SWIFT FOX CONSERVATION TEAM

REPORT FOR 2017 – 2018

SWIFT FOX CONSERVATION TEAM REPORT FOR 2017 – 2018

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The submissions in this biennial report represent the findings and conclusions of the submitters and have not been examined through a scientific, peer-reviewed process.

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INTRODUCTION

The swift fox (*Vulpes velox*) was petitioned to be listed as threatened under the Endangered Species Act in 1992. After review, the U.S. Fish and Wildlife Service determined the species was warranted for listing but precluded due to higher priority species (U.S. Fish and Wildlife Service 1995). In response to this petition, the Swift Fox Conservation Team (SFCT) was formed in 1994 and is comprised of state, federal, Canadian, tribal, and non-governmental organizations along with other interested organizations within the swift fox range. The SFCT works to assemble existing information, collect new biological data, implement swift fox monitoring and management programs, and advance swift fox conservation and restoration to avoid future listing under the Endangered Species Act. Since 1994, the SFCT developed the "Conservation assessment and Conservation Strategy of Swift Fox (*Vulpes velox*) in the United States" (CACS; Kahn et al. 1997), written 18 annual or biennial SFCT reports, and revised and updated the CACS to reflect new information and updated priorities (Dowd Stukel 2011). This report outlines the activities and accomplishments achieved on behalf of swift fox conservation by SFCT members in 2017 and 2018.

LITERATURE CITED

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Kahn, R., L. Fox, P. Horner, B. Giddings, and C. Roy. 1997. Conservation assessment and conservation strategy for swift fox in the United States. Colorado Division of Wildlife, Fort Collins, USA.

U.S. Fish and Wildlife Service. 1995. Endangered and threatened wildlife and plants: 12-month finding on a petition to list the swift fox as endangered. Federal Register 60:31663–31666.

SWIFT FOX CONSERVATION TEAM

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Swift Fox Investigations in Kansas, 2017-2018

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The swift fox population, distribution and harvest are monitored through multiple techniques in Kansas. Harvested swift foxes have been pelt tagged since 1994, and annual pelt tagging reports can be found on the Kansas Department of Wildlife, Parks and Tourism (KDWPT) website at https://ksoutdoors.com/Services/Research-Publications/Wildlife-Research-Surveys. In addition, KDWPT employees are asked to opportunistically document swift fox observations during their regular duties. This effort has been reported on in detail in previous SFCT reports and has been useful over time for documenting the distribution of swift foxes in the state. A more scientific and systematic approach to monitoring the population is desirable but has been difficult to implement since most of the swift fox range in Kansas is private land.

In the past, the Department conducted roadside track surveys to monitor swift foxes (1997-99 and 2002-04), but they have not been recently conducted due to various technical and logistical issues. Other states have effectively used trail camera surveys. Following some experimental camera survey efforts in the state in 2015 and 2016, the Department was interested in trying to use this technique to monitor swift foxes and other furbearers throughout the swift fox range in western Kansas.

In 2017, KDWPT funded a Pittman-Robertson (P.R.) project with Kansas State University (KSU) entitled "Assessing changes in the spatial distribution of swift fox (*Vulpes velox*) in western Kansas." The objectives of the project are to evaluate the role of ecological and environmental factors on the distribution of swift fox in the state and develop a predictive map of swift fox occupancy. In addition, a power analysis based on the results will be conducted to identify the number of sites needed for KDWPT to survey swift fox populations using camera surveys in the future. Year one of this project has been completed (see Werdel and Ahlers, 2018).

Camera surveys were conducted at 377 randomly selected sites throughout the potential swift fox range in Kansas (Figure 1). The survey period was May-October of 2018. Cameras were placed approximately 40 cm above the ground and baited with a mixture of skunk essence and Vaseline smeared on a garden stake placed 3 m in front of the camera. Cameras were left in place for 28 days. Batteries and memory cards were replaced and bait was refreshed at about 14 days.

At each site, local-scale habitat characteristics (vegetation height, percent cover type, crop type and soil type) were sampled. Landscape-scale habitat variables (percent crop, CRP, prairie, etc.) for each site were also acquired using national landcover maps and spatial pattern software. Current and historic precipitation data from weather stations positioned within the study extent are also being compiled. These variables will be used in subsequent analyses to identify predictors of habitat occupancy by swift fox.

Swift foxes were detected at 33 sites resulting in a naïve occupancy of 0.09. After controlling for detection, adjusted site occupancy was 0.13. In addition to swift fox, seven other furbearer species were detected. The camera survey will be repeated in 2019, and additional results will be available at a later date.

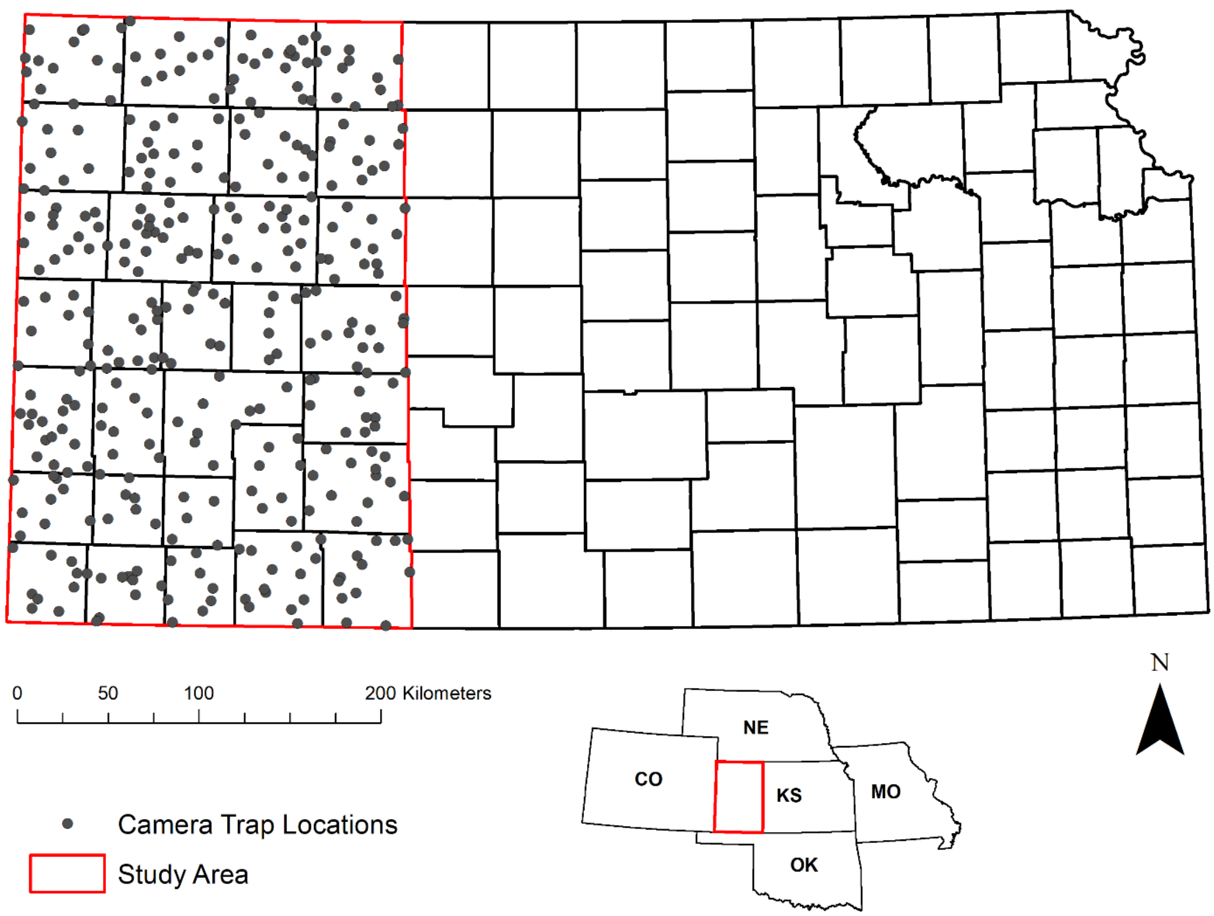

Figure 1. Location of study sites (n = 360) used to assess habitat occupancy status of swift fox (*Vulpes velox*) in Western Kansas, USA during 2018 (Werdel and Ahlers, 2018). (An additional 17 sites not indicated here were also surveyed.)

Literature Cited

Werdel, T.J. and A.A. Ahlers. 2018. Assessing changes in the spatial distribution of swift fox (*Vulpes velox*) in western Kansas. Annual performance report; W-99R-1. Kansas State University, Manhattan, KS.

MONTANA SWIFT FOX CONSERVATION AND MANAGEMENT, 2017-2018

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SUMMARY

Swift fox recolonized northern Montana after being reintroduced in southern Canada. Extensive efforts for swift fox surveying, monitoring and conservation continue in Montana. During 2017-2018, Montana continued progress towards the eight objectives of the Swift Fox Conservation Team (SFCT). Several representatives from states with swift fox participated in the SFCT meeting that Montana Fish, Wildlife and Parks hosted in 2018 in Bozeman MT. The Draft Montana Swift Fox conservation strategy has been written and is on the commission agenda for final approval in February 2019. The final report for the third international census (2014-15) was completed (Moehrenschlager and Moehrenschlager 2018) and the fourth international census was started in summer/fall of 2018. Efforts to promote awareness of the "Working Grasslands Initiative" continues by the Department and is a strategy to guide Montana Fish, Wildlife and Parks' grassland conservation efforts in partnership with private landowners and other conservation cooperators. Andrew Butler, Clemson University, continued to make progress on his graduate work. His project goal is to assess key factors influencing suitable habitats, population dynamics and regional connectivity for swift fox in the Northern Great Plains. Efforts to learn more about the swift fox in southeastern Montana continue. Public outreach efforts continue through social and print media to encourage appreciation of the species and reporting observations. Montana Fish, Wildlife and Parks thanks the many partners who have contributed to swift fox conservation during the reporting period.

BACKGROUND

Swift fox are native to the Northern Great Plains and were once considered to be abundant across their range, however, due largely to federal eradication campaigns focused on coyotes and wolves, they disappeared from much of their historical range in the late 20th Century. Swift fox were officially designated as extirpated from in Montana in 1969.

An extensive reintroduction of swift fox occurred from 1983 -1997 in southern Canada, adjacent to North-Central Montana. Soon afterward, swift fox established populations in suitable habitats in northern Montana resulting in the population that presently exists. Since that time subsequent translocations to two tribal nations in Montana have occurred in attempts to increase distribution of swift fox.

A self-sustaining stable population of swift fox currently exists in the northern Montana and there is an increase in confirmed sightings across Montana. With a notable increase occurring in the southeastern corner which appears to be a natural recolonization from Wyoming and South Dakota.

Swift fox in Montana area classified as a furbearer and are a species of concern with a state rank of S3 which is “potentially at risk because of limited and/or declining numbers, range and/or habitat, even though it may be abundant in some areas”.

ACCOMPLISHEMNTS RELATED TO SFCT OBJECTIVES

The Swift Fox Conservation Team’s (SFCT’s) Conservation Assessment and Strategy was updated in 2011 (Dowd Stukel 2011). The 2011 Conservation Assessment and Strategy defined objectives for 2011-2020 as listed below. This report details activities and progress within Montana as related to each objective.

SFCT objectives:

1. **Maintain the SFCT, to include 1 representative of each of the state wildlife agencies within the historical range of swift fox.**

Montana Fish, Wildlife and Parks hosted the 2018 Swift Fox Conservation Team Meeting held in Bozeman Montana. Several representatives from FWP attended, including Bob Inman, Heather Harris, Brandi Skone, Kristina Smucker, Ashely Taylor, Megan O’Reilly and Emily Mitchell.

2. **Maintain swift fox distribution in at least 50% of the suitable, available habitat.**

At present, there is no definitive and widely accepted map of suitable swift fox habitat in Montana that can be used to assess the status of this objective. While several efforts to identify and map suitable habitat have occurred, there are inconsistencies among these models and are often thought to be over-representations. Current work described below (#6) is focused on creating a spatially-explicit model for habitat suitability. Identifying suitable swift fox habitat is a primary objective of Montana’s draft swift fox conservation strategy.

3. **Periodically evaluate the status of swift fox populations.**

Swift Fox International Census In North-central Montana

Population surveys have occurred on an approximate 5-year schedule in north-central Montana, as a part of the International Swift Fox Census in collaboration with Canada and the Calgary Zoo. These population surveys have been conducted in 1996-1997 (Canada only) 2000-2001, 2005-2006 and 2014-2015.

The final report for the 2014-2015 Census was completed in 2018 (Moehrenschlager and Moehrenschlager 2018). Key findings from this report show that following previous years of growth the reintroduced swift fox population in Canada and Montana decreased in abundance and occupancy between 2005/2006 and 2014/2015. Swift fox did however, maintain a similar extent of occurrence (Moehrenschlager and Moehrenschlager, 2018). Genetically the population was indicated to be healthy (Cullingham and Moehrenschlager 2013), but demographic changes highlighted a need for additional monitoring to determine current population trends after 2015.

It was determined that an additional census, using cameras, would be conducted in the fall of 2018. Paired tests between cameras and live traps showed that the two methods are similar in their likelihood of detection, 0.81 and 0.93 respectively (Moehrenschlager and Moehrenschlager 2018). The objective of this monitoring was to assess whether there had been further changes to the distribution or occupancy of swift foxes on both sides of the international border.

Methods

Sampling Approach

During the summer of 2015, camera trapping was conducted with the goal of replicating sampling at all sites that were surveyed using either live or camera traps during the winter of 2014/2015. These results suggested that cameras could be used successfully in place of live capture. During the summer of 2018, camera trapping was conducted at all sites in Canada and Montana where live and/or camera trapping had been conducted during the winter of 2014/15 (Moehrenschlager and Moehrenschlager 2018).

Survey Techniques

Camera trapping methods replicated those of the winter 2014/2015 survey in Canada and Montana (Moehrenschlager and Moehrenschlager 2018). The same trap site locations, within the same townships, were repeated as in past surveys. Sampling involved camera traps spaced at 1 km intervals along 5 km transects, and placed as centrally as possible within respective townships (Figure 1; Cullingham and Moehrenschlager, 2003; Cullingham and Moehrenschlager, in press).

Camera trapping occurred for 3 consecutive 24-hour periods at sample sites. Attractants were disks soaked with mackerel oil or fatty acid attached to scent-posts. Scent-posts consisted of lumber stakes measuring 5 x 5 x 40 cm and pointed on one end to facilitate mounting in the ground. Approximately 5 cm from the top of the stake, a plaster of Paris disk was mounted on the wood using a nail. Plaster disks were soaked in mackerel oil at the time of deployment. Reconyx motion-sensor cameras were mounted on iron stakes and positioned approximately 40 cm from the ground facing the scent-post. Cameras faced the scent-posts at a distance of 2m (Camaclang et al. 2010; Moehrenschlager and Moehrenschlager 2018).

Preliminary Results for Montana

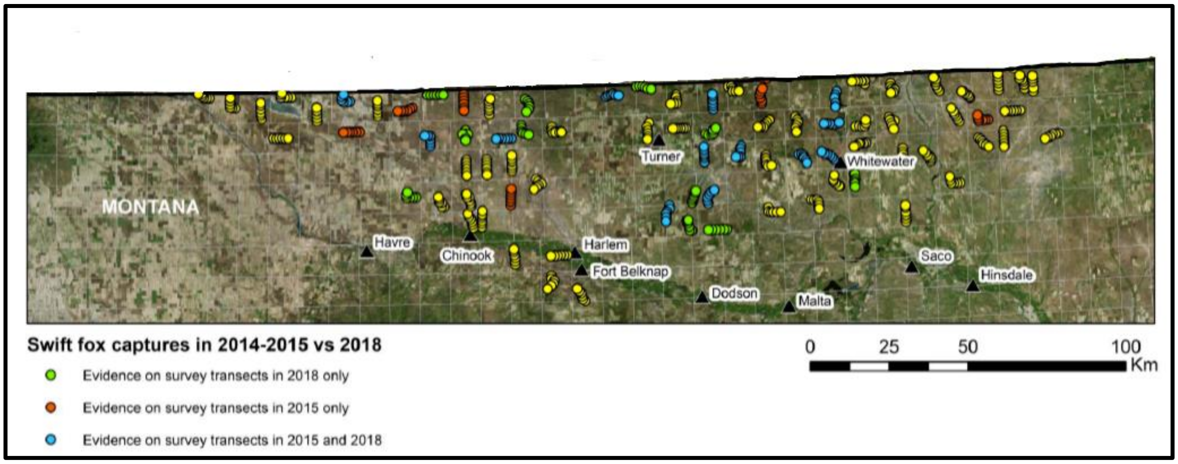

Figure 1: Location and preliminary results of replicated trap transects in Northeastern Montana in 2014/2015 and 2018.

Trap Transects:
How many surveyed - 80
How many detected foxes in 2018 - 24
How many detected foxes in 2015 - 19
Fox detected in 2018 only (green) - 11
Fox detected in 2015 only (red) - 6
Fox detected in both 2015 and 2018 (blue) - 13
Fox detected in neither 2015 or 2018 (yellow) - 50 (Figure 1)

There were a total of 80 townships surveyed in Montana. Of those townships, foxes were detected in 19 in 2014/2015 compared to 24 in 2018. This increase of townships combined with the fact they are still distributed across the survey area, is promising that they have the capability to recover under favorable conditions. This capability is somewhat expected given the fairly high fecundity of swift fox.

The status of swift fox, except for what appears to be natural fluctuations due to 2010-11's extreme winter, appears stable and with similar extent of occurrence. However, due to these fluctuations, coordinated monitoring between Canada and Montana should continue (Moehrenschlager and Harris, in press).

Swift Fox Work in Southeast Montana – Summary for 2017 and 2018 Efforts

Starting in 2015, we began to see an increase in the number of incidental swift fox observations in southeast Montana. To determine if we could successfully study foxes in southeast Montana, we deployed 6 VHF collars across 3 sites (2 at each) in 2017. We had great success and captured a total of 12 foxes over 7 nights (Table 1). Collars were placed on 3 juvenile males and 3 juvenile females. We tracked individuals using radio telemetry every 7-14 days. One individual was tracked for two weeks and never found again. Two were predated with coyotes as the likely cause. Two were shot and one died in the den from unknown causes. In 2018 we are continuing efforts with GPS collars and plan to distribute 15 collars across 3 sites to learn more about home range and habitat use in southeast Montana.

Table 1. Age and sex of foxes captured in southeast Montana in 2017.

Age	Sex	# Captured
Adult	Male	2
Adult	Female	1
Juvenile	Male	4
Juvenile	Female	5

This work along with continuing public outreach as discussed in SFCT objective number 7, has increased the documented number of swift fox observations and shows that, while we are unsure of population numbers, swift fox have been observed recently across a wide range of Montana (Figure 2).

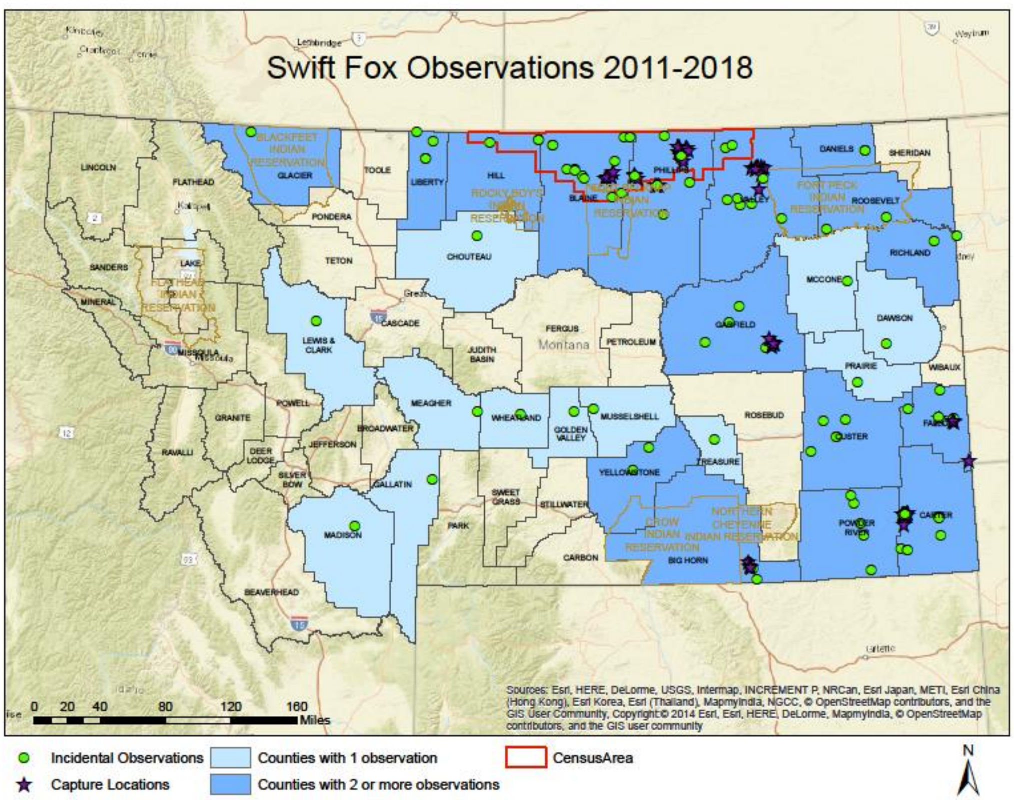

Figure 2: Swift fox observations reported in Montana from 2011-2018.

