Sovada et al. 2009, Schwalm et al.

2014). In Nebraska, swift foxes historically covered much of western and central Nebraska in short and mixed grass prairies (excluding the Sandhills) and are believed to have been absent from the state between 1901 and 1953. Today, the species is limited to only the far western panhandle and far southwest corner of the state (Fig. 3). Though the species has been reintroduced in much of the northern range, no reintroductions occurred in Nebraska, and the population is considered stable.



Figure 1. Adult swift fox with four pups at a den in Box Butte County, Nebraska. Notice the yellow/white coloration of pups, and the yellow/grey/white coloration of the adult, both with black-tipped tails. Also notice dark nose patch on adult. (Nebraskaland).

Research on swift foxes in Nebraska has focused on abundance and movement along the Heartland Expressway Corridor in the panhandle (Albrecht 2015), and a detailed study on space-use, land cover, genetics, and modeling throughout their entire estimated range in Nebraska (Corral Hurtado 2018), with a focus on interactions with red fox and coyote. Additional monitoring has included scent stations (see Bly 2011), den investigations, road mortalities, and other incidental observations.

Species Description

The swift fox is one of the smallest canids in the world, weighing roughly 2.2 – 2.5 kg (~5 lbs) and only 30 cm (12 in) tall at the shoulder. They are nocturnal and crepuscular, but can be seen above their dens during the day. They have an overall yellow appearance, with adults greying in the winter. They have white necks and bellies, with a dark nose patch (Fig. 1). A distinguishing characteristic of swift foxes is a black-tipped tail (Fig. 5), and can be differentiated from red foxes which have white-tipped tails (as well as black feet and black behind their ears). Often mistaken for coyote pups, swift foxes can be identified based on color and size. Photographic evidence and/or detailed behavioral descriptions should be provided to help experts identify species (e.g., preference for roads, and a bounding/bouncy gait can be indicative of swift foxes versus coyotes). Swift foxes use dens year-round for rearing young and for escaping predators (see more below).

For a short but detailed video on swift foxes, depicting coloration, size, and behavior, see Michael Forsberg's work: <https://www.nationalgeographic.com/photography/article/michael-forsberg-moving-slowly-to-capture-the-swift-fox>

Habitat, Dens, and Range

Ideal habitat for swift foxes is flat or slowly undulating areas of short- or mixed-grass prairie with high visibility (Fig. 2) and diversity of prey. In Nebraska, this includes the western panhandle and the southwest corner of the state (Fig. 3). Swift foxes likely never inhabited the Sandhills region of the state because of its unsuitable substrate for digging and maintaining dens, and steep sand dune topography.

Swift foxes live in underground dens year-round, which they dig themselves or modify from other species (e.g., prairie dogs, badgers), and inhabit different dens within their home range throughout the year. Dens provide protection from extreme heat and cold, provide escape from predators, and provide shelter for rearing pups. Dens are usually in open prairie (Fig. 2) but can be found in or near man-made structures (e.g., culverts, roads) and are generally in loamy soils. Active dens can be identified based on fresh tracks, scat, food items left around the den, and multiple unobstructed holes. Swift fox dens often have a mound or long track of excavated dirt

extending beyond the hole, created when adults clean the den and pull material above ground. Dens may be easiest to find mid-April through mid-June when new vegetation is growing, and it is noticeably taller and denser around dens than the rest of the prairie (Nevison 2017).



Figure 2. Collecting data at swift fox dens in western Nebraska. Notice ideal habitat conditions of short-grass prairie and flat topography (Nebraskaland).

Swift foxes are grassland specialists with a preference for native short-grass prairie, and they avoid trees, row crop agriculture, and developed/urban areas (Corral Hurtado 2018.) However, the species is adaptable and has been known to use marginal habitat as well. Throughout their range, swift foxes are known to inhabit prairie dog colonies for denning and foraging but are not solely dependent on prairie dog colonies in Nebraska. Studies have found that swift foxes select for home ranges and den sites near roads, possibly to avoid interference competition from coyotes, to ease in dispersal and/or movement, and to forage for carrion (Corral Hurtado 2018, Nevison 2017). The size of home ranges varies widely across their range, from 4 – 55 km² (~2 – 20 square mi.). In Nebraska, one collared fox had a home range of 25 km² (~10 square mi.) in northwest Nebraska (Albrecht 2015).