4. **Identify and conserve existing native shortgrass and mixed-grass grasslands, focusing on those with habitat characteristics conducive to swift fox**.

In 2017 Montana initiated an incentive designed to retain and enhance grasslands by targeting and offering a voluntary, incentive-based program for private landowners. The "Working

Grasslands Initiative" is a strategy to guide MFWP's grassland conservation efforts in partnership with private landowners and other conservation cooperators. Implementation of this program will help to achieve conservation targets identified in Montana's State Wildlife Action Plan, including for swift fox (Working Grasslands Initiative, 2017).

In 2017 -2018 several 30-year conservation lease agreements were completed under the grassland initiative, protecting approximately 17,500 acres.

5. **Facilitate partnerships and cooperative efforts to protect, restore, and enhance suitable habitats within potential swift fox range.**

On February 1, 2016, a group of interested organizations (hereafter referred to as the Montana Swift Fox Working Group) met in Billings, MT. Participants included representatives of the Northern Cheyenne Tribe, the Fort Peck Assiniboine and Sioux Tribes, the Blackfeet Nation, World Wildlife Fund, Oregon State University, American Prairie Reserve, The Nature Conservancy, the U.S. Fish & Wildlife Service C.M. Russell Refuge, and Montana Fish Wildlife and Parks. The meetings purpose was to gather information to formulate a statewide plan for swift fox conservation.

The Montana Swift Fox Conservation Strategy has been drafted and is intended to promote swift fox conservation and management by developing a statewide strategy that facilitates coordinated and effective efforts on the part of interested organizations. The following priorities will help guide FWP and partners in conserving swift fox in Montana and contributing to the eight objectives of the SFCT. This strategy is intended to compliment the SFCT strategy while clearly prioritizing those objectives that Montana can affect.

Priorities include:
1. Identify and Map Swift Fox Habitat in Montana
2. Conserve Swift Fox Habitat and Movement Corridors
3. Monitor Swift Fox Distribution/Status
4. Increase Distribution of Swift Fox into Suitable, Connected Habitats
5. Manage swift fox harvest sustainably

We anticipate the strategy will be endorsed by the Commission in early 2019.

6. **Identify and encourage research studies that contribute to swift fox conservation and management.**

Northern Great Plains Swift Fox Connectivity Graduate Project

In the past 60 years, despite six swift fox reintroductions to southern Canada, the Blackfeet and Fort Peck Reservations in Montana, and Bad River Ranches, Lower Brule Reservation and Badlands National Park in South Dakota, there is still a substantial range gap between northern populations in Montana and Canada, and those in Wyoming and South Dakota which are relatively contiguous with populations southward into Texas.

In order to enhance the distribution and connectivity of existing populations and identify habitat management priorities in the Northern Great Plains, more information is needed on what constitutes suitable habitat, and which factors limit swift fox population dynamics, dispersal, survival, and/or reproduction. These needs overlap with three primary objectives of the Swift Fox Conservation Team's 2011 Conservation Assessment Strategy, which are to: (1) identify and conserve existing suitable swift fox habitat; (2) maintain swift fox distribution in at least 50 percent of available suitable habitat by promoting natural dispersal and translocations; and (3) encourage research studies that contribute to conservation and management.

A graduate study conducted by Master's Student Andrew Butler under Dr. David Jachowski of Clemson University is currently being conducted on swift fox in the northern population of Montana. Funded by the National Fish and Wildlife Foundation, this project was initiated in 2016 and will be completed in 2019. For more information, please contact Dr. David Scott Jachowski at djackow@clemson.edu or Andrew Butler at abutle5@g.clemson.edu. Project partners include: Clemson University, World Wildlife Fund, Montana Fish, Wildlife and Parks, Calgary Zoo, Oregon State University, and the Bureau of Land Management.

The goal of this project is to assess key factors influencing suitable habitats, population dynamics and regional connectivity for swift fox in the Northern Great Plains.

Specifically, they are working to:

(1) estimate adult and juvenile swift fox survivorship and fecundity, space use and dispersal behavior in the core northern portion of their range (Blaine, Phillips and Valley Counties), and

(2) create a spatially-explicit model for habitat suitability and population connectivity for Montana that highlights key boundaries, bottlenecks and opportunities for targeted habitat conservation and restoration.

Some highlights from a progress report submitted to collaborators on May 03, 2018 and covering from April 2017-April 2018 are listed below. (Butler 2018).

Progress
Objective 1 and 2

- Captured and GPS collared 46 swift foxes during the fall of 2016 and 2017
    - Adult females- 10
    - Adult males- 10
    - Juvenile females- 14
    - Juvenile males- 12
- 3 Dens monitored in 2017
    4 pups at all dens

They will continue to attempt to download data from collars and trap to remove collars in fall of 2018.

A third objective was added in the summer of 2017, which was to use strategically placed trail cameras throughout the study area to identify tagged individuals as well as gather data on the distribution of coyote and red fox to improve habitat suitability models. To meet this objective over 100 cameras were deployed across the study area.

7. Promote public support for swift fox conservation activities through education and information exchange.

Montana Fish, Wildlife and Parks continues to promote awareness of swift fox. This is done through a variety of methods including:

- Initiating news releases through social and print media informing the public about recognizing swift fox, the species history and ecology, and asking for help by reporting any observations to their local biologists.
- Winston Greely, Montana Fish, Wildlife & Parks Video Producer did an outdoors report on Swift Fox available on YouTube - January 2018: https://www.youtube.com/watch?v=YZ20AoVzfR4
- A story was featured in the September-October 2018 issue of Montana outdoors magazine: Searching for Swift Foxes FWP biologists in eastern Montana look for a small carnivore making a big comeback in much of its historic range. By Marla Prell -Fish, Wildlife & Parks R7 Information and education coordinator.

8. Maintain swift fox population viability such that listing under the U.S. Endangered Species Act is not justified.

Montana has a draft swift fox conservation strategy that outlines specific priorities across the state. Grassland conservation programs have been initiated. Population surveys have occurred on an approximate 5-year schedule in north-central Montana. The 2014-2015 international census reported declines in swift fox numbers in their stronghold in northcentral Montana and the 2018 International Camera survey preliminary results show a slight increase in township occupancy since then. A harvest of up to 10 swift fox occurs in a portion of north-central Montana and all swift fox taken must be reported and data are collected on sex, age, and location. The status of swift fox has improved significantly since the time that the species was considered for listing under the ESA, including several recent observations in southeastern Montana for the first time in many years. Montana continues to take proactive steps to fund research and conservation of swift fox in order to aid the SFCT's efforts across the species range.

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STATUS OF SWIFT FOX IN NEW MEXICO: 2018 UPDATE

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ABSTRACT

The swift fox occurs in shortgrass prairies in the eastern one-quarter of New Mexico and is still found in the majority of areas where it was documented historically. The species is a harvestable furbearer in New Mexico and harvest data for 2016-2018 are presented and discussed. Formal surveys of the species were not conducted in New Mexico during the reporting period.

INTRODUCTION

The swift fox (*Vulpes velox*) inhabits shortgrass prairie communities in portions of 12 counties of eastern New Mexico. The species presently occurs throughout its historic range in New Mexico with the exception of areas in eastern Curry and Roosevelt counties, which have been developed as cropland, and in southeastern Quay County where taller grasses and shrub encroachment have replaced shortgrass prairie. Severe drought during much of the early 2000s has impacted grassland habitats used by this species in eastern New Mexico.

The range of New Mexico's subspecies of kit fox (*Vulpes macrotis neomexicana*), which includes grassland, shrubland, and desert habitats in the central, southern, and western parts of the state, overlaps with that of *Vulpes velox* in southeastern New Mexico (primarily in Chaves County), and hybridization between the two forms has been documented in this region. For conservation and management purposes, the New Mexico Department of Game and Fish (NMDGF) considers swift fox and kit fox as separate species but recognizes that genetic evidence supports the conclusion by some researchers that these two foxes are probably best considered as conspecific (i.e., *V. velox velox* and *V. velox neomexicana*, respectively). See Stuart (2013) for additional information.

MANAGEMENT STATUS IN NEW MEXICO

All fox species in New Mexico are classified by state statute as protected furbearers and can be legally harvested by licensed trappers during the regular furbearer trapping season (November 1 – March 15). Pelt-tagging is not required. Swift fox was formerly considered a Species of Greatest Conservation Need under the New Mexico State Wildlife Action Plan (SWAP) but was removed from this classification in the 2016 revision of the SWAP due to its existing legal status as a protected furbearer.

FURBEARER HARVEST DATA

The status of swift fox as a legally-harvestable furbearer in New Mexico was discussed by Stuart (2013). We provide below information from the most recent two trapper harvest years. Although trappers in New Mexico often use the terms “swift fox” and “kit fox” interchangeably, the species harvested can usually be discerned based on the county in which it was reportedly taken. Results of the 2018-2019 trapping season are not yet available.

Harvest results for 2016-2017 season – A total of 167 swift/kit fox (combined) was reported as harvested statewide in New Mexico by the 1,536 trappers who responded to the harvest survey (81% of all licensed trappers). Of these 167 foxes, 98 animals were taken within swift fox range in the following counties: Chaves (where kit fox and hybrids also occur), Colfax, and Mora. Notably, 90 of these 98 animals were taken in Chaves County alone and potentially included kit fox and/or hybrids.

Harvest Results for 2017-2018 season – A total of 120 swift/kit foxes (combined) was reported as harvested statewide in New Mexico by the 1,662 trappers who responded to the harvest survey (81% of all licensed trappers). Of these 120 foxes, 26 animals were taken within swift fox range in the following counties: Chaves (where kit fox and hybrids also occur), Colfax, Lea, Quay, and Union.

In most trapping seasons, the majority of swift/kit foxes reportedly taken in New Mexico are from counties west of the Pecos River and are therefore assignable to kit fox. Foxes taken by trappers in Chaves County are considered to be swift fox for purposes of tabulating harvest results although both species and hybrids are present there.

Even with an allowance for underestimates of harvest due to incomplete annual reporting data from trappers, the numbers of both swift and kit fox taken in New Mexico during 2016-2018 continue to be far below the estimated sustainable annual harvest limit for both species. Figure 1 illustrates the reported harvest rates by trapper-reporting year for swift and kit fox combined (both species) and for swift fox alone, from 2006 to 2018.

STATUS BY COUNTY

Swift fox habitat in eastern New Mexico is found in parts of 12 counties listed below. The year indicates the most recent documentation of swift fox in that county based on trapper harvest reports (h); reliable observations, photographs, or specimens (o); or formal track/scat survey efforts (s).

Chaves – 2018 (h)
Colfax – 2018 (h)
Curry – No recent data; not documented in surveys from 2002-2008.
De Baca – 2016 (h)
Guadalupe – 2014 (h)
Harding – 2013 (h)
Lea – 2018 (h)
Mora – 2017 (h)
Quay – 2018 (h)
Roosevelt – 2013 (o)
San Miguel – 2007 (o; D. Schwalm, pers. comm.)

Union – 2018 (h)

CURRENT AND FUTURE ACTIVITIES

Simulations using previously published estimates of swift fox population density, detection probability, and home range size were conducted to develop a logistically feasible and financially efficient spatial capture-recapture study design to estimate of swift fox density and abundance in north eastern New Mexico. A NMDGF pilot study using non-invasive methods will be implemented as a proof of concept tentatively scheduled for early 2020. Additionally, we will continue to compile roadkill and reliable observation data (obtained opportunistically) as done so during previous years. We also currently support research and habitat improvements of native grasslands via conservation projects that provide associated benefits to swift foxes and other prairie wildlife species, under the NMDGF Wildlife Action Plan. We will also begin collecting tissue samples from trapper harvested swift and kit foxes statewide during the 2019-2020 trapping season. Genetic data obtained from the samples will be used for species identification to better understand distribution in the state, as well as to look into hybridization dynamics where the two species overlap.

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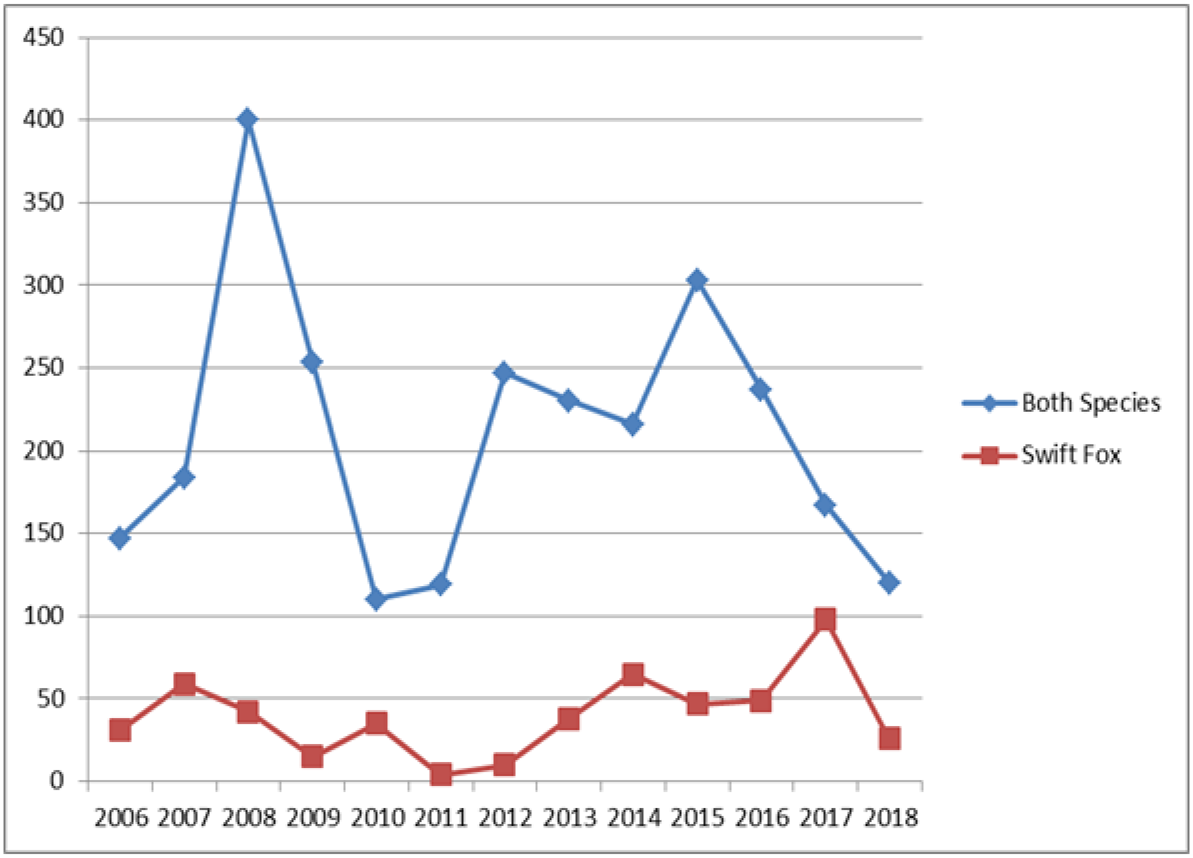
Figure 1. Annual harvest numbers for Swift and Kit Fox combined (Both Species) and for Swift Fox alone in New Mexico as reported by licensed trappers for trapper-reporting years 2006 to 2018.



2017-2018

NORTH DAKOTA REPORT TO THE SWIFT FOX CONSERVATION TEAM

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INTRODUCTION

Nationwide conservation of swift fox (*Vulpes velox*) began gaining momentum in 1994, when the United States Fish and Wildlife Service found that listing swift fox as threatened or endangered "may be warranted" throughout its entire range. The Swift Fox Conservation Team (SFCT) was formed and met annually with the objective of comparing and improving upon research and management techniques for swift fox throughout its range (Dowd Stukel 2011).

Locally, swift fox were common in North Dakota during pre-settlement times (Bailey 1926, Thwaites 1953); however, the species became rare about 1880-1900 (Bailey 1926). We have documented 33 reports of swift fox occurrence in North Dakota since 1970, of which 20 were verified to be swift fox. The majority (80%) of those verified reports have taken place since 2007 and were the result of photographs/videos (n = 1), incidental live-captures (n = 1) or deaths from automobile collisions (n = 8), incidental captures (n = 4), or mistaken identity by hunters (n = 2; Figure 1). We necropsied the dead swift foxes (10 males, 2 females, 2 unknown) and discovered that all of the foxes were young, dispersal-aged animals that showed no evidence of reproductive activity.

Because those reports of swift foxes were intermittent, widely dispersed, and did not indicate presence of a resident population from 2007-2012, we did not conduct additional surveys during that time.

Then, during August-September 2012, we investigated reports of resident swift foxes on private land in southwestern Bowman County via a site visit and deployment of several trail cameras. We discovered swift fox dens on the property and confirmed presence of the species using trail cameras. The following year in July 2013, we revisited the same area and once again confirmed the presence of swift fox via trail cameras. The presence of swift foxes in consecutive years indicated year-round residency and we suspected breeding activity.

As a result of the above findings, we conducted our first formal trail camera survey for swift fox in North Dakota in fall 2015. Additionally, a cooperative research project with National Fish and Wildlife Foundation, South Dakota Game, Fish and Parks, World Wildlife Fund, South Dakota State University, and Oregon State University was conducted during 2016-2018 (Mitchell 2018). Results from these investigations indicated there was a small population of swift fox in southwestern North Dakota and northwestern South Dakota that was contiguous and genetically viable. However, detections of swift fox were too low at the time to develop reliable occupancy maps for the region.

OBJECTIVES

To determine occurrence and/or distribution of swift fox in North Dakota.

METHODS

Department staff continue to be active participants in the SFCT. We consider this collaborative effort among state and federal agencies important to continued swift fox conservation and recovery throughout the Unites States.

In 2011, we began an awareness campaign for swift fox, directed at the public. This consisted of media releases, where we requested sightings and reports of occurrence be sent to the Department. We began distributing informational posters to Department cooperators who reside south and west of the Missouri River (Figure 2). The posters educate recipients regarding swift fox biology and potential occurrence, as well as request reports of occurrence. Additionally, we have distributed these posters during public events (e.g. State Fair), to our regional offices, and cooperating agency offices (United States Department of Agriculture-Natural Resources Conservation Service, United States Department of Agriculture -Wildlife Services, etc.). We investigated these reports and attempted to verify the species presence.

We continued to collect and necropsy swift fox that were incidentally killed due to automobile collisions, misidentification, or accidental trapping to collect demographic information and determine reproductive status.

RESULTS

From 1 July 2017 through 30 June 2018, we received 2 reports of swift fox occurrence, as a result of our media releases, informational poster distribution, or otherwise. Only 1 of those reports was verified, as it was illegally shot by a hunter. During necropsy, we determined that swift fox to be a 2-year-old male.

DISCUSSION

Our monitoring continued to indicate that swift fox have recolonized a small area in extreme southwestern North Dakota, which is a contiguous population with swift fox in northwestern South Dakota. We will continue to monitor reports of occurrence to determine if swift fox are expanding their distribution in the state. We will consider conducting more formal surveys and/or research in the future if our annual monitoring indicates a significant change in the specie’s distribution or abundance.

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Figure 1. Location of swift foxes that were live-captured or killed as a result of automobile collisions, misidentification, or incidental trapping in North Dakota, 1 January 2007-30 June 2018.