Approximately 42% of the historical range of swift foxes in Nebraska contains seemingly high-quality grassland habitat (Sovada et al. 2009), but the species appears to have a relatively restricted distribution in the state. From 2014 to 2016, researchers deployed baited camera trap stations at 902 locations within the historical range of swift fox in Nebraska (Corral Hurtado 2018). Habitat variables were collected at all locations and an occupancy model was developed using known swift fox locations (Fig. 4). By using genetic analysis, researchers found two main populations of swift foxes in Sioux and Kimball counties in the far western panhandle. Genetic analysis shows that foxes move between the two populations, and there is also evidence that foxes move across state boundaries into South Dakota, Wyoming, Colorado, and Kansas.

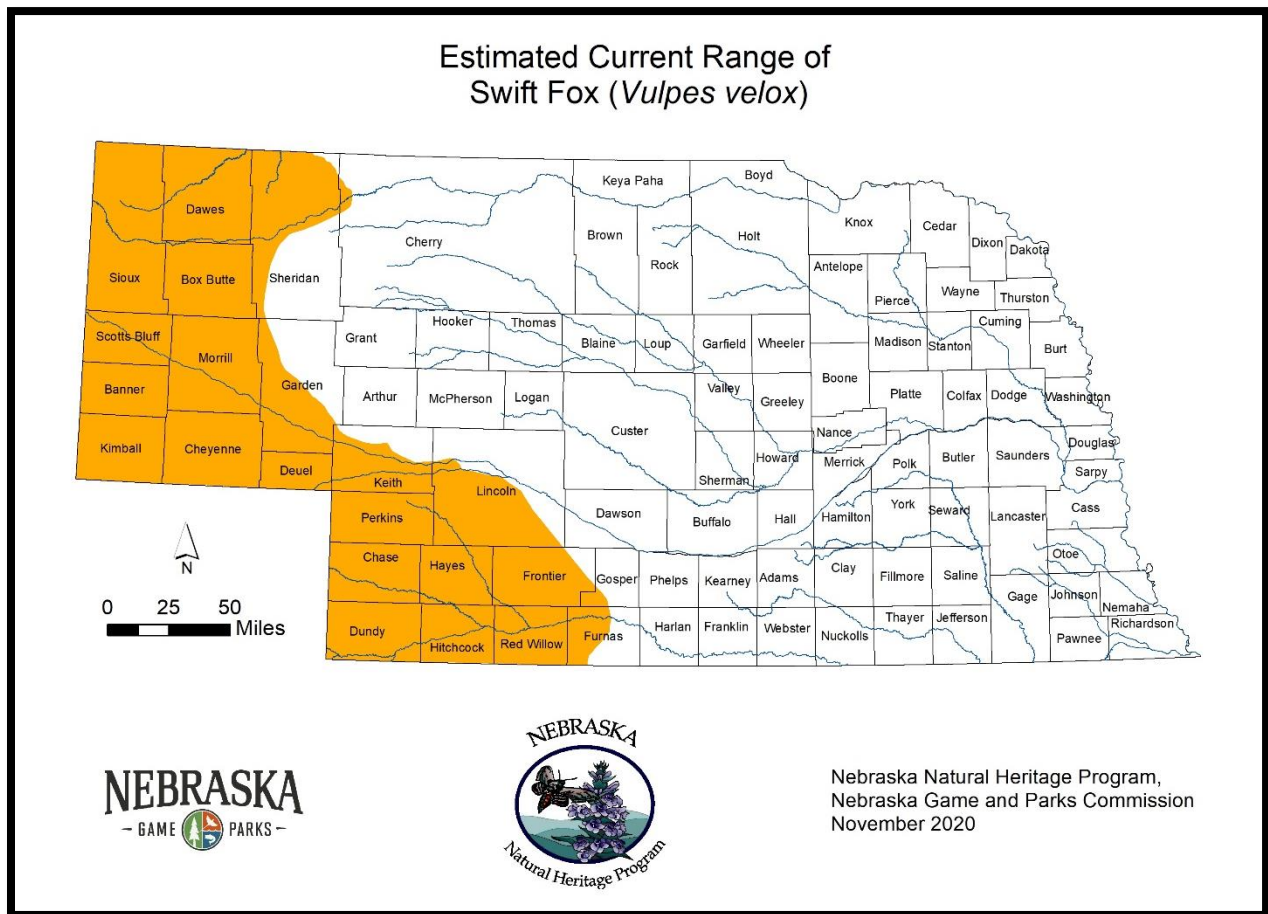


Figure 3. The current estimated range of swift foxes in Nebraska based on research surveys, field observations, and expert knowledge.