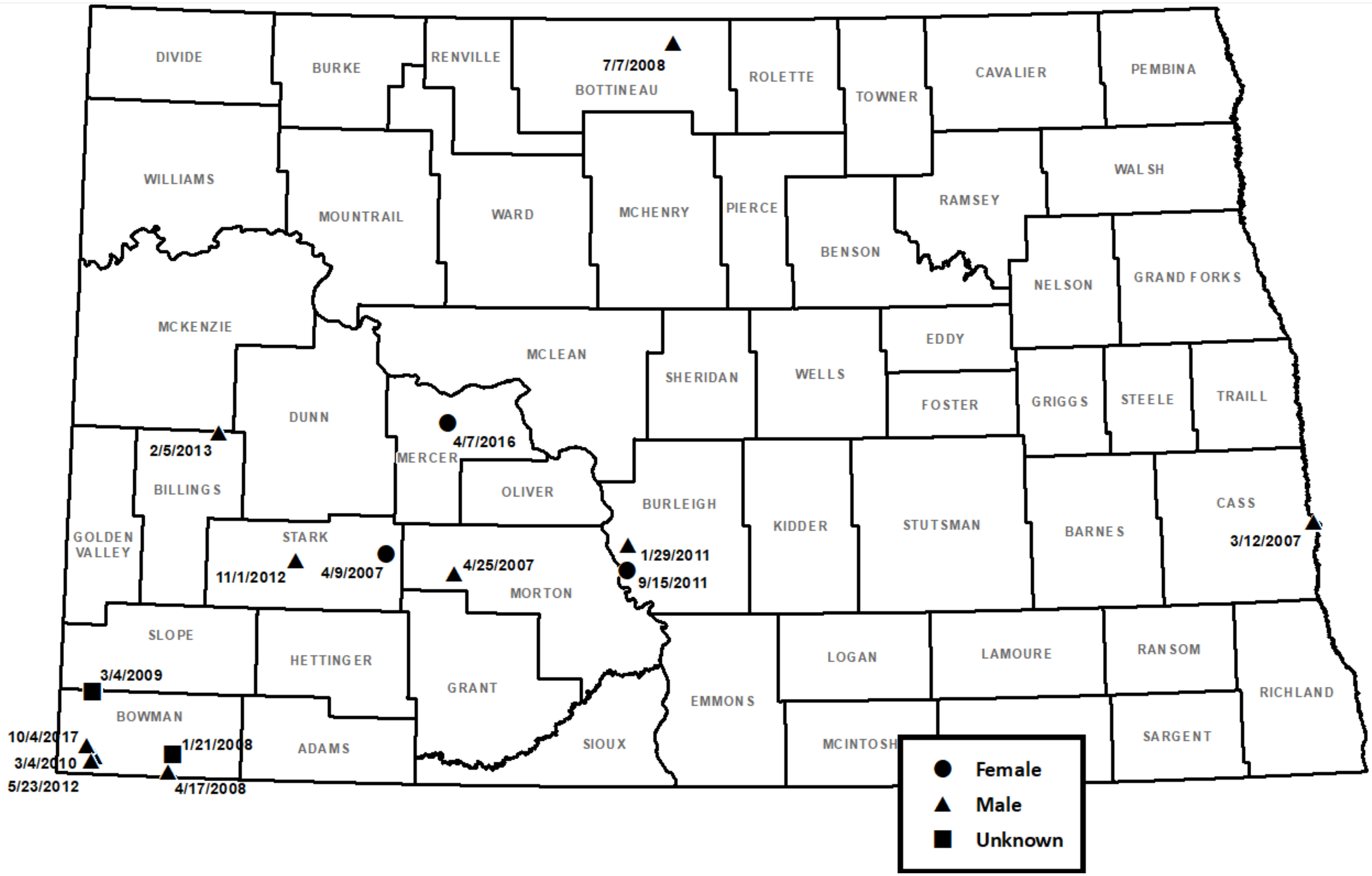

Figure 2. Informational poster distributed throughout southwestern North Dakota, and to a less extent statewide, beginning in 2011.

SOUTH DAKOTA GAME, FISH AND PARKS SWIFT FOX UPDATE, 2017-2018

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INTRODUCTION

The swift fox is a state threatened species and a species of greatest conservation need in South Dakota's Wildlife Action Plan (SDGFP 2014; Figure 1). This species is legally classified as a "fur-bearing animal" but with a closed season. South Dakota Game, Fish and Parks (SDGFP) has participated on the Swift Fox Conservation Team (SFCT) since the team's inception.

ADMINISTRATIVE ACTIVITIES AND FUNDING ASSISTANCE

SDGFP Wildlife Diversity staff drafted status reviews for all state threatened or endangered species to summarize what is known about the species in the state, to identify delisting or downlisting goals if current knowledge allows that step, and to list monitoring and research needs. These reviews were publicized through the SDGFP Commission process, with 60 days allowed for public comment before Commission approval on 5 April 2018. These reviews will be revisited every two years to demonstrate compliance with the state endangered species law. SFCT member comments were considered during this process. The swift fox status review did not include delisting criteria for this species in this version, because of the desire for the following additional information:

- need for additional surveys in areas where swift fox may be present;
- continued surveys in areas where the species is known to be present;
- quality of remaining native prairie as potential swift fox expansion areas;
- intact habitat requirements for swift fox occupancy;
- role of interspecific interactions with other canids;
- whether occurrence along roads is more important in habitat selection than prairie habitat quality; and
- minimum viable population estimate or population index within context of rangewide population estimate.

SDGFP provided financial assistance to research conducted by Emily Mitchell, work described later in this report. That assistance was provided through State Wildlife Grant T-78-R-1, titled "Associating swift fox presence with the distribution of other carnivores in western South Dakota."

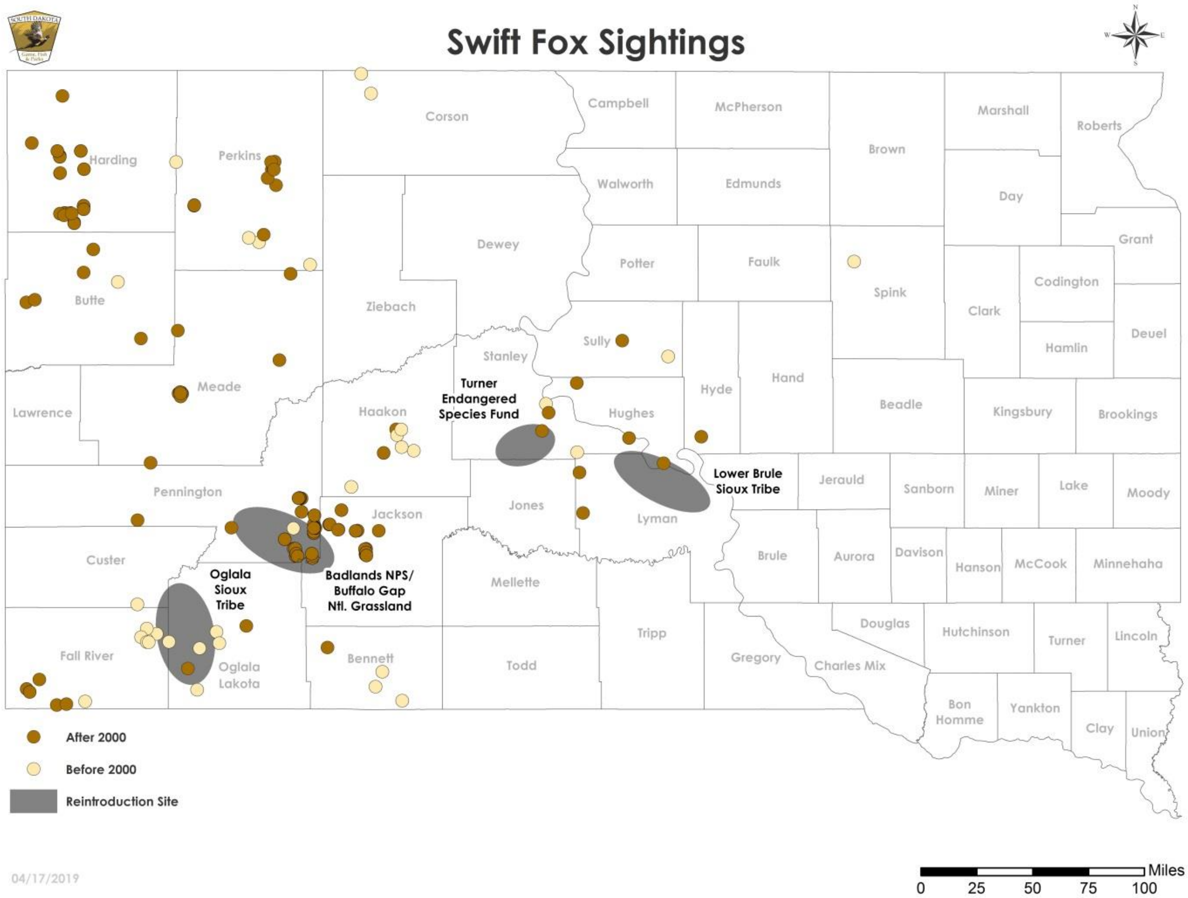

Figure 1. Locations of confirmed swift fox reports (1963 – April 2019) and general locations of reintroduction sites in South Dakota. Reports are confirmed or reliable sightings, incidental take, road kills, den sites, and one location of a radio collar. Map developed by Silka Kempema and updated by Heather Berg, SDGFP.

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TRENDS IN OCCUPANCY OF SWIFT FOX IN WYOMING

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ABSTRACT

The swift fox (*Vulpes velox*) is a small canid whose abundance and distribution declined greatly in the late 19th and 20th centuries due to loss of native prairie habitat and widespread predator control. The Wyoming Game and Fish Department classifies the swift fox as a Species of Greatest Conservation Need with Native Species Status of 4. From September through November 2017, we used remote cameras and scent stations to survey 131 grid cells throughout Wyoming as part of a long-term monitoring program. Additionally, we evaluated the influence of predators and energy development on the dynamic processes that may underlie changes in occupancy. The probability of occupancy was positively correlated with the percentage of the grid composed of suitable slope and negatively correlated with the presence of roads, energy development, coyotes (*Canis latrans*), and location, with sites within the predicted distribution having the highest probability of occupancy and those outside the predicted range having the lowest. In general, occupancy increased in 2017, from 0.28 in 2010 and 2013 to 0.42 in 2017, with swift fox detections at 11 sites outside the predicted range of the species in Wyoming. The probability of extinction varied throughout the survey, from 0.20 from 2010 to 2013 and 0.08 from 2013 to 2017. Given the potentially expanding distribution of swift fox in Wyoming, the species appears to be capable of exploiting new areas when conditions are favorable. However, they remain vulnerable to threats that face many wildlife species in Wyoming. Therefore, it is critical to continue to evaluate long-term trends and investigate the dynamic processes underlying changes in ψ and ε of swift fox in Wyoming, particularly in response to changing habitat conditions.

INTRODUCTION

The swift fox (*Vulpes velox*) is the smallest of the North American foxes and historically occupied the short- and mixed-grass prairie from northern Texas to southern Canada (Scott-Brown et al. 1987). Historically, swift fox covered 12 states, including areas east of the Continental Divide in Wyoming, but densities and distribution declined greatly in the late 19th and 20th centuries due to loss of native prairie habitat and predator control efforts (Scott-Brown et al. 1987). The swift fox was petitioned for listing under the Endangered Species Act (ESA) in 1992, and the U.S. Fish and Wildlife Service issued a "warranted but precluded" finding in 1995 (USFWS 1995). Due in large part to efforts from the Swift Fox Conservation Team and the collection of new data, the swift fox was subsequently removed from the ESA Candidate List in 2001 (USFWS 2001). However, the swift fox remains classified as a Species of Greatest Conservation Need with a Native Species Status of 4 (NSS4) by the Wyoming Game and Fish Department (Department; WGFD 2017). Although the distribution of swift fox is secure and the species is widely distributed, limiting factors from habitat loss and human activity may be severe. Additionally, data on status and trends of the species as well as overall distribution in the state are lacking (WGFD 2017).

In 2010, we developed a baseline occupancy model with which to monitor trends and evaluate population status for swift fox in eastern Wyoming long-term (Cudworth et al. 2011). As planned, the survey was repeated in 2013 (Van Fleet et al. 2014), allowing us to monitor trends and evaluate metrics that may be driving occupancy in the state. For example, both predation by coyotes (*Canis latrans*) and habitat loss have been identified as important factors contributing to mortality and declines of swift fox (Scott-Brown et al. 1987, Sovada et al. 1998, Kitchen et al. 1999, Olson and Lindzey 2002). Between 2010 and 2013, we did not find that the presence of coyotes had a negative impact on swift fox occupancy; however, the probability of localized extinction was positively correlated with the number of surveys where we observed energy development within a grid cell (Van Fleet et al. 2014). Understanding factors influencing trends is critical to species management and conservation; consequently, given the relatively recent and accelerating alteration of swift fox habitat by energy development, continuing to monitor populations and evaluate the impacts of these habitat changes on swift fox occupancy is critical to elucidate causes of changes in population trends of swift fox in Wyoming.

Swift fox habitat use in Wyoming differs from other areas of the range, with individuals using areas with a larger shrub component than the characteristic short-grass and mid-grass prairies that have defined typical swift fox habitat (Olson 2000). Although modeled and predicted swift fox distribution in Wyoming has typically consisted of these more traditional habitats in the eastern half of the state (e.g., Egoscue 1979, Buskirk 2016), recent, verified reports of swift fox outside of their predicted range in Wyoming have been increasing. For example, denning swift fox in La Barge, Powell, and Worland and mortalities reported from Evanston, Farson, and northwest of Cody (D. Herman, L. Keith, B. Kroger, J. Logobardi, M. Zornes, personal communication) have shifted known occurrences of swift fox westward in the state and made statewide range maps obsolete (e.g., WGFD 2010, 2017). Whether these reports represent swift fox populations that have always been present in low densities or a westward expansion of the species in the state is not known; however, the recent increase in the number and distribution of reports suggests populations are likely increasing in these areas.

Our objectives in 2017 were 3-fold. First, we revisited sites previously surveyed to estimate current occupancy and compare results to 2010 and 2013 to monitor and evaluate population trends. Secondly, we expanded survey efforts along the predicted current and expanded range boundary in western Wyoming to estimate occupancy, update distribution maps, and monitor potential expansions. Finally, we further evaluated the influence of predators, energy development, and other anthropogenic disturbances on local extinction rates to better estimate disturbance on the landscape and assess both current and cumulative impacts of landscape modification on this grassland species.

METHODS

Original site selection is described by Cudworth et al. (2011) and Van Fleet et al. (2014). In 2017, we used the same slope and habitat metrics used for site selection in eastern Wyoming to expand the survey area statewide and selected an additional 60 grid cells in western Wyoming outside the predicted range of swift fox. Following protocols outlined in Cudworth et al. (2011), we surveyed a total of 131 grid cells throughout the state (Table 1). Of these, 84 had been surveyed at least once previously, and 47 were surveyed for the first time in 2017 (Table 1). We contacted landowners twice, once to obtain initial permission to access or set up cameras on their property and again a week prior to conducting the survey. All surveys were completed between 11 September and 30 November 2017 to coincide with juvenile dispersal in an attempt to maximize detection probabilities (Finley et al. 2005).

We combined data from each of the five cameras to develop an encounter history for each grid and used program PRESENCE (Hines 2018) to develop occupancy models. We were specifically interested in the impact of habitat disturbance, namely energy development and roads, and coyotes on occupancy and extinction rates. However, previous analyses suggested the proportion of the grid cell composed of grassland and suitable slope were also important (Cudworth et al. 2011, Van Fleet et al. 2014); therefore, these covariates were included where appropriate. We determined well density by counting the number of producing wells for each year of survey available from the Wyoming Oil and Gas Conservation Commission (23 Sept 2010, 6 Sep 2013, and 28 Dec 2017). Producing wells included all wells with the following classifications: Producing Oil Well, Producing Gas Well, Active Injector, Active Permit, Well Spudded, and Waiting on Approval. We calculated road density by total km of roads in the grid cell with the following classifications: BLM road, county road, Forest Service road, interstate, light duty road, RAMP (i.e., interstate on/off ramps), rough bladed/2 track, state highway, and US highway. However, because rough bladed/2 track roads often result in less disturbance and reduced driving speeds, we also investigated the impact of roads without including this classification.

We conducted analyses in 2 steps. First, we used 2017 data only to evaluate occupancy statewide. In this stage, models included the probability of occupancy (ψ) and 5 detection probabilities (p) for each of the 5 trapping nights. Additional occupancy covariates included location of the grid (i.e., inside distribution, inside range but outside distribution, and outside range), the proportion of grid cell composed of suitable slope (<10%), density of producing wells, presence of coyotes (as determined by photographs during surveys), and density of roads. Detection probability covariates included the same covariates as for occupancy with the exception of location of the grid cell and the replacement of the proportion of the grid cell composed of suitable slope by the proportion of grid cell composed of mixed grass prairie. We standardized covariates before inclusion in the model (Franklin 2001) and conducted analysis in 3 stages. First, we held ψ constant as the global model while we investigated all additive models for p. Second, we held p constant from the best-fitting model (i.e., lowest AIC) while we investigated all additive models for ψ. Finally, we used AIC for model selection (Burnham and Anderson 1998) and model averaging for all models with ΔAIC < 2.0. Because models using total road density as a covariate for p consistently outcompeted those using road density without 2-tracks, we only used total road density when evaluating p. Conversely, models using road density without 2-tracks as a covariate for ψ consistently outcompeted those using total road density, we only used the 'reduced' road density when evaluating ψ.

We only used grid cells that had ≥2 surveys (n = 92) for multi-season analysis. We used a similar model selection process to evaluate changes in occupancy throughout time. However, once we determined the top model for both ψ and p, we tested each covariate for extinction (ε) separately. Occupancy and p covariates were the same as in the single season model with the addition of a year covariate for each metric. Extinction probability covariates included density of roads, number of years with coyote detections, number of years with producing wells, and change in number of producing wells between years. To calculate the change in producing wells, we first took the proportion of wells in each grid cell relative to the total number of wells throughout all grid cells and calculated the proportion change between surveys. In this analysis, models using total road density as a covariate for ε outcompeted those using road density without 2-tracks, and models using road density without 2-tracks as a covariate for ψ and p outcompeted models using total road density, so we used the best-fitting covariate for each metric. We report detection probabilities and average occupancy and extinction rates (± SE) from model averaged results.

RESULTS

We surveyed 131 grid cells, 84 of which had been surveyed at least once before, for a total of 3,250 camera nights. We recorded ≥641 photographs of swift fox on 40 grid cells (Figure 1). Despite cameras being operational for 24 hours, all swift fox were detected between 1800 and 0800, although detections dropped substantially after 0600 (Figure 2). As in 2010, most detections were within the predicted distribution of swift fox in Wyoming. However, outside of the distribution but within the predicted range of swift fox in Wyoming, we documented presence at 3 new sites in addition to the 5 sites where swift fox were documented in 2010. Finally, we found swift fox at 11 sites outside of the predicted range of the species in Wyoming, including 4 sites that were surveyed in 2010 where swift fox were not detected (Table 2, Figure 1). We detected 35 different non-target species. Of these, the most commonly detected species were domestic cattle, rabbits (*Lepus* and *Sylvilagus spp.*), pronghorn (*Antilocapra americana*), and mice (likely *Chaetodipus*, *Onychomys*, *Perognathus*, *Peromyscus*, and *Reithrodontomys spp.*). Mesocarnivore communities were similar among surveys, with most grid cells containing ≥1 mesocarnivore species (≥71.8% of cells). Coyotes, swift fox, striped skunk (*Mephitis mephitis*), and American badgers (*Taxidea taxus*) were the most commonly observed mesocarnivores each year, with red fox (*Vulpes vulpes*) and northern raccoons (*Procyon lotor*) also commonly observed in 2017 (Table 3).

When determining occupancy of swift fox statewide in 2017, we identified 4 top models with ΔAIC < 2.0 (Table 4). In the top model, ψ was negatively correlated with location (β = -0.68 ± 0.19), density of producing oil / gas wells (β = -0.44 ± 0.30), and the presence of coyotes (β = -0.80 ± 0.43) and positively correlated with percentage of suitable slope (β = 0.63 ± 0.26). Occupancy tended to decrease as grid cells moved from within the distribution, to within the range but outside predicted distribution, to outside of the predicted range in Wyoming. Road density (without the inclusion of 2-tracks) was also negatively correlated with ψ in the 3rd ranked model (β = -0.33 ± 0.26). Further, in the top model, p was positively correlated with the density of all roads within the grid cell, including 2-tracks (β = 0.29 ± 0.16). When models were averaged, ψ averaged 0.31 (± 0.02; range: 0.02-0.71) across all grid cells and p averaged 0.50 (± 0.01; range: 0.31-0.81).

When determining multi-season occupancy of swift fox in 2017, we identified 2 top models with ΔAIC < 2.0 (Table 5). In the top model, ψ was negatively correlated with location (β = -0.99 ± 0.35) and positively correlated with slope (β = 0.78 ± 0.25) and varied by year; ε varied by year; and p was positively correlated with the amount of grassland (β = 0.24 ± 0.12) and negatively correlated with road density (β = -0.44 ± 0.17) and varied by time within a survey. As with 2017 occupancy analyses, ψ decreased as grid cells moved from within the distribution, to within the range but outside predicted distribution, to outside of the predicted range in Wyoming. When models were averaged, ψ differed between years (Figure 3), remaining stable at 0.28 (± 0.02) in 2010 and 2013 before increasing to 0.42 (± 0.02) in 2017. When models were averaged, ε was 0.20 (± 0.11) from 2010 to 2013 and 0.09 (± 0.08) from 2013 to 2017. As in 2010, *p* was positively correlated with the percentage of the grid composed of grassland and was negatively correlated with road density (not including 2-tracks) and differed between years (Figure 4). When models were averaged, detection tended to decrease throughout the survey period and differed among years.

DISCUSSION

Overall ψ of swift fox in Wyoming increased from previous surveys in 2010 and 2013 (Figure 3), and the proportion of grid cells with detections increased regardless of location (Table 2). Additionally, we documented swift fox at 11 grid cells outside of the predicted range of the species in Wyoming in 2017. Although this was the 1st year surveys were conducted statewide, we revisited 10 grid cells outside the predicted range that were previously surveyed in 2010. We failed to detect swift fox at any of these sites in 2010, but documented swift fox at 4 of these sites in 2017. Although we cannot rule out that swift fox have always been present but remained undetected in western Wyoming, maps of historical distribution of the species in North America have depicted the western edge of swift fox range in central Wyoming (Egoscue 1979). The lack of historical records coupled with the recent increase in reports of swift fox outside of their predicted range in western Wyoming (e.g., Clark, Dubois, Evanston, Farson, Meeteetse, Pinedale, Powell, Wamsutter, Worland, etc.) likely suggest a species that is expanding its range westward into new areas of ‘nontraditional’ habitat. The cause for this expansion is currently unknown. One hypothesis is that increases in small mammal and other prey abundance (NLB, personal observation) have allowed swift fox to exploit previously unsuitable areas. However, work is still needed to evaluate potential mechanisms resulting in range expansion.

As in previous studies, percentage of the grid composed of suitable slope was positively correlated with ψ for both the 2017 analysis and the multi-season analysis, and percentage of the grid composed of grassland was positively correlated with *p* in the multi-season analysis (Cudworth et al. 2011, Van Fleet et al. 2014). Location was also correlated with ψ in all top models, with ψ decreasing from a high in grid cells within the predicted distribution of swift fox to a low in cells outside of the predicted range of swift fox (Figure 1), which lends further support to the models used to develop predictive maps for the species in Wyoming.

Predation, road-caused mortality, and habitat loss have been identified as important factors contributing to mortality and declines of swift fox (Scott-Brown et al. 1987, Sovada et al. 1998). Coyotes are known predators of swift fox and can be major causes of mortality (Sovada et al. 1998, Kitchen et al. 1999, Olson and Lindzey 2002). Although we did not find an effect of coyotes on either ψ or ε in the multi-season analysis, we did find that the presence of coyotes was negatively correlated with ψ in 2017. The impact of roads on swift fox in Wyoming, however, was less straightforward. Road density (excluding 2-tracks) was negatively correlated with *p* in the multi-season analysis and ψ in the 2017 analysis. Excluding 2-tracks allowed us to evaluate the impact of roads that were likely to support both higher speeds and greater traffic volume. It is possible that increasing density of these types of roads would limit movement of swift fox, thus resulting in a decrease in *p*, or even result in conditions that are unsuitable for swift fox (i.e., decrease in ψ). However, the density of roads including 2-tracks was positively correlated with *p* in the 2017 occupancy analysis. 2-tracks were by far the most common type of road present in grid cells, comprising, on average, 76.67% (± 1.59%) of all roads in a given cell (range: 15.09 to 100.00%). Although the speed and volume of traffic can be quite variable among roads classified as 2-tracks, they are still likely much lower than for other road types included in the model. Because of this, it is possible that swift fox view and use 2-tracks as travel corridors. Consequently, a higher density of 2-tracks could result in increased movement corridors, thus increasing *p*.

The demand for energy has been and is predicted to continue increasing, and Wyoming is likely to maintain its role as a major player in the energy industry (Copeland et al. 2010). Similar to coyotes, we did not find an effect of energy development on either ψ or ε in the multi-season analysis, but we did find that the density of producing wells was negatively correlated with ψ in 2017. The impact of energy development on wildlife is complex, and populations may be negatively impacted in many ways, such as through decreased food availability, loss of habitat, anthropogenic disturbance, or direct mortality due to collisions with vehicles (Carbyn et al. 1994, Cypher et al. 2003, Sawyer et al. 2006). For this project, we quantified the number of producing wells per grid cell, which is likely an appropriate measure of activity, but not necessarily overall disturbance. For example, many of our grid cells resulted in a decrease in the number of producing wells among surveys. It is unlikely that this translated into an increase in habitat, and more likely results in obviously older infrastructure where there is not any current activity. Consequently, this made it difficult to evaluate changes in disturbance through time. In general, we expect these levels of impacts and activity to have variable effects on swift fox (Sawyer et al. 2009, Gilbert and Chalfoun 2011), and it is important to continue to evaluate these impacts to swift fox in Wyoming.

Given the potentially expanding distribution of swift fox in Wyoming, the species appears to be capable of exploiting new areas when conditions are favorable. However, they remain vulnerable to anthropogenic threats that face many wildlife species in Wyoming, including habitat loss, as well as natural biological processes, including competition and predation from other native mesocarnivores (i.e., coyotes). Therefore, it is critical to continue to evaluate long-term trends of swift fox in Wyoming. Because of conservation concerns surrounding swift fox, it is especially important to investigate the dynamic processes underlying changes in ψ and ε of swift fox, particularly in response to changing habitat conditions.

ACKNOWLEDGEMENTS

Funding for this project was provided by USFWS State Wildlife Grants and the Wyoming Governor's Endangered Species Account Funds, for which the Department is extremely grateful. Department biologists J. Bernt, F. Calderon, D. Nelson, and J. Smith conducted all aspects of the field work and USFWS personnel P. Hnilika and M. Mazur conducted surveys on the Wind River Indian Reservation. C. Atkinson and S. Ryder assisted with gear maintenance and construction, and J. Stoinski and E. Whittle were instrumental in identifying photos. We are

especially thankful to the many private landowners and Wind River Indian Reservation Game Wardens who graciously provided access to their lands to assist this project. Department GIS analyst N. Whitford provided invaluable assistance selecting survey grids, developing maps, and compiling spatial covariates for the project.

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Table 1. Number and distribution of cells available to survey for swift fox (*Vulpes velox*) in Wyoming in 2017, including number of cells that have been surveyed for 1, 2, or 3 years.

Location	Total # of cells available	# of cells surveyed in 2017	# of cells surveyed 1 year	# of cells surveyed 2 years	# of cells surveyed 3 years
Distribution	54	39	7	13	34
Range	38	35	3	35	0
Western Wyoming	57	57	47	10	0
Total	149	131	57	58	34

Table 2. Number and proportion of cells with detections of swift fox (*Vulpes velox*) in fall of 2010, 2013, and 2017 in Wyoming.

Location	# of cells (%) with detections in 2010	# of cells (%) with detections in 2013	# of cells (%) with detections in 2017
Distribution	20 (41.7)	15 (31.3)	21 (53.8)
Range	5 (13.2)	-	8 (22.9)
Western Wyoming	0 (0.0)	-	11 (19.3)
Total	25 (26.0)	15 (31.3)	40 (30.5)

Table 3. Number and proportion of grid cells and type of mesocarnivores detected during swift fox (*Vulpes velox*) surveys throughout eastern Wyoming in fall 2010, 2013, and 2017.

Mesocarnivore species	No. (proportion) of grid cells with detections		
	2010	2013	2017
Canis latrans	25 (0.26)	21 (0.44)	59 (0.45)
Vulpes velox	25 (0.26)	15 (0.31)	40 (0.31)
Taxidea taxus	16 (0.17)	11 (0.23)	27 (0.21)
Mephitis mephitis	22 (0.23)	18 (0.38)	9 (0.07)
Vulpes vulpes	5 (0.05)	4 (0.08)	11 (0.08)
Procyon lotor	6 (0.06)	1 (0.02)	9 (0.07)
Felis rufus	4 (0.04)	2 (0.04)	8 (0.06)
Mustela frenata	0 (0.00)	0 (0.00)	3 (0.02)
Spilogale sp.	0 (0.00)	0 (0.00)	1 (0.01)
No. (proportion) of grid cells with ≥1 detection	68 (0.71)	37 (0.77)	100 (0.76)

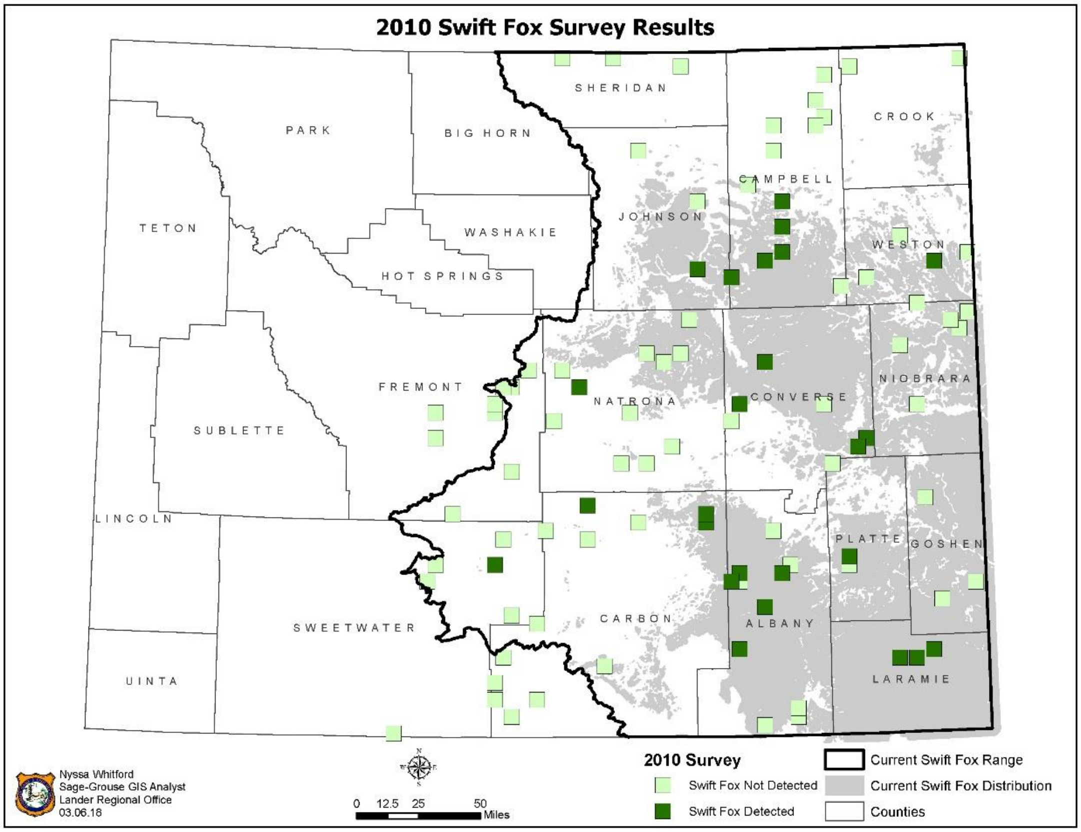
Table 4. Models and AIC scores and weights for models with ΔAIC < 2 developed to evaluate occupancy of swift fox (*Vulpes velox*) throughout Wyoming in fall 2017. "location" indicates location relative to predicted range and distribution in Wyoming; "energy" indicates the density of producing oil / gas wells within the grid cell; "coyote" indicates the presence of coyotes (*Canis latrans*); "slope" indicates the percentage of the grid composed of suitable slope (<10%); "road" indicates the density of roads (not including 2-tracks) within the grid cell; and "road_all" indicates the density of roads (including 2-tracks) within the grid cell.

Model	AIC	AIC weight
ψ(location+energy+coyote+slope),*p*(road_all)	408.45	0.327
ψ(location+coyote+slope),*p*(road_all)	409.53	0.191
ψ(location+coyote+road+slope),*p*(road_all)	409.69	0.176
ψ(location+energy+coyote+road+slope),*p*(road_all)	409.94	0.155
ψ(location+energy+slope),*p*(road_all)	410.00	0.151

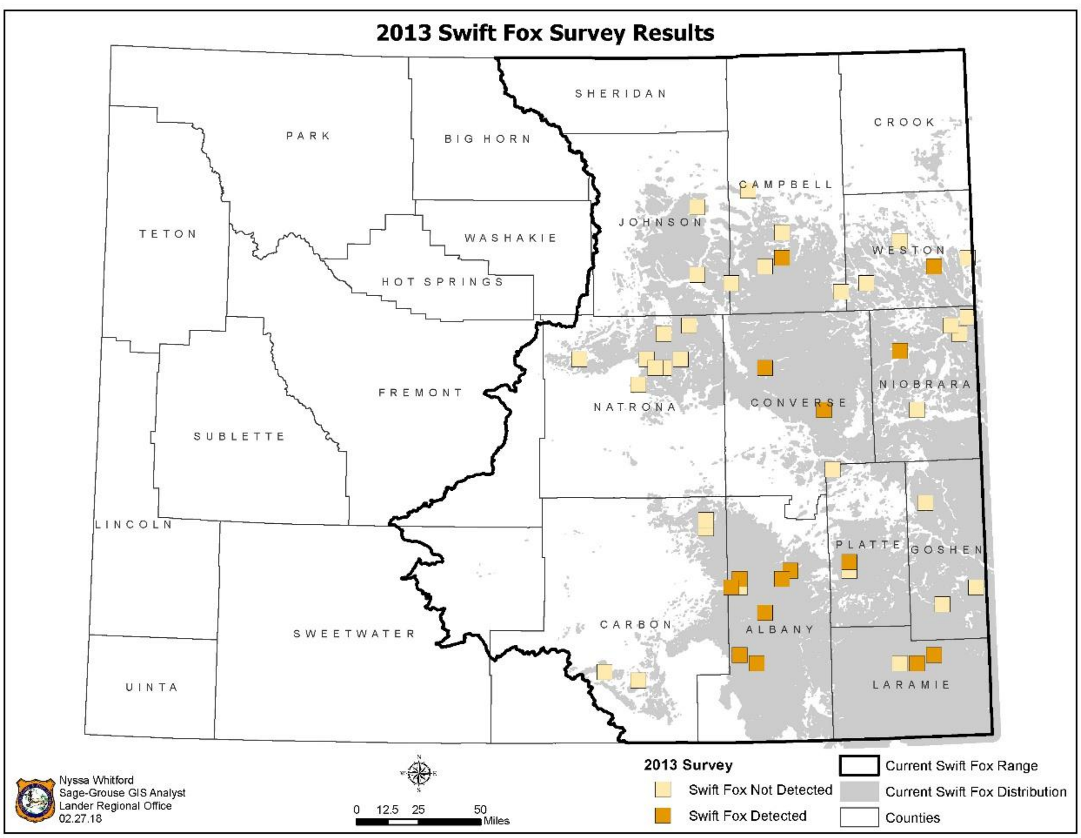
Table 5. Models and AIC scores and weights for models with ΔAIC < 2 developed to evaluate multi-season occupancy of swift fox (*Vulpes velox*) throughout Wyoming from 2010 to 2013. "location" indicates location relative to predicted range and distribution in Wyoming; "slope" indicates the percentage of the grid composed of suitable slope (<10%); "grass" indicates the percentage of the grid composed of mixed-grass prairie; and "road" indicates the density of roads (not including 2-tracks) within the grid cell.

Model	AIC	AIC weight
ψ(location+slope+year),*ε*(year),*p*(grass+road+time)	697.02	0.568
ψ(location+slope+year),*ε*(.),*p*(grass+road+time)	697.57	0.432

a)


2010 Swift Fox Survey Results
SHERIDAN
PARK
BIG HORN
CROOK
CAMPBELL
JOHNSON
TETON
WASHAKIE
WESTON
HOT SPRINGS
FREMONT
NATRONA
CONVERSE
NIOBRARA
SUBLETTE
LINCOLN
PLATTE
GOSHEN
SWEETWATER
CARBON
ALBANY
UINTA
LARAMIE
Nyssa Whitford
Sage-Grouse GIS Analyst
Lander Regional Office
03.06.18
0 12.5 25 50 Miles
2010 Survey
Swift Fox Not Detected
Swift Fox Detected
Current Swift Fox Range
Current Swift Fox Distribution
Counties

b)


2013 Swift Fox Survey Results
SHERIDAN
PARK
BIG HORN
CROOK
CAMPBELL
JOHNSON
TETON
WASHAKIE
WESTON
HOT SPRINGS
FREMONT
NATRONA
CONVERSE
NIOBRARA
SUBLETTE
LINCOLN
PLATTE
GOSHEN
SWEETWATER
CARBON
ALBANY
UINTA
LARAMIE
Nyssa Whitford
Sage-Grouse GIS Analyst
Lander Regional Office
02.27.18
0 12.5 25 50 Miles
2013 Survey
Swift Fox Not Detected
Swift Fox Detected
Current Swift Fox Range
Current Swift Fox Distribution
Counties

c)

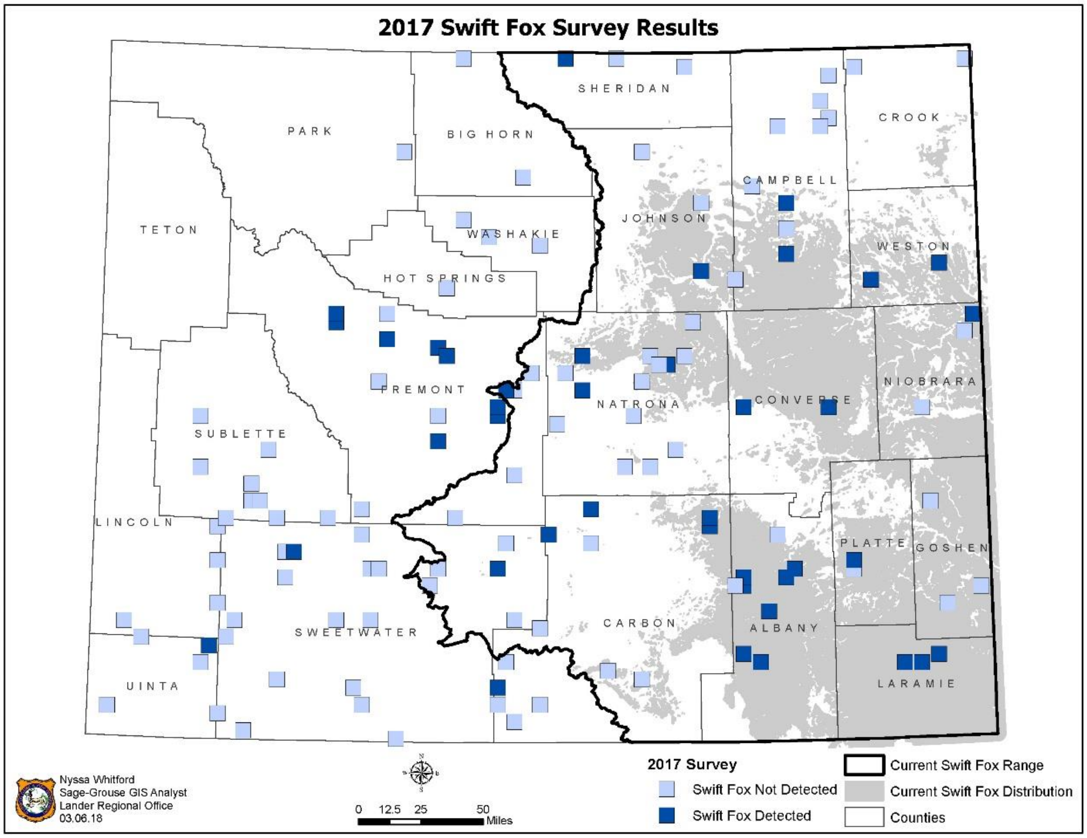


Figure 1. Locations and results of grids surveyed for swift fox (*Vulpes velox*) in Wyoming, fall a) 2010, b) 2013, and c) 2017. Only grid cells that were surveyed within a given year are depicted.

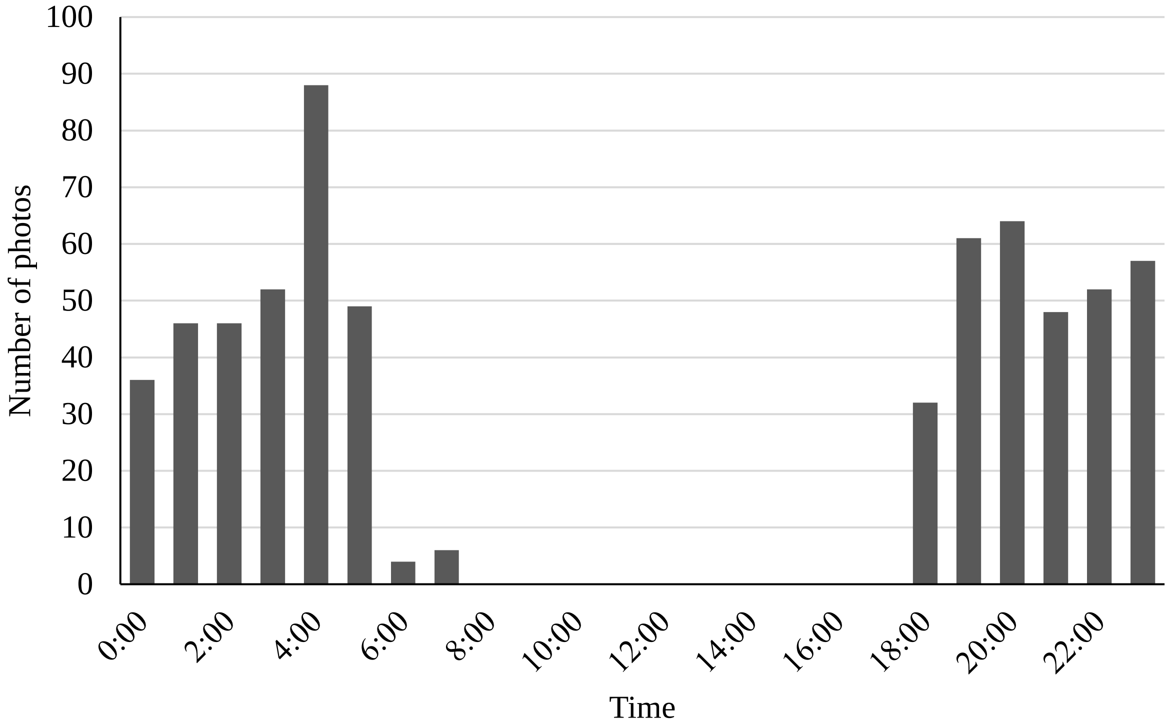


Figure 2. Total number of photos of swift fox (*Vulpes velox*; *n* = 641) taken per hour at 131 grid cells across Wyoming from September-November 2017.