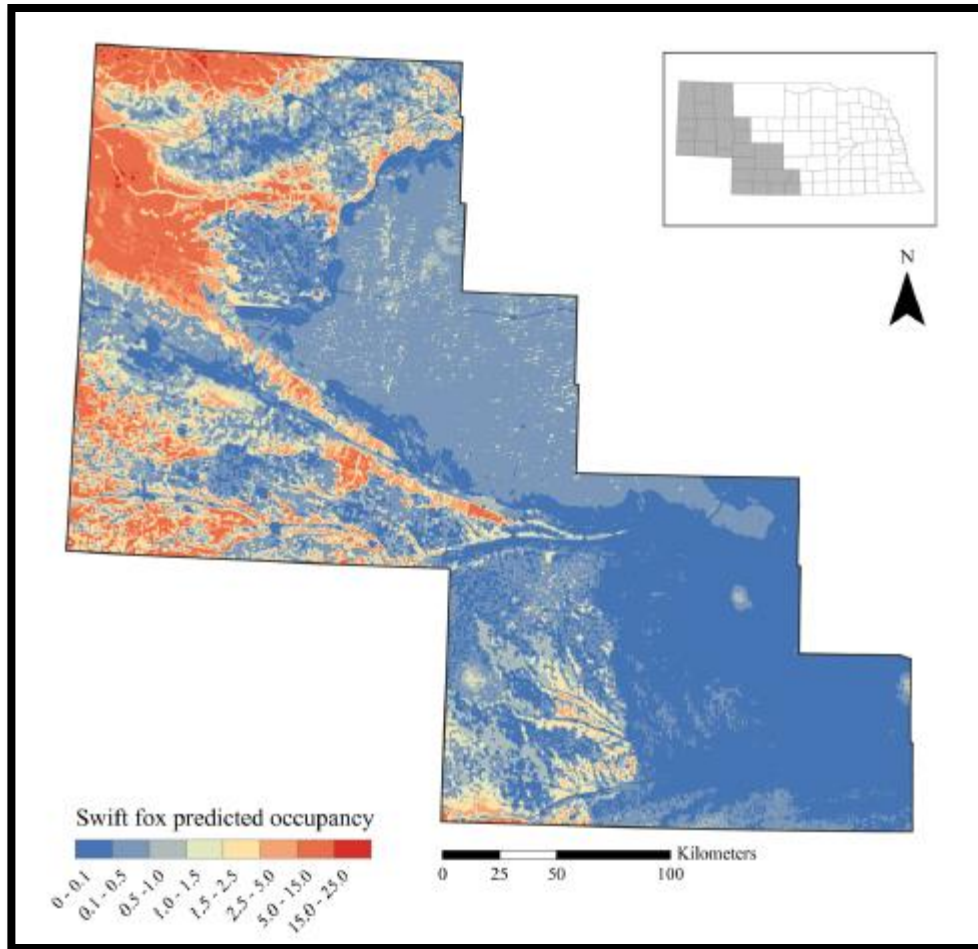


Figure 4. Predicted swift fox species occupancy model for western Nebraska based on land cover variables, published in Corral Hurtado (2018). Land cover variables included short-grass, mixed-grass, sage grass, Sandhills, trees, small grain, row crop, roads, and development. Model was developed and verified using known locations from trail camera surveys. Swift fox occupancy is predicted to be highest in the areas depicted in shades of orange and red.

Diet and Foraging

Swift foxes are omnivores with a bias toward carnivory. They are opportunistic foragers and can adapt their diet to food availability. Diets often contain mammals (e.g., rabbits, prairie dogs, rodents), birds, insects (particularly grasshoppers), and vegetable matter like grasses and berries. They also scavenge roadkill and other carrion.

Survival and Reproduction

Swift fox mortality has been attributed to depredation by coyotes and raptors (e.g., golden eagles), vehicle collision, incidental take (e.g., trapping, shooting), and intentional take in other states where harvest is legal. Longevity is around four years of age, though swift foxes have been documented up to nine years old in the wild (Nevison, unpublished data), with sexual maturity occurring in their first year.

Swift foxes are monogamous, though copulation with other mates is known to occur. The breeding season is in late winter (January – March). Pups are born underground and emerge from the den near the end of May or early June. They have one litter per year with 3–6 pups. Both parents care for the young, occasionally assisted by older sibling helpers.