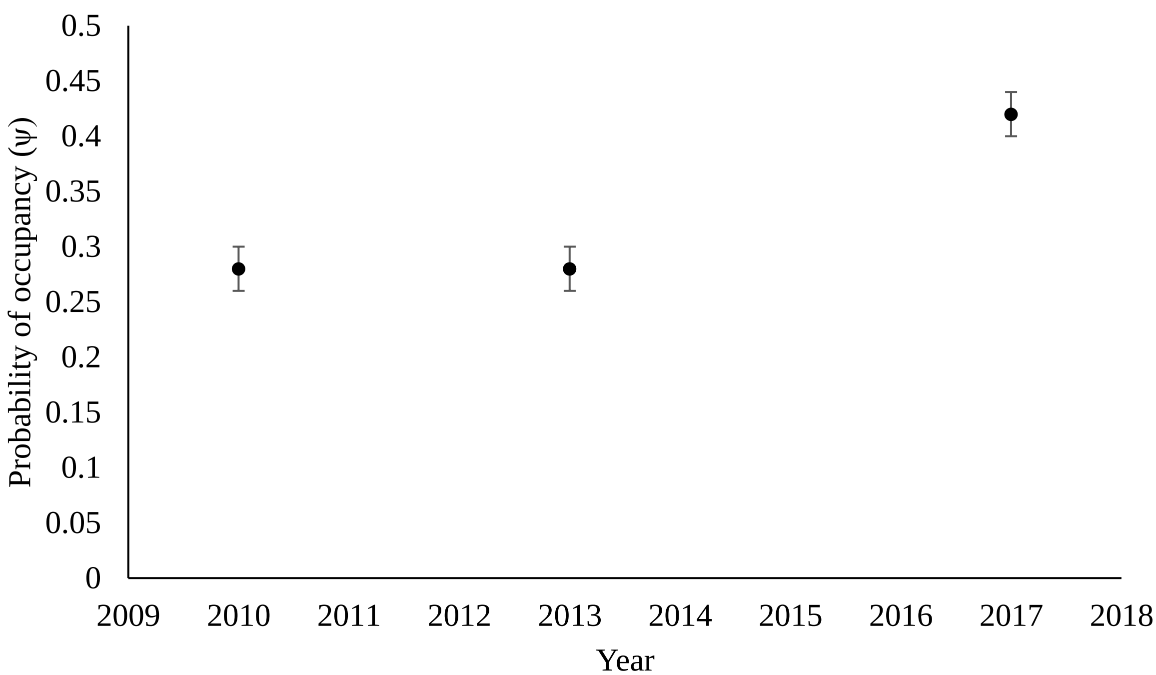


Figure 3. Probability of occupancy (*ψ*; ± SE) of swift fox (*Vulpes velox*) throughout eastern Wyoming from September-November 2010, 2013, and 2017.

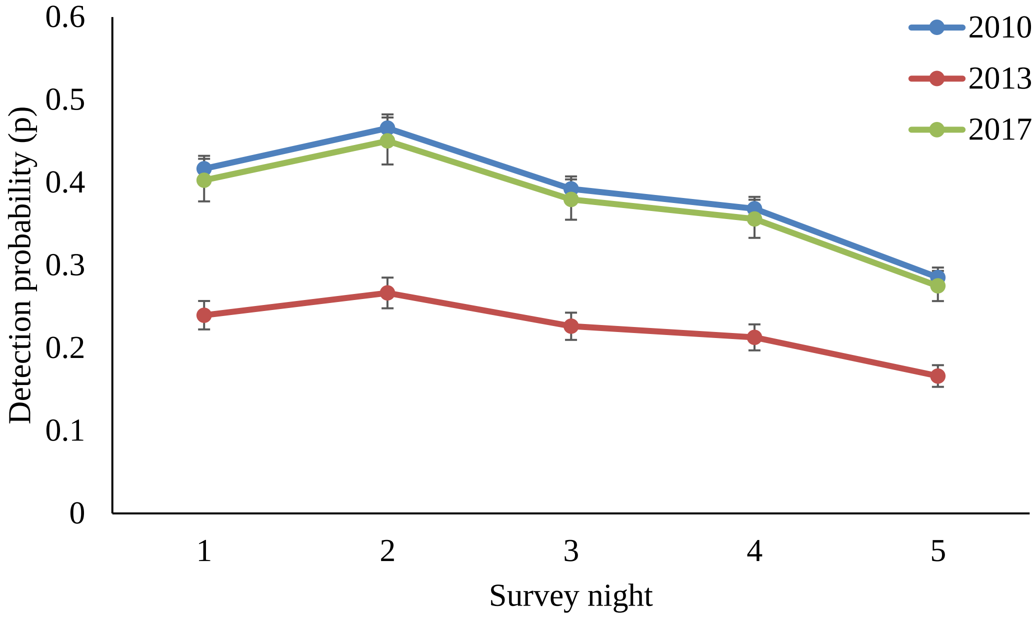


Figure 4. Detection probability (*p*; ± SE) of swift fox (*Vulpes velox*) throughout eastern Wyoming from September-November 2010, 2013, and 2017.

SPECIES SURVIVAL PLAN FOR SWIFT FOX

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The Association of Zoos and Aquariums (AZA) swift fox Species Survival Plan (SSP) population currently consists of 48 animals in 21 institutions. There were no births in 2016 or in 2017.

A Breeding and Transfer plan was created in September 2018 for the 2019 breeding season which recommended 10 transfers and 10 breeding pairs. The SSP will be putting together another Breeding and Transfer plan in fall of 2019 for the 2020 breeding season to address the recent low reproductive rate.

PROPOSED SWIFT FOX REINTRODUCTIONS IN NORTH CENTRAL MONTANA

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Summary

In 2018 American Prairie Reserve hired a biologist dedicated to preparing plans to reintroduce swift foxes to American Prairie Reserve lands in north central Montana, south of the Milk River. Habitat modeling conducted by the World Wildlife Fund indicates that there is abundant suitable habitat in the proposed reintroduction area, and a ground-truth survey conducted in 2016 supports the model. Camera trap surveys conducted in 2010 and 2015 did not find swift foxes occupying the area. Based on the availability of quality, unoccupied habitat, as well as the resources to support such an effort, American Prairie Reserve, and partners Fort Belknap Department of Fish & Wildlife and the Smithsonian Conservation Biology Institute proposed to reintroduce swift foxes in Blaine and Phillips Counties south of the Milk River, following the recommendations of the IUCN Guidelines for Reintroductions and Other Conservation Translocations. Regional biologists from Montana Fish Wildlife & Parks do not support the proposed action, and thus a reintroduction of swift foxes on American Prairie Reserve lands will not take place in the foreseeable future. Research into fine-scale habitat suitability for potential release sites and population viability analyses of potential source populations, which was initiated in conjunction with the proposed reintroduction will continue.

1. Introduction

The historic range of swift foxes (*Vulpes velox*) covered the majority of eastern Montana (Sovada et al., 2009, Figure 1). Today, swift foxes occupy only a fraction of their former range in Montana (Moehrenschlager and Moehrenschlager 2018, USGS and IUCN 2016). On a continental scale, swift foxes exist in two populations, one in northern Montana and southern Canada, and one which extends from Wyoming south to Texas. Suitable habitat occurs within the gap between populations, including abundant, high quality habitat on Fort Belknap Indian Reservation (FBIR), and American Prairie Reserve (Olimb et al., 2017) which is perpetually protected from development or degradation. Despite the presence of high-quality habitat, this area is currently unoccupied by swift foxes (Schwalm et al., 2017, Smithsonian Conservation Biology Institute, unpublished data). In 2018 American Prairie Reserve proposed a plan for reintroduction of swift foxes to American Prairie Reserve and Fort Belknap Indian Reservation.

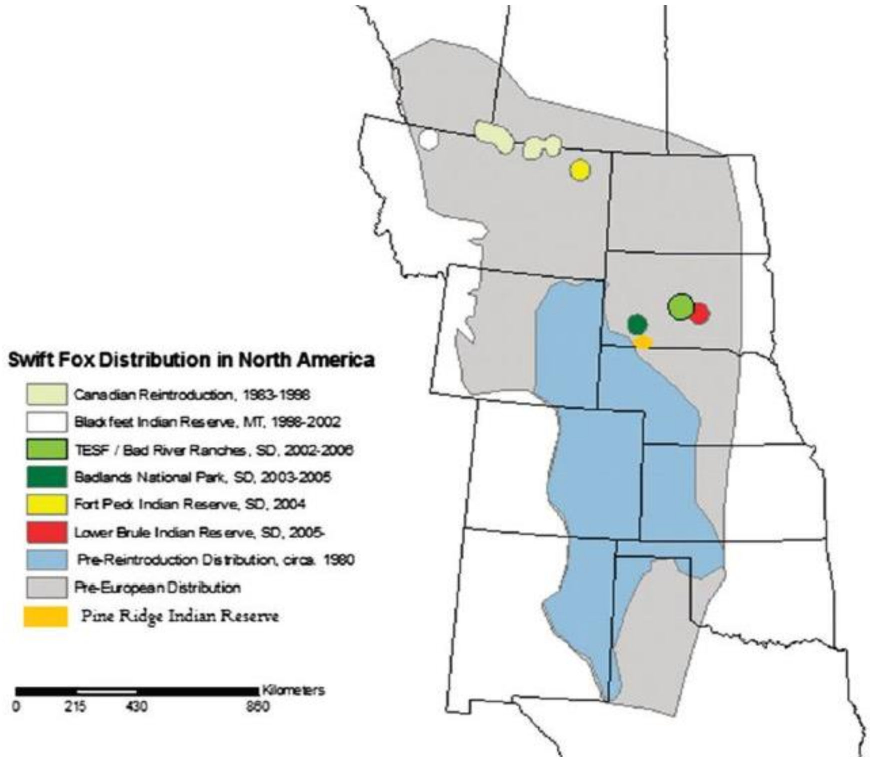

Figure 1 Historic and current range of swift foxes, from Sasmal et al., 2015

1.1 History of Swift Fox in Montana

One of the earliest European records of swift fox in Montana come from the journals of Lewis and Clark, who noted seeing swift foxes on multiple occasions during their journey across Central Montana on the Missouri River in the early 1800's (Coues 1893). Throughout the 19th century sale fur records indicate that swift foxes were abundant across their large range (Johnson 1969). Despite their historically wide range both across the continent and over the majority of eastern Montana (Sovada et al., 2009, Figure 1), the species was believed to be extinct in the state by 1969 (Hoffmann et al., 1969).

As a result of reintroduction efforts outside the state, swift foxes spread back into northern Montana from Canada by 1996 (Zimmerman 2003). Swift foxes have been surveyed 4 times in Montana along the international border, using varying techniques over time. The most recent occupancy estimate was conducted using camera traps in 2018; the results of that survey are not yet available. There have also been numerous incidental sightings of swift foxes in the southeastern portion of the state since 2016 (MT FWP, 2019).

Prior to the flurry of sightings in 2016, a camera trap occupancy survey was conducted in 2015 in suitable habitat throughout Montana by Oregon State University, and the World Wildlife Fund (WWF). This survey found foxes at both the Blackfeet Indian Reservation (BFIR) and Fort Peck Indian Reservation (FPIR), where swift foxes were previously reintroduced. The survey also detected foxes adjacent to the current area known to be occupied by the Northern population, and at three points in southeastern Montana.

The 2015 survey was preceded by a similar camera trap occupancy survey conducted by WWF in 2010 which focused on the proposed project area in south Phillips and Valley Counties.

This survey carefully considered the location of 6 observations of swift foxes reported to Montana's Natural Heritage Program between 1999 and 2006, but did not detect any swift foxes (Bly et al., 2010).

1.2 Status of Swift Fox in Montana

Swift foxes are a state species of concern in Montana. They are classed as a tier II priority species in the Montana Comprehensive Fish and Wildlife Conservation Strategy. This means that, compared to other species in the state, they are considered a "Moderate conservation need" such that Montana Fish, Wildlife & Parks (MT FWP) "could use its resources to implement conservation actions that provide direct benefit to these species, communities, and focus areas" (MT FWP, 2005). They are also considered to be a state S3: "Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations" (MT FWP, 2005)

1.3 American Prairie Reserve's Mission and Development

Temperate grasslands or savannas historically made up approximately 30% of the Earth's landmass, but are currently considered among ecosystems that are the most threatened by conversion or degradation, with less than 50% remaining intact (Sala et al. 2000, Hoekstra et al. 2005). In western North America, the loss of native grazers, inappropriate livestock management practices, and human-driven land conversion or degradation have resulted in steadily declining biodiversity and rangeland health (Dreitz et al. 2017). These global and regional trends have resulted in grasslands being cited among the world's biomes in crisis (Hoekstra et al. 2005). In response, the conservation and restoration of grassland ecosystems has become a popular theme in rangeland ecology (Fuhlendorf and Engle 2001, Briske et al. 2005, Havstad et al. 2007).

American Prairie Reserve was established as a nonprofit organization in 2001 to help address the urgent need for comprehensive grassland conservation in western North America. American Prairie Reserve's mission is to create, in the northern plains of Montana, the largest nature reserve in the continental United States, a refuge for people and wildlife preserved forever as part of America's heritage.

Restoration of native prairie species is central to American Prairie Reserve's mission. To realize this mission American Prairie Reserve is acquiring private land and collaborating with public land agencies to assemble a land base of 3.5 million acres devoted to biodiversity conservation. As of April 2018 American Prairie Reserve completed 26 acquisitions, totaling 399,379 acres, composed of 91,588 acres deeded and associated 307,791 acres of leased public lands. Much of this land is near or connected to the 1.1-million-acre Charles M. Russell National Wildlife Refuge (CMR Refuge), part of the reserve complex.

1.4 Habitat Suitability

A thorough assessment of the suitability of habitat in and around potential release site should be conducted prior to any reintroductions (IUCN/SSC 2013). Here, we summarize available habitat suitability models, and illustrate predicted habitat suitability on American Prairie Reserve. Over the past two decades, five habitat suitability models have been developed for north central Montana:

(1) Moehrenschlager et al., 2006
(2) Sovada et al., 2009
(3) World Wildlife Fund, 2010
(4) Montana Natural Heritage Program, 2016
(5) Olimb et al., 2017 (World Wildlife Fund) (see Figure 2)

Of these models, one includes only areas north of US Hwy 2 (1), one includes only the state of Montana (4), and three include habitat features across large portions of the species' range (2, 3, 5). Of the models that cover the proposed reintroduction area (2-5), the WWF model (5) provides the most robust, frequently revised estimation of quality swift fox habitat in the state of Montana and surrounding counties. In our opinion, the WWF model is the best available model, as it combines both predicted suitability based on habitat variables and actual swift fox observations and is continually updated as new and revised information become available. This contrasts with other models that are stand-alone versions, which are not regularly updated to incorporate new information.

The WWF model is specific to habitat features important to swift fox in the Northern Great Plains (NGP). The fine scale allowed the authors to distinguish between habitat features important in sub-sections of the NGP, thus creating specific output models for both the Northern region north of the Milk River (currently inhabited by swift fox) and the Southern region south of the Milk (occasional sightings of swift fox). Finally, this model is the most thorough consideration of habitat requirements, including six different inputs in each of the two sub-regions. The habitat factors found to predict suitable habitat in the Northern region include soil type, percentage of grass, percentage of clay in soil, road density, brightness and wetness (Olimb et al., 2017). In the Southern region these factors were percent forest, percent sand in soil, road density, brightness, wetness and distance to prairie dog colonies (Olimb et al., 2017).

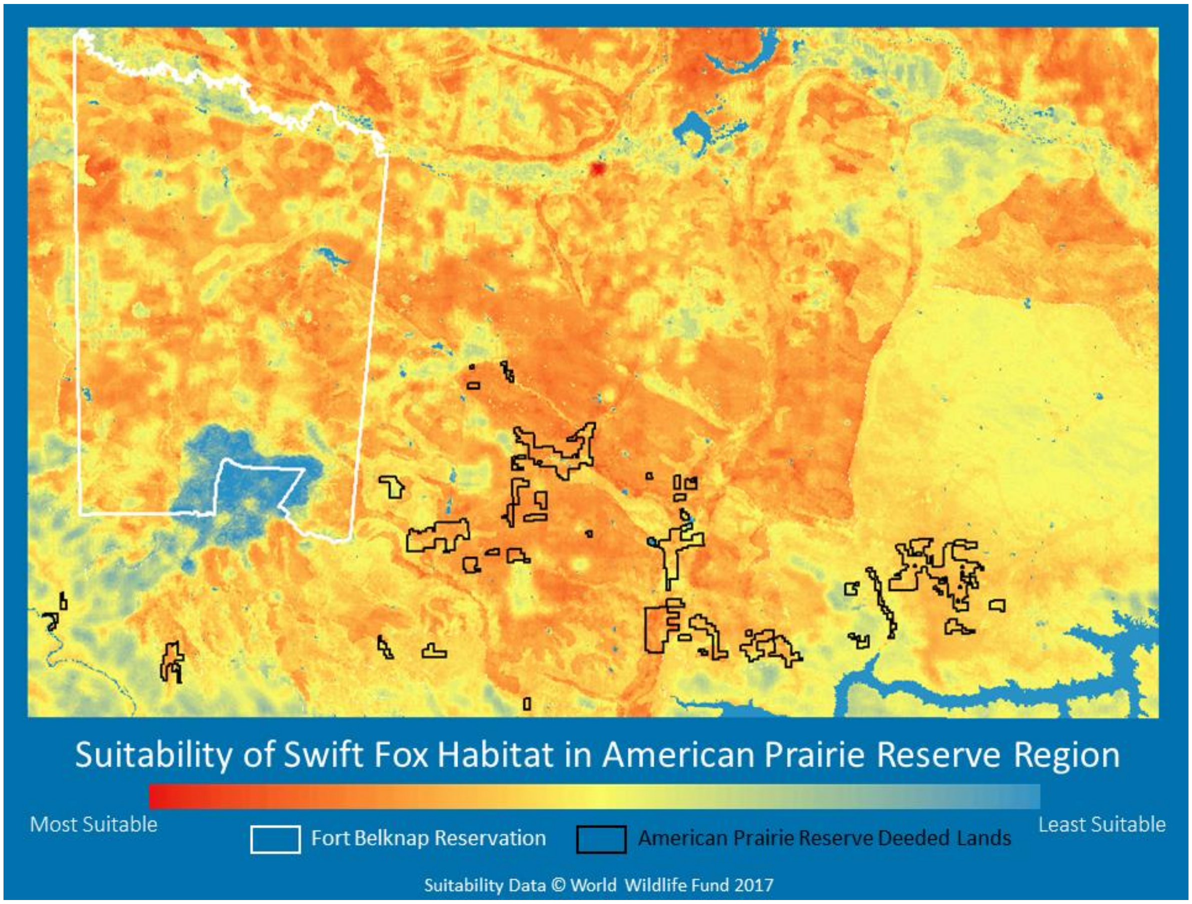

Figure 2 Suitability of swift fox habitat on American Prairie Reserve and surrounding area, based on the 2017 WWF model (Olmib et al., 2017). © 2017, World Wildlife Fund, Inc. All rights reserved

1.5 Goals

Following the guidelines of the IUCN, and lessons learned from previous reintroductions of swift foxes, we believe the proposed reintroduction could help achieve these overarching goals: to 1) develop a robust and resilient population of swift foxes in Montana by augmenting the existing Northern population and 2) help establish a connection between the disjointed Northern and Southern populations. The specific objective of the proposed reintroduction is to establish a founding population of swift foxes in the American Prairie Reserve region that persists at a minimum population size of 200 animals for at least 100 years.

This objective is aligned with the broader goals of multiple organizations, including American Prairie Reserve, Montana Fish Wildlife & Parks (see section 4.1) and the Swift Fox Conservation Team (see section 4.2). The reintroduction would establish swift foxes in a potential movement corridor between the Missouri and Milk Rivers, which would facilitate genetic exchange between the populations at the BFIR, the FPIR, and the Canadian border. Expanding the range and size of the Northern population could improve its resilience to environmental stochasticity and bottleneck effects. Finally, expanding the range of the Northern population southward is the first step toward eventually reuniting the populations.