Dispersal

Swift foxes are good dispersers, as evidenced by radio-collared foxes and genetic surveys (e.g., Corral Hurtado 2018). Juvenile swift fox dispersal occurs in the fall and winter (October – March), often aligning with the breeding season. Not all juveniles disperse, some stay near their parent’s den to assist in rearing next year’s young. Dispersal can be relatively short (< 5 km or < 3 mi.) or quite long distances (100–200 km or ~60-120 mi.; Ausband and Moehrenschrager 2009, Nevison 2017).



Figure 5. Pup swift fox in Box Butte County, Nebraska. Note the characteristic black-tipped tail. This pup is developing adult coloration with a grey back and yellow/white body (Nebraskaland).

Principal Risk Factors

1. Habitat Loss and Degradation:
 - Conversion of native, short-grass prairie into cropland and other agricultural uses.
 - Fragmentation of habitat by agriculture, urban development, and invasive species.
 - Introduction/expansion of invasive species (e.g., Canada thistle [*Cirsium arvense*], cheatgrass [*Bromus tectorum*], eastern redcedar [*Juniperus virginiana*], sweetclover [*Melilotus officinalis*]) which reduce the quality of habitat, particularly by reducing visibility.
 - Altered frequency, duration, and/or intensity of disturbance, like fire and/or grazing, which historically maintained short structured, high-quality habitat.

2. Reduction of Black-tailed Prairie Dog Colonies:
 - Conversion and removal of black-tailed prairie dog (*Cynomys ludovicianus*) colonies for agricultural purposes or landowner preferences.
 - Poisoning, hunting, and shooting of prairie dogs on individual and colony-wide scales.
 - Effects of sylvatic plague (*Yersinia pestis*), with the potential for complete extirpation of localized colonies.

3. Population Dynamics and Genetics:

- Effects of small population and subpopulation size on population growth, dispersal, and genetic health.
 - Corral Hurtado (2018) found that swift foxes are restricted to only two pockets in Nebraska, in primarily Sioux and Kimball counties. See more in “Habitat and Range” below.
- Effects of disjunct and fragmented populations, potentially reducing gene flow between populations on a local and regional scale.
 - Corral Hurtado (2018) found the population of swift foxes in Nebraska to be genetically healthy and stable, with high levels of heterozygosity and high genetic diversity. However, the author warns about the potential for future reduction of genetic diversity because of small population sizes and landscape fragmentation that could further isolate the populations in the state.

4. Disease:

- Sylvatic Plague (*Yersinia pestis*) – a bacterial infection associated with fleas and rodents. Infections can kill off entire colonies of prairie dogs, which reduces high-quality habitat that the colonies provide, and reduces a high-quality food source for swift foxes. The disease does not usually cause mortality in swift foxes.
- Canine Distemper Virus (*Canine morbillivirus*) and Canine Parvovirus (*Canine parvovirus*) – viral infections associated with all canine species. Effects on swift foxes are understudied, though swift foxes have tested positive for the viruses and high mortality is known to affect other canine species (e.g., Mitchell 2018).
- Tularemia (*Francisella tularensis*) – a bacterial infection associated with ticks and lagomorphs, “rabbit fever.” Infection often leads to death in rabbits – a common prey item for swift foxes. Effects on swift foxes are understudied, though swift foxes have tested positive for the bacterium (e.g., Mitchell 2018).
- Other internal and external parasites are also known to affect swift foxes, including fleas, ticks, mites, and nematodes. Other diseases may also affect the species, like adenovirus, but more research is needed.

5. Other Potential Risk Factors:

- Interspecific competition, depredation, and/or interference of swift foxes between both coyotes and red foxes is possible. Depredation of adults and pup swift foxes by golden eagles, badgers, bobcats, and great horned owls has been documented in other states.
 - Corral Hurtado (2018) found little effect of coyotes and red foxes on swift fox occupancy but had low detection rates of all species during research and analysis. The author suggested that the effects of competition may be better reflected through swift fox population size or abundance, which was not measured in the study. However, research in other states found high mortality rates due to coyote depredation (e.g., Nevison 2017) and evidence of intraguild depredation between coyotes and swift foxes (e.g., Thompson and Gese 2007).
- Incidental take of swift foxes in Nebraska occurs (e.g., trapping, hunting, poisoning), but is not likely to be a significant factor affecting the population. It is unlawful to export, take, possess, process, sell, deliver, carry, transport, or ship, or violate any regulation pertaining

to the conservation of swift foxes, according to the Nebraska Nongame and Endangered Species Conservation Act (Nebraska Revised Statute 37-806.)