2. Methods

2.1 Ground-Truthing of Habitat at American Prairie Reserve

During previous discussions of a proposed swift fox reintroduction, MT FWP expressed concerns that the habitat at American Prairie Reserve, which contains both shrub steppe and grassland, may be unsuitable for swift foxes because it looks different than the habitat currently occupied by the Northern population. In response, American Prairie Reserve undertook a survey to ground truth the WWF 2015 model results in the spring of 2016.

The survey consisted of 351 point counts on 21 systematic transects over 4 separate units of American Prairie Reserve property. In the survey, we recorded the dominant vegetation class, height of vegetation, the number of shrubs (greasewood, sage), and sight range at standardized points along each transect. We also recorded photos of habitat at every ½ mile of each transect.

The transects were distributed over a mix of habitat suitability ratings, based on the 2015 WWF model (Olimb & Bly 2015). Despite being selected from a mix of sites, the data from this survey indicates that there is a high proportion of high-quality habitat available on American Prairie Reserve. Overall, grasses were the dominant vegetation type at 74% of sampled points, and 90% of sampled points had a sight distance ≥ 100 meters. Swift foxes prefer habitat with visibility ≥ 100 meters, as it allows them to detect predators with sufficient warning to escape (Russell 2006).

Vegetation heights were recorded every 10 yards (9.1 meters) interval, resulting in 1,754 measurements. Of these, vegetation height was <12 inches (31 cm) at 83% of sample points and <10 inches (25 cm) at 76%. Given an average eye height of 30 cm (11.8 inches) on a swift fox (Schroeder, 2007), we found that the majority of our sampled sites, both those rated as suitable and unsuitable, contained vegetation low enough to provide swift foxes with visibility.

Due to their preference for long-range visibility, swift foxes are commonly associated with short and mixed-grass prairie throughout their range (Allardyce and Sovada 2003). However, multiple examples from Wyoming demonstrate that shrub steppe habitat is also suitable for, and occupied by, swift foxes. For example, Olson and Lindzey reported that home-range size and survival were similar between foxes in both shrub steppe and grassland habitat types (2002), suggesting that these two habitat types are similarly capable of fulfilling swift fox habitat requirements. In the Wyoming study, sagebrush steppe or sagebrush-grassland mix covered 60% of the study area (Olson and Lindzey 2002). Litter sizes were larger in shrub steppe habitats, possibly because the varied vegetation provided more abundant prey (Olson and Lindzey 2002). We included counts of greasewood and sage bushes within 1 yard (.91 m) along each transect in our ground truth survey. We found that 65% of the sampled points had a density of shrubs <0.5 shrubs/yd^2 (0.42 shrubs/m^2), with an average density of 0.37 shrubs/yd^2 (0.33 shrubs/m^2).

The results of this survey demonstrate that American Prairie Reserve has a high percentage of habitat that contains features suitable to swift foxes, according to the literature, including low vegetation, moderate shrub densities and long site distances. This is true for survey points taken for a range of suitability ratings, suggesting that the 2015 WWF model may have underestimated the quality of habitat available at American Prairie Reserve. Using the top 40% most suitable habitat of WWF's updated swift fox habitat suitability model (Olimb et al., 2017), we calculated that deeded and leased lands at American Prairie Reserve contain 1,101 km^2 of habitat suitable for swift foxes.

2.2 Release Site Selection

In 2019 American Prairie Reserve's project partner, the Smithsonian Conservation Biology Instituted initiated a study to quantify risks and resources at a variety of potential swift fox release sites around the proposed project area, and investigate patch sizes and connectivity of suitable habitat. The field data will be collected by a master's student from St. Andrew's University in the summer of 2019. The three primary components of the study are:

1. Quantify risks & resources
2. Model habitat quality
3. Select optimal release sites

The first phase of the study to will use camera traps to quantify coyote sightings at each survey point, track plates to investigate presence of small mammals, and audio recorders to investigate insect species richness and relative abundance. A fine scale shrub layer will be produced using the National Agriculture Imagery Program 2017, classifying data using a supervised random forest model processed on Google Earth Engine servers. Finally, suitable habitat for burrow digging will be identified from soil, bedrock and digital elevation data available from the state of Montana.

The information gathered in the first phase will be used to create a new habitat suitability model. The new model, considerations of connectivity and consultation with stakeholders on non-ecological factors will be used to identify release sites that could be used in future swift fox reintroductions.

2.3 Risk Assessment

The IUCN Reintroduction Guidelines recommend assessing the full array of hazards that may affect translocations both during and after release of new animals (IUCN/SSC 2013). Our risk assessment considering possible risks to and from a swift fox reintroduction are included in Appendix A.

2.4 Source Population

The long-term viability of swift fox, and all native prairie species, are central to our mission as an organization, thus we are taking every precaution to ensure that our actions do not cause unexpected harm to this species. In partnership with the Smithsonian Conservation Biology Institute and the IUCN Conservation Planning Specialist Group, we have commissioned a specialist to conduct a population viability analysis (PVA) to model potential outcomes of varying levels of take, which will be used to guide decisions for potentials source populations for any future reintroductions.

2.5 Monitoring and Adaptive Management

We planned to monitor our progress towards goals and follow an adaptive management approach, continuing to evaluate and adjust over time. One arm of our adaptive management strategy would involve monitoring survival and reproduction of released foxes using radio-telemetry. The reintroduction would be considered an initial success, and translocations would continue at 30 foxes per year in years 3-5 if the following conditions were met by the end of year 2:

- Average survival rate greater than or equal to 0.50
- At least two successful reproductions

If these conditions were not met, we would discontinue translocating foxes until the issues hindering success can be identified and addressed. Continued monitoring would allow us to evaluate progress toward these success metrics, as well as help identify barriers to success. We would then consider strategies to address these barriers before proceeding with continuing efforts to reintroduce swift foxes.

We planned to use GPS collars to monitor swift fox survival and reproduction, assess progress towards our goals, and identify barriers to success. For the first two years we would collar all released swift foxes. We planned to incorporate high school and university students in ecology and science courses to assist with monitoring efforts as an education community and outreach component. We planned to use the expertise of our education and storytelling partners of SCBI and NGS to develop national and global science and conservation education from the project. We are currently working with Montana Outdoor Science School (MOSS) to develop swift fox-related curriculum for Montana schools.

3. Anticipated Outcomes

3.1 Short-term (0-5 years after project initiation)

- Establish swift fox population in American Prairie Reserve region
- Build public awareness and support for swift foxes in the region
- Provide recreational opportunity to wildlife viewers
- Increase conservation partnerships between interested parties
- Expand experiential science education for Montana students by involving schools in monitoring efforts
- Publish results of outcomes of initial translocation.

3.2 Long-term (5-10 years)

- Self-sustaining population of swift fox population in American Prairie Reserve region, dispersed over 14,150 km^2 of suitable, currently unoccupied habitat (Figure 3).
- Publish results of post-release monitoring
- Population large enough to support connection with population north of Milk River
- Enhance connectivity between BFIR and FPIR
- Progress toward complete ecosystem restoration, with associated ecological impacts
- Enable revision of state status of swift fox from S3 to a more secure status

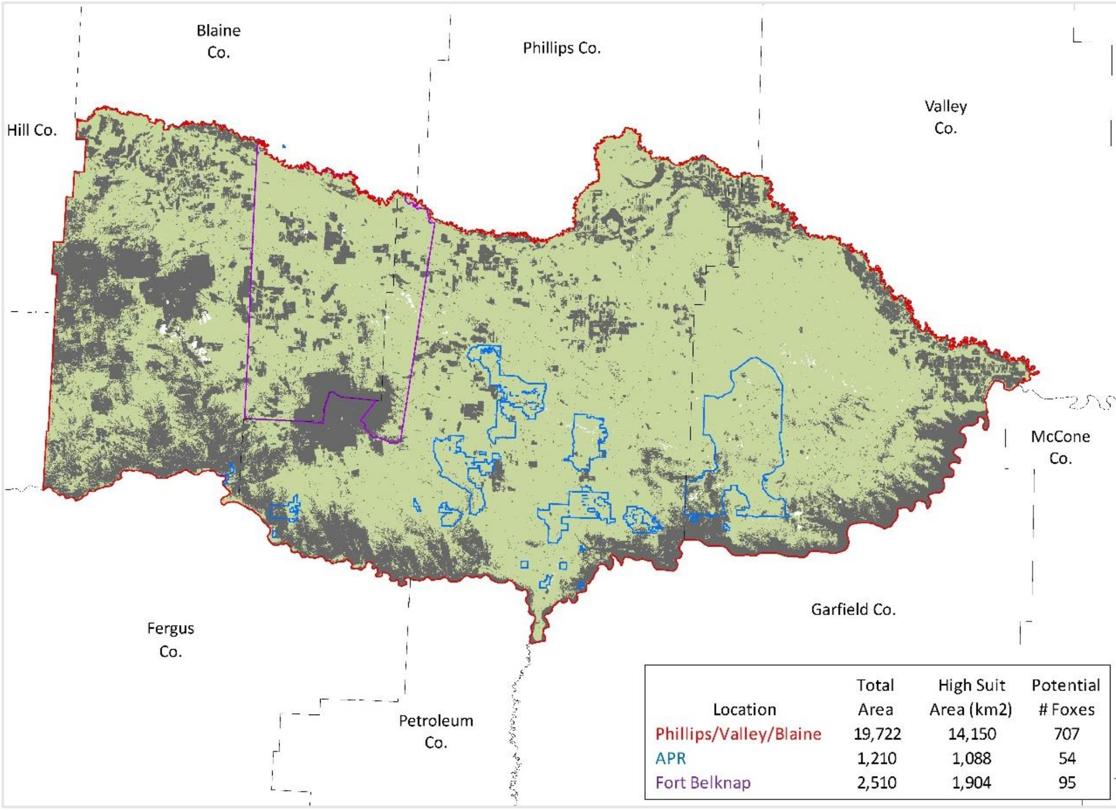

Figure 3 Estimated carrying capacity of swift foxes in the American Prairie Reserve region, based on highest categories of suitable habitat from Olimb and Bly (2015) and average density of swift fox in the Northern population during years of positive growth (Moehrenschlager & Moehrenschlager 2006).

4. Discussion

4.1 Alignment with broader strategies: Montana Swift Fox Conservation Strategy

The proposed reintroduction fit into each of the four priorities of the Montana Swift Fox Conservation Strategy (MT FWP 2019).

Priority 1. Identify and Map Swift Fox Habitat in Montana
Strategy 1A: Core Areas - Identify and Map Core Areas of Swift Fox Habitat
Strategy 1B: Connectivity - Identify and Map Connectivity of Swift Fox Core Habitats
Priority 2. Conserve Swift Fox Habitat and Movement Corridors
Strategy 2A: Conserve Swift Fox Habitat on Private Lands
Strategy 2B: Develop Specific Swift Fox Habitat Management Guidelines
Strategy 2C: Conserve Swift Fox Habitat on Public Lands
Priority 3. Monitor Swift Fox Distribution/Status
Strategy 3A: Develop and Fund a Repeatable, Long-Term Population Distribution Survey Technique
Priority 4. Increase Distribution of Swift Fox into Suitable, Connected Habitats
Strategy 4A. Foster Public Support for Swift Fox Expansion and Awareness of Habitat Programs

Strategy 4B. Improve Core and Dispersal Habitat Quality on Public and Private Lands
Strategy 4C. Expand Distribution of Swift Fox Via Strategic Reintroductions in Priority Areas

Priority 1. Assessment and identification of suitable swift fox habitat in the state has been attempted several times, with several suitability maps produced. The WWF model has been continually revised and improved and represents the best available science. We conducted a ground truth of American Prairie Reserve habitat based on the WWF model. Suitability of habitat at American Prairie Reserve and FBIR is illustrated in Figure 2. Monitoring foxes during and after our reintroduction would allow us to conduct a resource selection analysis to better define habitat in the region.

Priority 2. In addition to conserving habitat for swift foxes, American Prairie Reserve is actively managing the landscape to enhance habitat for native prairie species. American Prairie Reserve currently protects over 400,000 acres of land, which will be safe from development in perpetuity. American Prairie Reserve is already the largest reserve in the grasslands after the Charles M. Russell National Wildlife Refuge. American Prairie Reserve continues to grow annually toward its goal of >5,000 square miles of reserve, contiguous with CMR, the largest reserve in the lower 48 states and the largest grassland reserve in North America.

Priority 3. In order to measure progress towards our ultimate goal of establishing a population of at least 200 individuals, we planned to conduct population surveys using camera traps every 5 years following the initial 3-5 years of reintroductions. This effort would dovetail with the state's priority to develop a long-term, repeatable population survey. We would undertake surveys in our project area using the same protocol determined by MT FWP for the rest of the state, removing a survey burden of over 19,000 km^2 MT FWP.

The proposed action directly addresses **Priority 4**: Increase distribution of swift fox into suitable, connected habitats. It is possible that swift fox could slowly re-establish themselves in and around the American Prairie Reserve without assistance. However, given that the only significant expansion of this species' range was a result of reintroduction into Canada, the capacity of this species to recolonize on its own appears to be limited. The Canadian reintroduction commenced 35 years ago and no foxes have established south of the Milk River. By reintroducing swift foxes to American Prairie Reserve, we could strategically expand the population's distribution southward, improving the likelihood that the Northern and Southern populations would eventually reconnect. We anticipate that our reintroduction could eventually result in over 700 swift foxes in 14,150 km^2 of suitable unoccupied habitat (Figure 3)(Olimb and Bly 2015).

A reintroduction at American Prairie Reserve has great potential to achieve Priority 4, and covers all three of the strategies outlined in the Strategy that could be used to achieve this objective. We are protecting and improving habitat (Strategy 4B) on American Prairie Reserve property and are currently in the process of restoring 10,000 acres back to native prairie. Our reintroduction would expand the distribution of the Northern population southward (Strategy 4C). Finally, a reintroduction at American Prairie Reserve would directly address the state's goal to "Foster Public Support for Swift Fox Expansion and Awareness of Habitat Programs" (Strategy 4A). American Prairie Reserve has a strong communication network with both its own donors, and partner organizations. For example, we planned with National Geographic to document and publicize the reintroduction effort, allowing us to reach and educate a broad audience. By using our project to draw attention to, and support for, the conservation challenges for swift fox we could help create a base for public interest and potential habitat conservation state-wide. In addition to public support on a national scale, we also planned to involve the local community in the reintroduction by organizing local groups to assist with releases and monitoring, if interest exists.

4.2 Alignment with broader strategies: Swift Fox Conservation Team Strategy

Conservation Assessment and Conservation Strategy for Swift Fox in the United States (SFCT 2011).

The 8 primary objectives for 2011-2020:

1. Maintain a Swift Fox Conservation Team, to include 1 representative of each of the state wildlife agencies within the historical range of the swift fox.
2. Maintain swift fox distribution in at least 50 percent of the suitable, available habitat.
3. Periodically evaluate the status of swift fox populations.
4. Identify and conserve existing native shortgrass and mixed-grass grasslands, focusing on those with habitat characteristics conducive to swift fox.
5. Facilitate partnerships and cooperative efforts to protect, restore, and enhance suitable habitats within potential swift fox range.
6. Identify and encourage research studies that contribute to swift fox conservation and management.
7. Promote public support for swift fox conservation activities through education and information exchange.
8. Maintain swift fox population viability such that listing under the U.S. Endangered Species Act is not justified.

The proposed reintroduction would also address seven out of the eight objectives of the Swift Fox Conservation Team (SFCT) for 2011-2020. In 2018 American Prairie Reserve was represented at the biannual Swift Fox Conservation Team meeting. It will continue to send representatives to each meeting and work as an active member of the SFCT **(Objective 1)**. By assisting the Northern population in southward expansion through reintroduction adjacent to the southern limit of their current range, the proposal to reintroduce swift foxes into American Prairie Reserve and Ft. Belknap directly supports the goal of maintaining swift fox distribution in at least 50% of suitable available habitat **(Objective 2)**. Similarly, by helping reinforce the existing population in north central Montana, we would support the viability of the continent-wide population such that listing under the Endangered Species Act is not necessary **(Objective 8)**.

American Prairie Reserve's work to ground-truth suitable and unsuitable habitat based on the WWF model represented an effort to help identify habitat characteristics suitable to swift fox **(Objective 4)**. American Prairie Reserve's main goal as an organization is to conserve and enhance existing mixed-grass prairie **(Objective 4)**, and thus our proposed work with swift foxes is an ideal fit to both the goals of the SFCT as well as American Prairie Reserve.

Based on our proposed plans to reintroduce swift foxes, the Smithsonian Conservation Biology Institute will be hosting a master's student to assess fine-scale suitability for swift foxes in the project area (see section 2.2) **(Objective 6)**. We planned to monitor the well-being of reintroduced foxes via radio-telemetry, allowing us to track home-range size, survival, reproductive success and dispersal of reintroduced individuals. We planned to engage the local community in these monitoring efforts and expect that the reintroduction of this charismatic species would enhance wildlife tourism in the area. Both of these would provide opportunities for educating the public on swift foxes, and ideally enhance support for the species **(Objective 7)**.

Just as we planned to engage locals in radio-telemetry monitoring of swift foxes, we also planned to engage with local students from the Fort Belknap community college to build infrastructure for foxes (soft release pens, escape dens) in advance of the reintroduction effort. Our research on the suitability thus far has already included partnerships with WWF and Oregon State University to survey for swift fox presence, and Adventure Science's Landmark crew to ground-truth habitat. We hope that continued swift fox work will enable us more opportunities for positive collaboration with Montana Fish Wildlife & Parks as well **(Objective 5)**.

5. Conclusion

The proposal to reintroduce swift foxes into suitable habitat where they are currently absent fulfills the goals outlined by the Montana State Swift Fox Conservation Strategy, those outlined by the Swift Fox Conservation Team, and American Prairie Reserve's mission. The reintroduction effort could serve as a source of inspiration for prairie conservation through the story telling and educational opportunities. Finally, restoration of a non-controversial native mammal represents a positive, proactive, step towards securing the species and supporting full restoration of its ecosystem.

Presently, there are no active efforts to reintroduce swift foxes on American Prairie Reserve lands. In November 2018 representatives from American Prairie Reserve, Fort Belknap Department of Fish & Wildlife and MT FWP met and reviewed the results of the 2016 ground truth survey, and toured habitat in the proposed reintroduction area. In March of 2018 MT FWP prepared to bring the proposed action before the state's Fish & Wildlife Commission for endorsement to conduct an Environmental Assessment considering the proposed action. In April of 2018 MT FWP withdrew their support for the proposed action, citing concerns over the habitat in the region, and the belief that if the habitat was suitable swift foxes would disperse there unaided, given enough time.

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Risk Assessment : Potential Threats to Reintroduced Swift Foxes at American Prairie Reserve

1. Historic Threats to Reintroduced Population

1.1 Conversion of grassland to agriculture

Historically, European settlement of the Great Plains resulted in large-scale conversion of native prairie to agriculture. This loss of habitat was a major factor contributing to the decline of swift foxes on a continental scale (Egoscue 1979). American Prairie Reserve lands are specifically set aside, protected from development. While habitat conversion is possible on lands surrounding American Prairie Reserve and public grazing lands, the core reintroduction sites will be dominated by fully protected lands.

1.2 Poisoning

Poisonings, both incidental and targeted, were the other major factor that resulted in the wide-scale decline of swift foxes. Widespread use of non-selective poisons to kill large predators, such as wolves (*Canis lupus*) and coyotes (*Canis latrans*), began in the 1800's (Allardyce and Sovada, 2003). Since the 1950's the use of non-selective poisons such as strychnine have greatly decreased, and some have been legally restricted, resulting in modest recovery of swift fox populations in the 1960's through 1980's. Poisoning of predators or pest species does not occur on American Prairie Reserve lands and is heavily restricted on adjacent public lands, so we consider this historic threat to be an insignificant risk for reintroduced populations.

1.3 Fur trapping

In Montana there a trapping season for swift fox, with a quota of 10 animals per year. This quota was implemented to protect the population from over-harvesting, while allowing for a small amount of recreational use that concurrently provides MT FWP with limited demographic and genetic data (H. Harris, MT FWP personal communication). MT FWP considers this harvest to be a negligible risk to the extant Northern population (MT FWP 2019).

Swift foxes may be incidentally trapped in traps set for coyotes, and trapping for coyotes takes place year-round in the area surrounding reintroduction sites. Although swift foxes are legally protected from trapping on American Prairie Reserve property, we consider legal trapping if swift foxes range outside American Prairie Reserve, and illegal trapping anywhere in the region to be a moderate risk to a newly established population swift foxes.

2. Abiotic Interaction

2.1 Drought

Drought has the potential to limit the success of a swift fox reintroduction. Based on recent climate change models, it is likely that summers will become drier across the state, including the reintroduction area (Whitlock et al., 2017). With the predicted steady increase in temperature due to climate change, these droughts will likely be more severe (Whitlock et al., 2017). Research on kit foxes (*Vulpes macrotis*) shows that droughts can reduce reproductive output through limiting prey availability (White and Ralls, 1993), a scenario that would likely apply to swift foxes as well. Therefore, we consider this to be a moderate severity threat with a high likelihood of occurrence. The are no feasible options to mitigate the loss of prey due to drought.

While climate change predictions suggest Montana will encounter lower summer precipitation, increases in precipitation in the spring, fall and winter are also predicted (Whitlock et al., 2017). It is unclear how these changes would impact swift fox. Increases in spring precipitation could promote the growth of tall vegetation, which limits fox's ability to detect predators (Allardyce and Sovada, 2003). Alternatively, increased precipitation may increase abundance and diversity of small mammals (Whitford, 1976), which could positively affect fox survival. We planned to provide supplemental food at known den locations of swift foxes if drought occurs during the first three years of the reintroduction effort.

2.2 Severe Winters

Severe winters are a threat to reintroduced swift foxes. Winter precipitation is expected to increase in Montana (Whitlock et al., 2017). Recent severe winters are likely responsible for the recent decline seen in the Northern population (Moehrenschlager and Moehrenschlager 2018). Severe winters may change the food sources available to foxes, by reducing accessibility to small mammals, but potentially increasing the availability of ungulate carcasses. We planned to provide supplemental food at known den locations of swift foxes if severe winters occur during the first three years of the reintroduction effort.

3. Biotic Interactions

3.2 Prey density

Swift foxes consume a diverse variety of prey, which may be negatively affected by climatic extremes such as droughts (e.g. White and Ralls, 1993) and severe winters (Korslund and Steen, 2005). Variation in diet based on season and habitat type show that swift fox are opportunistic foragers, capable of adapting to changes in prey availability (Sovada et al., 2001). Despite this flexibility, decreased prey density represents a moderate risk to swift foxes, as it has been shown to drive local declines of related kit foxes (White and Ralls, 1993). To mitigate this risk, we are working to enhance the number of prairie dogs and availability of prairie dog habitat on our property. As a keystone species increased prairie dog presence will increase the biodiversity of the ecological community (Martínez-Estéves et al., 2013), and specifically promote a more diverse assemble of prey for swift foxes.

3.3 Genetic Diversity/Isolation

Genetic isolation is a slight concern if a population were reintroduced at American Prairie Reserve. Dispersal distances for reintroduced swift foxes are highly variable, with swift foxes reintroduced to the Blackfeet Indian Reservation averaging 51 km, excluding an outlier which dispersed 190 km (Ausband and Moehrenschlager 2009). The average dispersal distance for wild-born yearling swift foxes from this same population was 10 km (Ausband and Foresman 2007*a*). Proposed reintroduction sites at American Prairie Reserve are located approximately 58 km distance from previously known locations of other swift foxes (Butler 2017).

There have been multiple documented sightings of swift fox south of the Milk River (Montana Natural Heritage Program, 2018) presumably individuals from the Northern population dispersing southward. This indicates that the Milk River should not be considered an insurmountable barrier, and connectivity between current swift foxes in Northern Montana and the proposed reintroduced population is possible. Therefore, we consider the likelihood of a genetically isolated population to be moderate, rather than high. We planned to attempt to minimize the effects of potential isolation of this population by drawing from multiple source populations, if a reintroduction were to occur.

3.4 Hybridization

Interspecific hybridization between swift foxes and kit foxes has been reported in other parts of this species' range (COSEWIC, 2009). However, kit foxes do not occur in Montana (Reid, 2006). There are rare records of hybridization between kit foxes and red foxes (Thornton et al., 1971), suggesting that swift foxes could also hybridize with red foxes. Given the scarcity of these reported hybridization events in kit foxes, and the competition between red foxes and swift foxes, we consider hybridization between these two species to have a low likelihood of occurrence. The consequences of hybridization are unknown.

Intraspecific hybridization is not a concern for the reintroduced population. Breeding between reintroduced foxes and extant foxes from the Northern population would be beneficial to genetic diversity of the metapopulation. Breeding between reintroduced swift foxes and swift foxes from the Southern population would also be beneficial, though it is unlikely given the distance between the reintroduction area and the Southern population.

3.5 Predation & Competition

Predators of swift fox include coyotes, badgers (*Taxidea taxus*), and a variety of raptor species (Ausband and Foresman, 2007). Multiple studies cite coyotes as the highest source of known mortality (Carbyn et al., 1994, Ausband and Foresman 2007, Olson and Lindzey, 2002; Schauster el al., 2002). Reported rates of predation due to coyotes range from 32% - 51% (Carbyn et al., 1994, Ausband and Foresman, 2007, Olson and Lindzey 2002; Schauster el al., 2002). Raptors represent the second most common predators of swift fox, with golden eagles (*Aquila chrysaetos*) accounting for 71% of raptor mortality in the Northern population (Carbyn et al., 1994). Several authors note that while coyotes often kill swift foxes, the carcasses are rarely consumed, indicating that the interaction between these species is likely a case of competition, rather than predation (Sovada et al., 1998, Kitchen 1999). Regardless of the motivation, the effects of coyotes on swift fox constitute a serious risk to the reintroduced population. Interspecific competition with red fox (*Vulpes vulpes*) has also been shown to negatively affect smaller foxes (Ralls and White 1993).

Lethal control of coyotes was used to enhance survival of swift foxes in the Bad River Ranches reintroduction in South Dakota. While lethal control of coyotes appears to be an intuitive step prior to translocation, we have identified several limitations to this strategy.

- A study of collared coyotes in South Dakota reveals that coyotes who are persecuted tend to move more at night compared to coyotes who are not (Schroeder 2007). Increased pressure on coyotes may cause them to change their behavior and contact swift foxes more frequently than if the was no increase in coyote persecution.
- Suppression of coyotes may lead to an increase in red foxes, another competitor of swift foxes (Sovada et al., 1998).
- Multiple studies cite that while coyote removal can be effective at increasing swift fox survival in the short-term, it requires substantial removal and long-term commitment for this benefit to be sustained (Karki et al 2007, Kamler et al., 2003*b*).
- A study of the closely related kit fox found that despite substantial efforts to lethally control coyotes, abundance, survival and proportion of known-cause deaths of kit fox attributed to predation did not change in response to coyote control efforts (Cypher and Scrivner 1992).

- Lethal removal of coyotes may result in a compensatory increase in female reproduction, (Nellis and Keith 1976) increasing population levels, though evidence for this effect is mixed (e.g. Cypher and Scrivner 1992).

Coyote control is costly, may be controversial to the public (Goodrich and Buskirk 1995) and its results are not guaranteed. Therefore, we do not propose predator control efforts as part of our reintroduction strategy. As an alternative measure to enhance survival of translocated swift foxes, we planned to install artificial escape dens throughout the proposed release area. Installation of these dens has been shown to increase both survival and relative abundance of swift foxes in the wild (McGee et al., 2006*a*). This study demonstrated a consistent 56% increase in survival between untreated and treated sites, and an increase in abundance in 2 out of the 3 years of the study (McGee et al., 2006*a*).

4. Disease

4.1 Plague

Sylvatic plague (caused by the bacteria *Yersinia pestis*), which first occurred in the area in 1992 (R. Matchett, CMR National Wildlife Refuge, personal communication) does not constitute a direct threat to swift fox survival as canids are generally not affected by the disease (Abbott and Rocke 2012). However, black-tailed prairie dogs are highly susceptible to plague (Cully and Williams 2001). Reduction in prairie dogs could have an indirect, negative impact on swift foxes by reducing a source of prey, and altering the vegetation structure in the region.

4.2 Canine Distemper Virus

Canine distemper virus (CDV) affects most canid species (Pybus and Williams 2003) and therefore represents a risk to swift fox, though the susceptibility of this species to the disease is unknown. Surveys indicate exposure to at a rate of 10% in Western South Dakota (E. Mitchell, South Dakota State University, unpublished data), and 13% across multiple Western states (Miller et al., 2000). We planned to vaccine all captured foxes for CDV. Given the high efficacy of this vaccine in other canids (Abdelmagid et al., 2004) we consider CDV to be a low risk to translocated foxes.

4.3 Rabies Virus

Like CDV, rabies virus represents a potential risk to translocated swift foxes, though there is little information available about the incidence of rabies in this species. In the Northern portion of this species' range, rabies virus is carried by striped skunks, bats and domestic dogs (Pybus and Williams 2003). We planned to vaccine all foxes for rabies, and therefore consider this to be a low risk to the reintroduced population.

4.4 Canine parvo virus

Canine parvo virus (CPV) also represents a potential risk to translocated foxes. Recent work in South Dakota found seroprevalence of 71% among sampled foxes, indicating a high level of exposure to CPV (E. Mitchell, South Dakota State University, unpublished data). Work in Colorado also found seroprevalence of 71% for adult and 38% for juvenile (≤ 9 months) swift foxes (Gese et al., 2004). These high rates of exposure suggest that the incidence of CPV is high, but the virulence is low, resulting in high rates of survival in this species. The subclinical effects of this disease on the population are unknown. A vaccine for CPV that is effective in other canids is available (Abdelmagid et al., 2004) and would be used to mitigate the risk of this disease, if a reintroduce were to occur.

5. Ecological Threats of Reintroduction

Swift foxes have the potential to transmit *Y. pestis* bacteria by physically transporting fleas from an infected to uninfected area (McGee et al., 2006*b*). To mitigate this risk, we planned to dust foxes with insecticide powder prior to transportation away from their source.

6. Economic Threats of Reintroduction

Swift foxes are opportunistic foragers, with a varied diet, including small mammals, birds, insects, plants and carrion (Sovada et al., 2001). Of these, mammals make up 40 – 58% of the diet, and arthropods make up 32 – 43% of the diet (Sovada et al., 2001). Birds, on the other hand, make up only 2 – 6% of this species' diet, both in natural and cultivated landscapes (Sovada et al., 2001). Given this animal's small size (4.0 – 6.5 pounds (Kilgore, 1969)) they do not constitute an economic threat to large livestock. Similarly, given the small percentage of the diet containing birds, we do not believe they should be considered a major threat to sage grouse or domestic chickens. There are some reports of swift foxes feeding on seed waste from commercial sunflower crops (Sovada et al., 2001), but given the low economic weight of this crop in the region, the effects of foxes on sunflower crops are likely negligible.

7. Social Threats of Reintroduction

Reintroductions of carnivores are often controversial. American Prairie Reserve is also a controversial organization in the region. Considering these factors, a swift fox reintroduction may be controversial, despite the fact that this species poses no economic threat. The consequence of a controversial reintroduction would be increased distrust for American Prairie Reserve in the region. In an attempt to mitigate this risk, we have been soliciting feedback from community members during the planning process, giving community presentations on the proposed plans, and had planned to incentivize support for the presence of this species by providing incentive payments to private landowners who leave verified swift fox dens on their land undisturbed, a method showed to be effective at increasing tolerance in a previous reintroduction (Ausband 2005).

Risk is the likelihood of a threat occurring, combined with the severity of the impact (IUCN/SSC 2013).

Threat	Likelihood of Occurrence	Severity of Impact	**Risk**	Mitigation Strategy	Threat eliminated by mitigation?
Historic Threats					
Conversion of habitat	None	Moderate	**0**		
Poisoning	Low	Moderate	**2**		
Trapping	Moderate	Moderate	**3**		
Abiotic Interaction					
Drought	High	Moderate	**5**	Supplemental feeding	No
Severe winters	High	High	**6**	Supplemental feeding	No
Biotic Interactions					
Predation	High	High	**6**	Artificial escape dens	No
Unstable prey availability	Low	High	**4**		
Genetic Isolation	Moderate	Moderate	**3**	Multiple source populations	No
Intraspecific hybridisation	Low	Low	**1**	Positive impact	
Interspecific hybridisation	NA	Unknown	**0**		
Disease					
Sylvatic plague	Moderate	Low	**2**		
Canine distemper virus	Low	High	**4**	Vaccination	Yes
Rabies virus	Low	High	**4**	Vaccination	Yes
Canine parvo virus	Low	Moderate	**2**	Vaccination	Yes
Ecological					
Transmission of plague (+) fleas	None	Moderate	**0**	Dusting with insecticide	Yes
Social					
Conflict with locals	Moderate	Low	**2**	Public education	No
Economic					
Foxes are a negligible economic threat	Low	Low	**1**		

Risk Ranking			
	Low	Mod.	High
Low	1	2	4
Mod.	2	3	5
High	4	5	6

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DISTRIBUTION, ECOLOGY, DISEASE RISK, AND GENETIC DIVERSITY OF SWIFT FOX (*VULPES VELOX)* IN THE DAKOTAS

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INTRODUCTION

The swift fox (*Vulpes velox*), a native species once abundant throughout the Northern Great Plains (NGP), has declined due to changes in land use, historic predator eradication programs, and predation by larger canid species. Currently, the species is estimated to occupy 44% of its historic range. In the NGP, the status of the swift fox varies by state, ranging from furbearer to endangered species. However, knowledge of the current status of swift foxes in the NGP is lacking due to an absence of systematic population monitoring. Improving the current state of knowledge concerning swift fox populations in the NGP is necessary to assess the population status of the species and will be instrumental in assisting managers in conservation and, if needed, restoration of this rare species.

The swift fox is considered rare in North Dakota and state threatened in South Dakota. In the early 2000's reintroductions occurred in four areas in west-central South Dakota: Bad River Ranches (Stanley and Jones counties), Lower Brule Sioux Tribal Land (Lyman county), Badlands National Park (Pennington and Jackson counties), and Pine Ridge Indian Reservation (Oglala Lakota county). Today, swift foxes are known to exist around Badlands National Park and in Fall River County (a remnant population) South Dakota. Beginning in 2006, intermittent swift fox sightings in northwest South Dakota and southwest North Dakota were recorded via aerial telemetry, incidental capture, or recovered mortality, implying the potential re-establishment of swift fox in the region.

Therefore, in 2016 South Dakota State University, South Dakota Department of Game, Fish, and Parks, and North Dakota Department of Game and Fish initiated graduate research project to systematically survey the distribution of and assess the status of swift fox in northwest South Dakota and southwest North Dakota. The objectives of the study are to (a) determine the distribution of swift fox. red fox, and coyotes in northwest South Dakota and southwest North Dakota, (b) determine swift fox survival, den site selection, reproductive rate, home range size, and juvenile dispersal timing and distance, (c) assess the prevalence of canine parvovirus, canine distemper, plague, and tularemia in swift fox, and (d) assess the genetic diversity and population viability of the swift fox population in northwest South Dakota and southwest North Dakota.

A formal thesis is available from South Dakota State University at: https://openprairie.sdstate.edu/etd/2692/.

SUMMARY OF RESULTS

To accomplish our objectives, we first conducted a systematic camera-trap survey to assess occupancy and distribution of swift fox, coyotes, and red fox. Using camera trap detections and anecdotal sightings, we livetrapped, radio-collared, and tracked swift foxes to locate den sites to assess den site habitat selection. Using samples collected during camera-trap surveys and radioix collaring, we conducted disease and genetic diversity analyses.

We conducted a systematic survey of suitable swift fox habitat in 6 counties and all suitable home ranges in 2 counties from August - December 2015 (North Dakota), and 2016 (South Dakota). We used camera detections, radio collar locations, den site locations, and confirmed incidental sightings to conducted occupancy and distribution analysis. We created occupancy and distribution models at two different scales (sympatric canids: double-home range (figure 1), 6.68 km, and home range (figure 2), 3.34 km; swift fox: sub-home range, 30 m, and home range, 3.34 km); both scales created overfit models, producing inaccurate distribution maps for swift fox. Therefore, we do not suggest using either of these models for management purposes. However, we found that coyotes occupied 63-69% of the study area while red fox occupied 46-53% of the study area.

We live captured 41 swift fox, 26 of which were fitted with VHF radio collars and tracked weekly for one to one and a half years. We conducted 27 den surveys, finding that dens were farther from roads than other studies, with no correlation between den-site location and vegetation height. We monitored 8 dens for pups, documenting pups at 4 of those with an average litter sizes of 3.25 pups. We documented large home ranges sizes, with an average home range size of 55.38 km^2 and an average core area size of 12.19 km^2. We monitored 14 radio-collared juvenile swift fox, 7 of which we documented dispersal events. Juveniles dispersed from late October to mid-February, with most juveniles dispersing in February. Dispersal dispersal distances were fairly large, averaging 17.20 km. We documented high survival (0.857), with coyotes being the leading cause of death.

We collected blood from 31 individual swift fox for disease analysis. We found high prevalence of canine parvovirus (71.43%) and *Francisella tularensis* (67.74%), but low prevalence of canine distemper virus (10.34%) and *Yersinis pestis* (3.32%). The high prevalence of canine parvovirus and exposure to canine distemper are cause for concern, due to their typically highly fatal outcomes. In the future infectious diseases, such as canine parvovirus and canine distemper virus should be consider as important factors in swift fix conservation.

The swift population found in the Dakotas is assumed to be a small, isolated population resulting from recolonization by founders from either reintroduced populations in central South Dakota or a naturally occurring population in northern Wyoming. We used 59 scat and tissue samples for microsatellite DNA analysis, 50 of which were successfully genotyped and used in our analysis. We estimated an effective population size between 33.6 and 68.9 individuals and identify 24 first order, 34 second order, and 186 third order relationship within the population. We further found that all individuals exhibited at least one third order relationship with another individual. These relationships were found to be distributed throughout the study area. The swift fox population occupying northwestern South Dakota and southwestern North Dakota is genetically viable, with high intrapopulation connectivity and no sign of a genetic bottleneck.

Our study is the first of its kind in northwest South Dakota and southwest North Dakota and most of our findings can and should be used in future monitoring, conservation, and restoration plans for this native species in the Dakotas.

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Figure 1. Predicted distribution of swift fox in the Dakotas, using Random Forest (Breiman 2001) at the 30 m scale. Overall out of bag error (OOB) was 0.108, OOB for records of presence was 0.140, and OOB for records of absence was 0.078. Of the roughly 40,600 km^2 in our study area, about 5,000 km^2, or 12%, have a likelihood of ≥50% of swift fox presence.