- Mortality from vehicle collisions also occurs, and although it is not likely to have a significant effect on the population in Nebraska, swift foxes are known to use roads in western Nebraska (Albrecht 2015). Vehicular collisions are a high cause of mortality in other states (e.g., Nevison 2017).
- Lack of education about swift foxes and short-grass prairies, including prairie dog towns, likely result in decreased appreciation and conservation of the species by many local landowners, managers, and policymakers.
- The Nebraska Natural Legacy Project (Schneider et al. 2011, Schneider et al. 2018) classified the Climate Change Vulnerability Index for swift foxes as “not vulnerable, increase likely.” Still, the effects of climate change could result in negative outcomes for swift foxes if not actively managed (e.g., increasing spread of invasive species and diseases).

Research and Conservation Strategies

A multitude of factors should be considered before implementing any conservation actions. Within the guidelines of state and federal law, the Nebraska Natural Legacy Project recommends: 1) consider, but do not limit options to, scenarios that benefit not only the species of interest but also property owners, 2) consider species dispersal and landscape context, 3) plan for multiple years, and 4) do no harm.

In Nebraska, there are three main BULs where one can make conservation considerations for swift foxes: Oglala Grasslands, Panhandle Prairies, and Kimball Grasslands. An additional five BULs fall within the likely range of swift foxes and flat, grassland areas within these BULs can also be considered: Pine Ridge, Upper Niobrara River, North Platte River, Wildcat Hills, and Sandsage Prairies. The Nebraska Natural Legacy Project identified these landscapes as places that offer the best opportunities for conservation of swift foxes in the state based on current knowledge. See the Nebraska Natural Legacy Project for locations, detailed descriptions, stresses, conservation strategies and opportunities of each BUL (Schneider et al. 2011, Schneider et al. 2018). Given the principal threats identified, research and conservation efforts for swift foxes may want to employ the following conservation and management actions as well as the research topics listed below. These are summarized in Table 2 at the end of this document.

Conservation and Management Actions

1. Habitat

- a. Identify and maintain native, short-grass prairie on large scales in western Nebraska. Actively work to minimize conversion of grasslands to agriculture, particularly surrounding occupied swift fox habitat (see Fig. 4 for predicted occupancy), by use of state, federal, and other conservation programs. Funding examples below:
 - i. Nebraska Natural Legacy Project
 - ii. Pheasants Forever
 - iii. United States Department of Agriculture:
 1. Natural Resources Conservation Service, NRCS, (Conservation Reserve Program [CRP], Conservation of Private Grazing Land [CPGL], Grassland Reserve Program [GRP], Wildlife Habitat Incentives Program [WHIP])

2. Farm Service Agency

iv. United States Fish and Wildlife Service

1. Partners for Fish and Wildlife Program (PFW)

- b. Restore short-grass prairie. Ensure that restorations are not planted with tallgrass prairie species. Short- and mixed-grass prairie plant species often associated with swift fox habitat include blue grama (*Bouteloua gracilis*), buffalograss (*Bouteloua dactyloides*), needle and thread (*Hesperostipa comata*), needleleaf sedge (*Carex duriuscula*), and western wheatgrass (*Pascopyrum smithii*).
- c. Reduce effects of invasive species (e.g., Canada thistle [*Cirsium arvense*], cheatgrass [*Bromus tectorum*], eastern redcedar [*Juniperus virginiana*], sweet clover [*Melilotus officinalis*]) on swift foxes by actively managing native short-grass prairie. Methods may include spraying, burning, mechanical removal, etc. Avoid planting invasive woody vegetation on grasslands.
- d. Introduce or expand ecologically-sensitive prescribed burning and/or grazing efforts aimed at maintaining short vegetation. Land managers should aim to replicate the timing, intensity, and distribution of disturbances that historically shaped short-grass prairie.
 - i. Rotational grazing, varied grazing regimes, and ecologically-sensitive stocking rates to maintain a landscape mosaic.
 - ii. Prescribed burning to control invasive woody vegetation, maintain varied plant height, promote biodiversity and prairie health. Recommendation from NRCS is every 5–8 years for short-grass prairie, during the dormant season (Marks 2005).
 - iii. Patch burning (combining rotational grazing with prescribed burning) can also help maintain a landscape mosaic characteristic of historical grasslands.
 - iv. Mowing/haying or disking can also be used on smaller scales, an interval of every 3–5 years is recommended by NRCS (Marks 2005).
- e. Increase connectedness of fragmented landscapes by coordinating with interested private landowners, state, federal, and other landowners and conservation organizations to increase large-scale, short-grass prairie or corridors.

2. Prairie Dog Colonies

- a. Maintain or improve prairie dog colonies at ecologically-functional levels. This may include working with private, state, or federal landowners to keep prairie dogs on the landscape, actively managing sylvatic plague, and/or reducing the poisoning, shooting, and hunting of prairie dogs at an ecologically-functional level.

3. Populations and Genetics

- a. Promote dispersal of swift fox by increasing connectedness of fragmented landscapes; coordinate with interested private, state, federal, and other landowners and conservation organizations to increase large-scale, short-grass prairie.

4. Disease

- a. Actively manage sylvatic plague outbreaks in prairie dog colonies, potentially by dusting with insecticides.

- b. Recommend vaccinating domestic dogs against canine distemper and parvovirus to reduce the potential spread of disease.

5. Human Dimensions

- a. Facilitate partnerships and cooperative efforts to protect, restore, and enhance suitable habitats.
 - i. Federal partners may include the US Forest Service, US Fish and Wildlife Service, National Park Service, US Department of Agriculture Natural Resource Conservation Service, etc.
 - ii. State partners may include Nebraska Forest Service, Nebraska Game and Parks Commission, Nebraska Natural Legacy Project Partnership Team, Universities/Colleges, etc.
 - iii. Other conservation organizations may include The Nature Conservancy, Ducks Unlimited, Platte River Basin Environments, etc.
 - iv. Private partners may include landowners already enrolled in state or federal conservation programs (e.g., Open Fields and Waters, CRP), landowners with prairie dog colonies on their property, interested landowners with suitable habitat, etc.
 - v. Tribal partners should also be contacted.
- b. Gain and maintain relationships with private landowners by working with Coordinating Wildlife Biologists, University Extensions Specialists, federal programs, etc.
- c. Minimize incidental take of swift foxes by educating trappers and hunters about swift fox identification, especially when hunting coyotes, and using target-specific trapping methods.
- d. Educate the general public, school children, visitors, wildlife viewers, agricultural groups, conservation organizations, city/county governments, landowners, managers, and policymakers about swift foxes, grasslands, and prairie dogs, to garner interest and support in conservation of the species.
- e. If vehicle collisions increase, consider posting signs near known home ranges encouraging motorists to avoid collisions with foxes.

6. Other

- a. Continually update location data with incidental observations and research study findings. Update county maps and range map as appropriate and share with neighboring states and other conservation partners.
- b. Periodically evaluate the status of swift foxes at state and regional levels, and consider appropriate status classification.
- c. Integrate swift fox conservation and management into other species/landscape management plans where applicable.
- d. Maintain working relationships with the Swift Fox Conservation Team and neighboring states; share county/location information with our neighbors for a better understanding of the species on a regional scale; collaborate on region-wide research opportunities (e.g., genetics); submit reports to the Swift Fox Conservation Team and attend meetings.

- e. Reduce interference competition if deemed necessary. Coyote control programs are not likely beneficial to the swift foxes in Nebraska at the present time. Control programs could be a tool used in the future so long as it is conducted in conjunction with habitat restoration and done in a manner that ensures no inadvertent harm to swift foxes, and the cost and time of the program are taken into consideration.

Research Topics

1. Habitat

- a. Conduct studies to assess how swift foxes are affected by habitat in Nebraska. In particular, home range, space use, landscape-level changes, vegetation structure, use of restored grasslands, patch size, cropland use, shifting prey base, depredation pressure, etc. Permitted trapping, radio-collaring, and tracking of foxes will likely help assess these objectives.
- b. No known studies exist on the effects of grassland management on swift fox populations (e.g., prescribed burning, rotational grazing, mechanical removal of woody invasives). Studies assessing the loss of historical disturbance regimes, the effect of different grazing patterns, prescribed burning, and restorations are needed. This may be particularly possible in Nebraska where prescribed burning is occurring as a habitat management activity.
- c. Update empirically developed fine-scale maps for swift fox distribution for better visualization of overall range and connectivity.

2. Populations and Genetics

- a. Monitor genetic diversity and interconnectedness of subpopulations, as well as regional populations. Collect tissue samples from all roadkill swift foxes and periodically collect scat from all known dens for inclusion in regional genetic analysis. Collection, storage, and shipping information is available from the Nebraska Game and Parks Commission Furbearer Biologist or Natural Legacy Biologist.
- b. Strategically monitor distribution with various detection methods (camera surveys, trapping surveys, road mortalities, incidental trapping or shooting, observations, solicit public participation, iNaturalist, etc.) on a standard timeline and update population assessment as needed.
 - i. As per the designation of endangered and a Tier 1 at-risk species, the Nebraska Natural Heritage Program tracks all extant occurrences of swift foxes, including but not limited to live observations, dens, pups, adults, mortalities, etc. Therefore, any and all occurrences of swift foxes in Nebraska must be reported to the Natural Heritage Program for tracking.
- c. Analyze functional connectivity and dispersal; incorporate both demographic, habitat, and genetic information, including broader regional context - particularly, examine genetics at a regional scale, including South Dakota where there is likely continuous gene flow between northwest Nebraska and southwest South Dakota populations.
- d. Estimate population size range-wide and within subpopulations.
- e. Monitor dens to estimate reproduction rates.

- f. Collar foxes to estimate survival, mortality, and dispersal. If mortality can be determined, later assess methods to reduce mortality.

3. Disease

- a. Explore zoonotic diseases carried by swift foxes that may affect their populations and/or transfer to domestic pets. Specifically, serology of swift foxes and sympatric species; prevalence and likelihood of disease transmission between canids; hematology, and parasite load of swift foxes.
- b. Consider results from disease analysis of red foxes in Nebraska (see Dougherty 2019) for potential implications or other research ideas for swift foxes.

4. Human Dimensions

- a. Investigate public perceptions about swift foxes, prairie dogs, grassland ecosystems, etc., and investigate effective education techniques locally; conservation campaign.

5. Other

- a. Continue to study interference competition between swift fox, red fox, and coyote and estimate the occurrence and species favorability. Particularly fine-scale spatial and temporal avoidance, which may be minimizing the effect of interference competition and promoting the coexistence of sympatric canid species. How temporal activity patterns affect different species and individuals, populations, and ecosystems.
- b. Explore how climate change may affect the species at various scales (habitat fragmentation, genetic connectivity, prey base, habitat selection, disease spread, invasive species) and short-grass prairie ecosystems as a whole.
- c. Reassess the current regulatory mechanisms and status of swift fox in the state with forthcoming endangered and threatened species guidelines by NGPC; reassess population goals and other details in revisions of the Nebraska Natural Legacy Project.
- d. Additional research topics are included in Corral Hurtado (2018) on pages 48–52, including research topics identified by the Swift Fox Conservation Team.

Considerations for Additional Species

At-risk species, including keystone and indicator species, which also inhabit short-grass prairie ecosystems, should be considered when managing for swift foxes. On-the-ground conservation for swift foxes may affect or be influenced by species found in the same BULs. Actions to conserve these sympatric species should also integrate swift fox conservation where appropriate. Associated species that may also benefit from conservation of swift foxes are listed below. This list will not apply to all sites of occupancy, nor is the list all-inclusive.

TABLE 1. Associated species that may benefit from conservation of swift foxes.

* Species conservation assessment exists for NGPC

^ State threatened or endangered species in Nebraska

Birds	Mammals
Black-billed Magpie (<i>Pica hudsonia</i>)	Black-tailed Prairie Dog (<i>Cynomys ludovicianus</i>)
Brewer's Sparrow (<i>Spizella breweri</i>)	Cheyenne Northern Pocket Gopher (<i>Thomomys talpoides cheyennensis</i>)
Burrowing Owl (<i>Athene cunicularia</i>) *	Pierre Northern Pocket Gopher (<i>Thomomys talpoides pierreicolus</i>)
Chestnut-collared Longspur (<i>Calcarius ornatus</i>)	Plains Spotted Skunk (<i>Spilogale putorius interrupta</i>)
Golden Eagle (<i>Aquila chrysaetos</i>)	White-tailed Jackrabbit (<i>Lepus townsendii</i>)
Greater Prairie-Chicken (<i>Tympanuchus cupido</i>)	
Ferruginous Hawk (<i>Buteo regalis</i>)	Reptiles
Loggerhead Shrike (<i>Lanius ludovicianus</i>) *	Glossy Snake (<i>Arizona elegans</i>)
Long-billed Curlew (<i>Numenius americanus</i>)	Mountain Short-horned Lizard (<i>Phrynosoma hernandesi</i>)
Thick-billed Longspur (<i>Rhynchophanes mccownii</i>) * ^	Sagebrush Lizard (<i>Sceloporus graciosus</i>)
Mountain Plover (<i>Charadrius montanus</i>) ^	Terrestrial Garter Snake (<i>Thamnophis elegans</i>)
Prairie Falcon (<i>Falco Mexicanus</i>)	
Short-eared Owl (<i>Asio flammeus</i>)	Insects
	Colorado Rita Dotted-blue (<i>Euphilotes rita coloradensis</i>)
Plants	Nine-spotted Ladybird Beetle (<i>Coccinella novemnotata</i>)
Colorado Butterfly Plant (<i>Gaura neomexicana coloradensis</i>) ^	Regal Fritillary (<i>Argynnis idalia</i>)
Gordon's Wild Buckwheat (<i>Eriogonum gordonii</i>)	Southern Plains Bumble Bee (<i>Bombus fraternus</i>)
Large-spike Prairie Clover (<i>Dalea cylindriceps</i>)	Suckley's Cuckoo Bumble Bee (<i>Bombus suckleyi</i>)
Short's Milkvetch (<i>Astragalus shortianus</i>)	Western Bumblebee (<i>Bombus occidentalis occidentalis</i>)

TABLE 2. Summary of suggested management strategies and considerations for swift foxes in Nebraska. The following are general guidelines based on the best available knowledge at the time of this publication. See the Research and Conservation Strategies section of this document for more detail and the Literature Cited section for sources of additional information.

FOCUS	STRATEGIES	CONSIDERATIONS
Habitat	<ul style="list-style-type: none"> • Maintain native short-grass prairie; actively work to minimize loss of prairie • Restore short-grass prairie • Reduce effects of invasive species • Introduce/expand prescribed burning and/or rotational grazing • Increase connectedness of fragmented short-grass prairie • Research how habitat variables affect swift foxes by conducting radio-collaring study • Research grassland management actions (e.g., prescribed burning, rotational grazing, restorations) and their effects on swift fox populations • Update fine-scale maps of swift fox distribution 	<ul style="list-style-type: none"> • Seek state, federal, and other conservation programs for funding assistance • Ensure restorations are not planted with tallgrass species • Consider burning, grazing, spraying, or mechanical removal of invasives • Ensure disturbance regimes are replicating timing, intensity, and distribution of historical regimes • Public and private landowner participation should be voluntary and incentive-based
Prairie Dog Colonies	<ul style="list-style-type: none"> • Maintain or improve prairie dog colonies at ecologically-functional levels • Consider managing sylvatic plague • Reduce poisoning, shooting, hunting 	<ul style="list-style-type: none"> • Understand landowner views and needs in conjunction with ecologically-functional levels • Public and private landowner participation should be voluntary and incentive-based
Populations and Genetics	<ul style="list-style-type: none"> • Strategically monitor distribution (camera surveys, trapping surveys, road mortalities, other observations) on a standard timeline • Monitor genetic diversity on local and regional scales by collecting tissue from road kills and scat from dens; estimate population size • Promote dispersal by connecting patches of habitat • Research functional connectivity on local and regional scales • Monitor dens to estimate reproduction • Collar foxes to estimate survival, mortality, and dispersal 	<ul style="list-style-type: none"> • Consider cost and feasibility of sample collection • Public and private landowner participation should be voluntary and incentive-based • Seek state, federal, and other conservation programs for funding assistance

FOCUS	STRATEGIES	CONSIDERATIONS
Disease	<ul style="list-style-type: none"> Actively manage sylvatic plague in prairie dog colonies Monitor for disease outbreaks Vaccinate domestic dogs from disease Research other zoonotic diseases 	<ul style="list-style-type: none"> Consider cost and feasibility of disease management
Human Dimensions	<ul style="list-style-type: none"> Facilitate partnerships and cooperative efforts Gain and maintain private landowner relationships Educate trappers, hunters, and the general public about the species Research perceptions and investigate effective education 	<ul style="list-style-type: none"> Build and maintain relationships that will be longstanding
Other	<ul style="list-style-type: none"> Continually update location data Evaluate the status of the species Integrate conservation and management with other species Maintain relationships with Swift Fox Conservation Team Research interference competition Research climate change effects Reassess status in the state 	<ul style="list-style-type: none"> Consider cost and feasibility of research opportunities

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