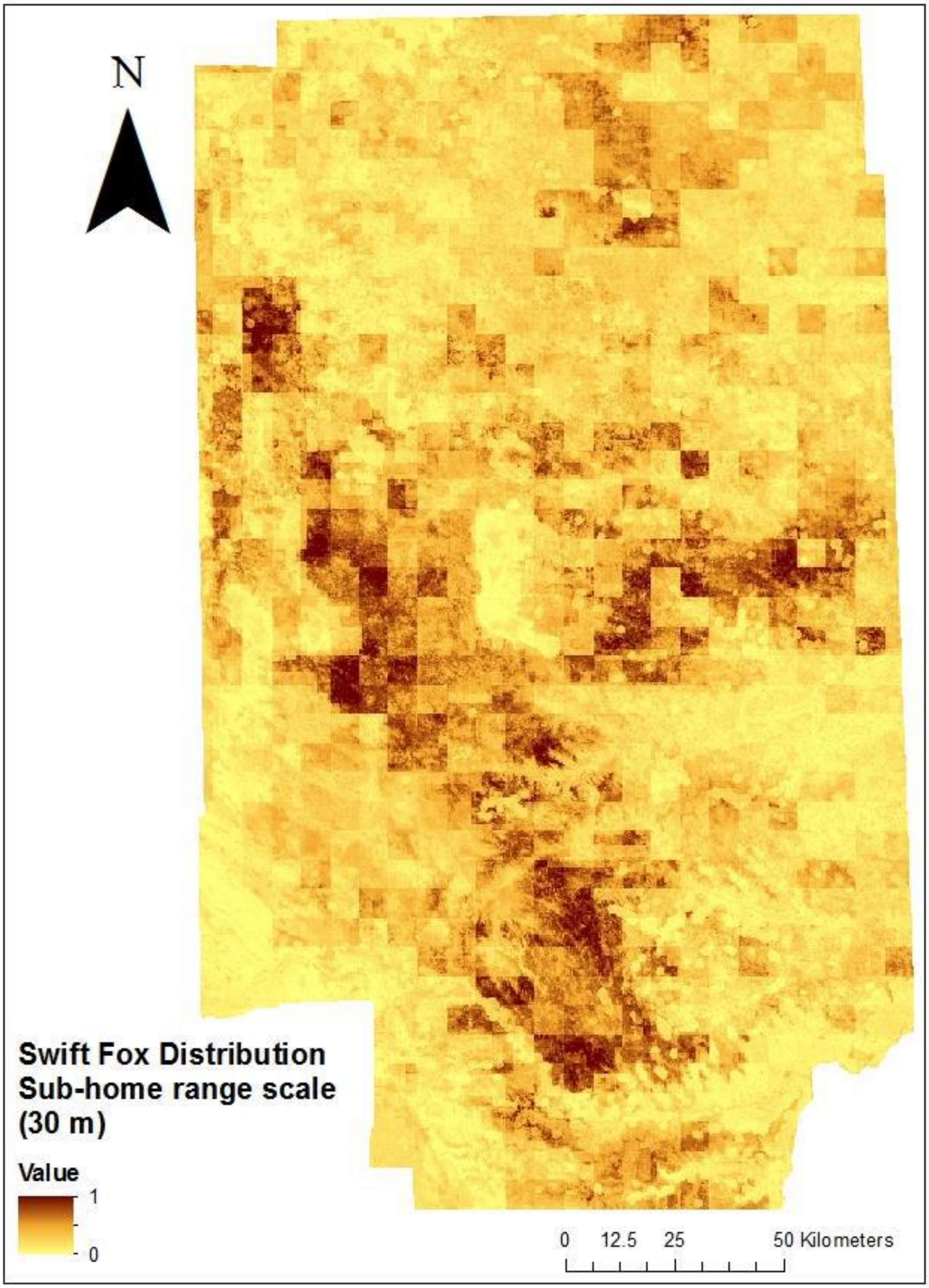
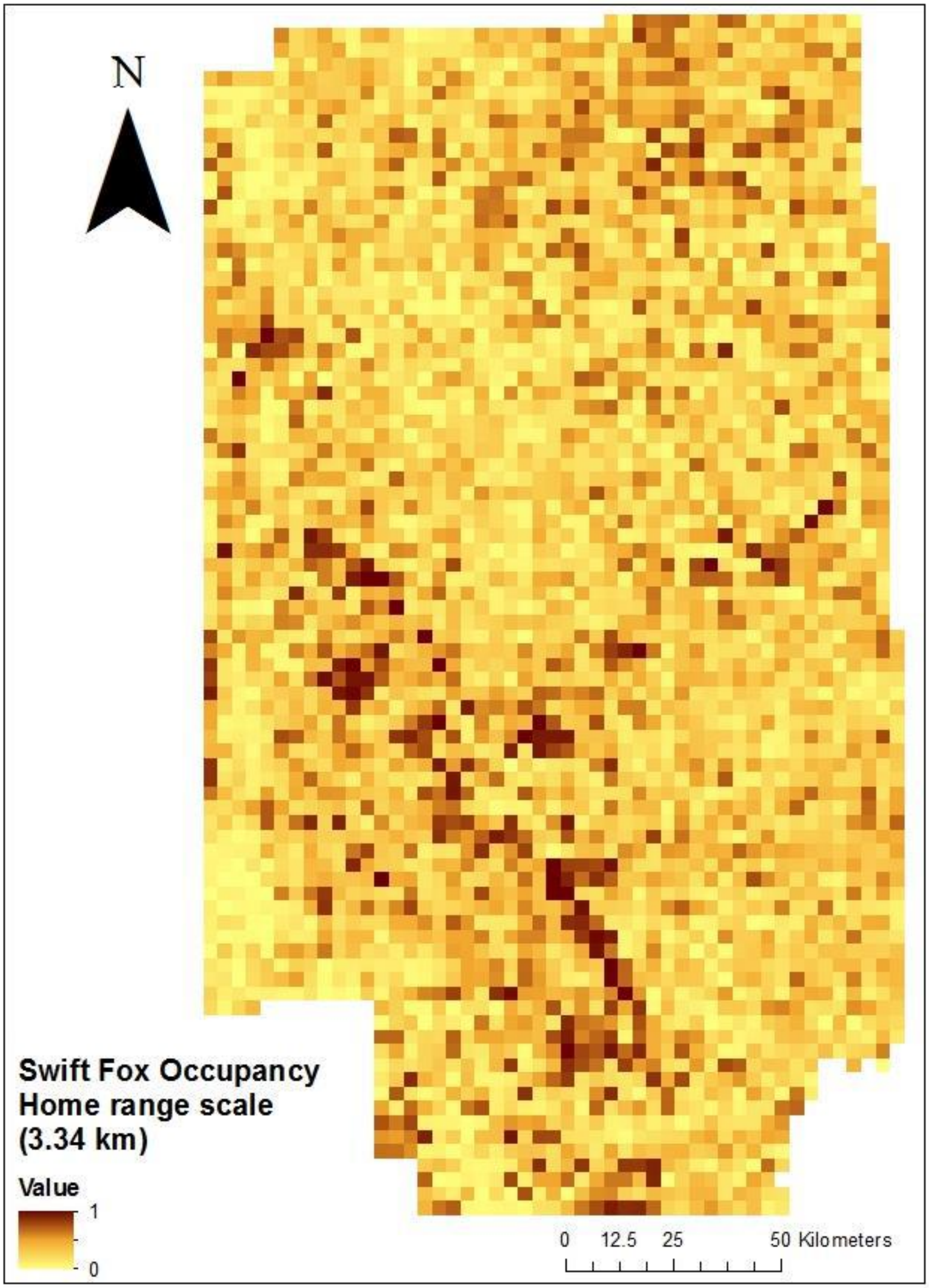


Figure 2. Predicted distribution of swift fox in the Dakotas, using Random Forest (Breiman 2001) at the 3.34 km scale. Overall out of bag error (OOB) was 0.480 OOB for records of presence was 0.259, and OOB for records of absence was 0.559. Of the roughly 40,600 km^2 in our study area, about 14,000 km^2, or 34%, have a likelihood of ≥50% of swift fox presence.



Swift Fox Conservation Team
Minutes from the 2018 biennial meeting

Bozeman, MT
April 18, 2018

Patrick Isakson, North Dakota Game and Fish Dept. Phone: (701) 328-6338; email: pisakson@nd.gov

Colorado Parks and Wildlife (Marty Stratman)

- Surveys every 5 years
- Camera surveys
- Skunk essence with Vaseline
- Estimates of distribution and occupancy within shortgrass prairie
    - 3 patch sizes
        - Small 1-3 sq mi: 1 camera; 0.33 occupancy probability
        - Med 3-5 sq mi: 2 cameras; 0.50 occupancy probability
        - Large >5 sq mi: 4 cameras; 0.85 occupancy probability
    - 3 consecutive nights
    - N=227 foxes
    - 0.48-0.59 detection probability
    - 0.694 occupancy probability
    - Small patches of disjunct patches are prevalent in CO
        - 12,956 sq miles of occupied shortgrass prairie
- 500-1,000 swift foxes harvested annually – unlimited permits
- Mange in coyote populations

Wyoming Game and Fish Department (Nichole Bjornlie)

- Surveys every 3 years
- All habitat types, but each grid had to have at least 25% suitable habitat
- Camera surveys on 12 square mile grids
- Skunk essence with Vaseline with fish oil
- 131 grid cells – August to November
- N=641 photos of foxes (includes Wind River); foxes on 40 of the 131 grid cells
- 31% occupancy statewide; increase in occupancy to 42% in 2017 from ~30% in 2013
- Detection = .50
- Detections between 6 pm to 6 am
- Occupancy

    positively associated with suitable slope (10% or less),
    negatively correlated with active oil/gas well density,
    negatively correlated with coyotes,
    negatively correlated with road density,
- Detection probability positively correlated with road density (includes two tracks)
- Higher occupancy in predicted suitable habitat
- WY swift foxes still vulnerable:
    - Roads
    - Coyotes
    - Oil and gas development

- Swift foxes capable of exploiting new areas
- Speculate an increase in prey populations is coinciding with increases in swift foxes
- Possible mange in swift fox in Laramie county near CO border
- Swift foxes are non-game so no harvest; pelts can be sold with warden approval if accidentally trapped
- WY sfox HIS – habitat (short grass/mixed grass/sagebrush/crop) and slope
- 3 full time people, 1 person part time, 95 cameras, 12 weeks
- Cameras for 5 nights

<u>ND/SD – Emily Mitchell</u>

- 617 camera trap locs in both states (526 in SD, 81 in ND) 87% of private land
    - 7 days
    - 10 cameras with foxes (1 in ND, 9 in SD)
    - 250,000 photos
- Live trapping n= 41 trapped/ 23 juvs and 18 adults – n = 26 radio collars
- Of the 26 foxes: 4 morts (coyotes, roads), 4 disappeared
- 0.86 yearly survival
- 7 of 14 juvs dispersed (all females) – Oct 23-Feb 14
    - Ave dispersal 17.20 km
- Home range: 21.53 – 132.44 km sq
  Average 55.38 sq km
- Plague – 1 of 31 tested positive
- Tularemia – 21 of 31 tested positive
- Distemper – 3 of 29 tested positive
- Parvovirus – 20 and 28 tested positive (lethal for canids)

<u>Swift fox interactions with BUOW/MOPL on BTPDs in WY – Ryan Parker</u>

- BUOW eating MOPL chicks
- Swift foxes eating BUOWs

<u>Montana – Bob Inman/Brandi Skone/Heather Harris</u>

- MT conservation strategy – 4 priorities tied to SFCT strategy
    - ID and map sfox habitat
    - Conserve habitat and movement corridors
    - Monitor distribution and status
    - Increase distribution into suitable, connected habitat
- Grid system for wolverine and fisher 15 x 15 km sq grid wolverine/7.5 x 7.5 km for fisher; plan is to add swift foxes
- Working Grasslands Initiative
    - Habitat program through MFWP to support sustainable ranching and stewardship of wildlife habitat – targets grassland habitat
    - Can be used as a tool to meet priorities within the MT Swift Fox Conservation Strategy
    - Matching funds (mitigation) – example TBGPEA
        - Looking for partners to assist with program- contact Catherine Wightman with MT FWP if have ideas for potential projects
- Swift fox SE MT Surveys

    - Pre 2015 swift fox sightings rare in SE Montana
        - Swift fox sightings increased in 2015, and in 2016 IDed dens, documented kits
        - 6 VHF collars from Emily Mitchell – small pilot on juvs
          3 males, 3 females in 3 areas (between Jordan and Miles City, Powderville, and Decker)
        - 1 Powderville fox shot, 1 Decker fox dead in burrow, 1 lost
- Glasgow foxes crossing the spillway of the Fort Peck dam
- Lu – 1980s some sightings in the Miles City area
- Trapping quota (only open in a portion of NE MT) 20, 30 in 2013, 10 in 2016
- North Central MT/Canada Swift Fox Survey
    - 1996/97
    - 2000/1
    - 2005/6 (n= 243)
    - 2014/15 – swift fox population contraction/demographic changes from 05/06 (n= 78 total; 63 live trapped + 15 camera trapped fox)

- 2014/15 Cameras plus live traps (38 townships used both methods)
- Occupancy camera traps – mackeral lure
- 189 townships Oct – March
- Detection probability for traps 0.93 and 0.81 for cameras
- Of a total of 170 replicated townships, 76 (45%) had evidence of foxes in 05/06 compared to 42 (25%) in 14/15. Representing an approximate 45% drop in townships
- Slightly offset by the fact that foxes were detected on townships where they had not been documented in previous census 12 townships had evidence in 14/15 which did not in 05/06
- Good news is the extent of occurrence is unchanged However demographic declines appear evident

- 2010/2011 winter was severe….
  2018 camera trapping survey
- NGP Swift Fox Connectivity Project
    - N= 46 foxes collared (20 adults 26 juvs)
      Lotek GPS and VHF collars
- -create resource selection and demographic models
- -Use movement and resource selection models to build spatially-explicit model for dispersal and -population connectivity
- -habitat suitability and movement resistance surface predictive maps will be overlaid with camera traps
    - Cameras to get extent in study area
        - 233 camera sites

<u>Testing Reintroduction Strategy for Swift Foxes – Doni Schwalm</u>

- Developed a model to simulate reintroduction scenarios and assess success
    - Based in the Northern Great Plains, but results translatable to swift fox translocations in general
    - Goal: establish populations with long-term persistence that created a link between populations in northern Montana, the western Dakotas, and northern Wyoming

- Potential release sites identified based on habitat suitability index (WWF), patch size, and contiguity of habitat. Some release sites tested based on desire of entities to restore swift fox in that area. Majority selected based on potential to contribute to inter-population connectivity and expansion.
- Release site scenarios varied in:
    - Which patches were used for translocation
    - Order in which patches were used; swift fox were released patch-by-patch
    - Number of foxes released (30, 60 or 90 based on assumption of max 30 individuals from each of 3 historic source populations – Colorado, Kansas and Wyoming)
    - Number of years of translocation per patch (3 or 5)
- Used HexSim to build a detailed life history model that varied survival, dispersal, pair bond formation and reproduction by age, sex, mating status (paired or unpaired) and "native" status (resident or translocated individual)
    - Based on extensive review of empirical data
    - Reintroduction scenarios were then tested in HexSim using this life history model to predict rate of population growth and spread
- Results
    - Translocation failure was linked to:
        - Patch size, edginess, and isolation from other release sites and larger habitat patches
        - Short duration of translocation (3) years, fewer foxes released per site (30 foxes and sometimes 60), and fewer patches used (e.g., single-site releases)
        - Some failed translocations had at least a few foxes present for as many as 50 years post-translocation; decline was very slow and steady and could be misconstrued as successful if only monitored for a few years post-translocation
    - Multiple successful approaches identified
        - Most required decades of translocation and 100's – 1000's of released foxes, limiting feasibility
        - After identifying patches which were consistently successful during translocation and observing that more years/foxes was a better approach, tested 2 scenarios which:
            - released 90 foxes simultaneously
                - 30 foxes per patch in a group of 3 separate patches
                - After 5 years of ongoing releases, switched to a different group of 3 patches and maintained translocation for 5 years
                - Final result required 10 years of translocation and 900 foxes
                - Comparable to effort required to re-establish swift fox in Canada – however, resulting swift fox distribution much larger under these scenarios
                - Long term viability (100 years), large effective population size and expansion which links extant populations observed
    - General recommendations for future swift fox translocations
        - No less than 5 years
        - No less than 60 foxes per release area
        - Use release areas with capacity to hold 30+ swift fox home ranges
        - No releases in isolated locations or highly fragmented habitat
    - Important implications for natural recolonization also demonstrated

    - Expansion beyond release sites, even those that eventually had robust, self-sustaining swift fox populations, was limited by:
        - Distance to available habitat
        - Patchiness of available habitat
        - Availability of large patches of available habitat (e.g., hold at least 30 swift fox home ranges)
        - Size of closest reintroduced population
    - Recolonization followed by extirpation after as many as 20 years was observed in isolated patches
    - Expansion into fragmented habitats resulting in stable populations did not generally occur until large populations existed surrounding fragmented habitat and, generally, when habitat saturation was complete or near complete in large habitat patches.
    - May explain why swift fox have been slow to recolonize the Northern Great Plains
        - Potential source populations are distant and in most cases, small
        - In some areas, suitable habitat is fragmented or separated by potential barriers
        - Pulse of new detections in SE Montana may not indicate long-term swift fox presence if driven by dispersal from WY population, which may crash after outbreak of plague

        - Habitat patches big enough to hold 10 swift fox home ranges

<u>Update on swift fox surveys in TX – Doni Schwalm</u>

- First year of a 2 year survey, conducted between August and December each year starting in 2017.
- Using cameras to survey ~8 counties in the Texas panhandle, 2 with swift fox detections within the last 10 years, the others with either 1) habitat that appears suitable or 2) proximity to swift fox distribution in neighboring states
- Setting cameras in grids of 5 within roughly 1 swift fox home range; 1 focal camera in the center and 4 satellite cameras spaced ~1.5 km from the focal camera and each other
- Cameras are baited with Canine Call and Powder River trapping lures, plus a nailed-down can of cat food with holes in the lid.
- Cameras are deployed for 10 days. All species observed are recorded.
- Scats are also being collected at camera sites for non-invasive DNA analysis using 15 microsatellite markers and a species ID test. In the first year, collected 123 scats, which was more than was anticipated. Potentially enough sampling frequency to use mark-recapture techniques to estimate density instead of simply occupancy. Scats were not observed at cameras until October; however, this coincided with moving into the primary distribution of the species so may not be seasonally related.
- Live trapped 13 swift fox for an undergraduate independent study. Goal was to give individuals unique markings using black hair dye, but subsequently discovered that the infrared cameras to not capture the marks at night. Additional goal was to collect samples for DNA analyses.
- Preliminary results indicate that swift fox are missing from areas where they were consistently found between 2005-2007 (Schwalm et al. 2012). Unseasonably high precipitation and

subsequent increase in vegetation height and density in 2017 may be to blame. Plague epizootic also occurred within the previous 2 years.

<u>Recommendations for scat collection for DNA analysis – Doni Schwalm</u>

- Collecting scats for DNA analysis provides opportunities for identifying individuals, assessing parentage, monitoring genetic diversity and gene flow, and conducting mark-recapture studies for swift fox without capturing the animals.
- However, not all scats are created equal! Exposure to the elements, in particular UV, precipitation, and freeze-thaw cycles can reduce DNA quality.
- Currently working with several projects to analyze 257 scats collected in CO, MT, NE, SD, TX and WY.
- Analysis is ongoing. Thus far, 56 scats have been analyzed in the lab.
    - 82% of high enough quality for species ID
    - 69% of high enough quality for genotyping with microsatellites
- Effect of scat age on amplification success (all scats stored at room temperature in the dark after being dried; majority stored with silica beads after initial drying for ~3 – 7 days).
    - <6 months: 21% (5 of 24) failure
    - 6 months to 1.5 years: 19% (5 of 27)failure
    - 1.5-2.5 years: 20% (1 of 5)failure
    - Preliminary conclusion: you can store scats for a long time after collection as long as storage protocols favor DNA persistence. Preservation buffers (e.g., lysis, DMSO) may increase amplification success further.
- Effect of season on amplification success
    - Collected Aug-Dec (majority Oct-Nov): 16% (4 of 43) failure
    - Collected Feb-July: 69% (9 of 13) failure
    - Preliminary conclusion: recommend collecting scats between Aug-December. Higher DNA degradation in later winter – summer likely driven by precipitation and freeze-thaw cycles, although no formal analysis has been completed.
    - When planning to collect scats in spring-summer, design study to limit the exposure of scats to the environment to a small window (<3 days?). In instances where there are high levels of precipitation in fall/early winter sampling period may need to be similarly shortened.
- Majority of scats were collected during camera surveys, and were known to be between 7 and 10 days old. Some scats were collected opportunistically at den sites, along roads, etc and were of unknown age.
    - Of these, 86% (6 of 7) failed.
    - Recommendation: opportunistic collection of scats may not yield quality DNA; only those that appear very fresh are likely worth the effort.
    - Clearing dens or social areas (e.g., where multiple scats have accumulated near fence intersections, etc.) of scat and returning in a week to collect new scats may be a viable way to collect quality scats for DNA analysis in these situations.

Facebook Page – update from Tracy. Still working on the site. Can email swiftfoxssp@gmail.com to have things added to the page.

Scat Collection

-Doni will pull together a summary and provide recommendations to the group.

-Focus efforts in the fall for sample collection

Standardized surveys for range-wide monitoring proposal for WAFWA – that did not happen since the last meeting.

-If considering for the future need to keep in mind: #days and #cameras

-BLM (WY) would like to see us develop a standardized protocol to help with assessing impacts of energy development and know what is necessary to determine swift fox are there or not. Also wants to know what to do when an active den is on a project site – how to determine active and what can be done for mitigation efforts.

-Doni recommended considering creation of artificial den structures if the den on site will be destroyed.

-Do we want to develop a standardized protocol now? Is it possible across multiple states?

-Different approaches will be necessary for high density and low density populations

-Not feasible for some states (i.e. MT) where trying to determine distribution initially, unlike CO where population is wide-spread and higher density.

-Wyoming has recently updated their standard techniques for sampling swift fox – will share with the group. Doni will help edit and other folks will comment on the protocol. Need to try to fit protocol into existing multi-species approaches if possible.

TWS Symposium – decided to remove that from the list for now.

Addressing effects of oil well pad density and road density on occupation of swift fox

-Should we try to determine a threshold? Did not come to an agreement as a group.

-Doni believes we could address these questions (look at broad scale and all forms of energy development effects (wind, oil, etc.)) with a multi-state cSWG.

-Requires a state lead. But discussing potential to have WAFWA be the lead. Isaac will contact Bill about being the lead on that type of project. Some states (Dakotas and NE, KS) are part of WAFWA and MWAFWA, but could partake in WAFWA project.

-Also interested in looking at disease aspect (relatively inexpensive) – look at whether it's a limiting factor for populations (research has shown canine diseases increase with development). Possible ways to look at this aspect:

-Could pull samples from the soil – look at the number of pups produced and survived from the den.

-Put cameras on the dens to monitor health of pups (KS saw a pup die within 2 days from Parvo).

-Potentially use eDNA to monitor for disease prevalence (Doni will look into this)

-Nubuto strips – see if we could get help from local trappers and biologists to collect samples from harvested fox.

**Need to identify a state vet willing to work with us on this project and help us determine how to answer our questions – might be able to work with multiple state vets/disease ecologists (WY, SD, MT, CO all have one or both). MT will take the lead to see if their vet can assist.

Swift Fox Conservation Assessment

-Last meeting every state went through the strategies and updated what each of their states did. Possibly do this again as a starting point for what has happened and what needs to happen.

-Each state will compile work and findings in relation to the assessment before next meeting in 2020.

Agency Updates (additions from what was not covered on 4/18/18)

Kansas

-harvested about 35 swift fox (mostly unintentional harvest) this last year, 3 years ago tagged 278 (most of this was from 1 county)

-had a lot of success with incidental observations from biologists and public

-Ty's project: 360 camera sites throughout southwestern part of state (took 6 months to get permission). Each site will have 28 days with cameras to maximize detection probability (will refresh bait every 14 days). Looking at occupancy modeling and intraspecific competition with coyotes. Will collect scat. Will begin trapping next year.

Missouri

-American Zoo – population is currently 53 animals

-has a new stud bookkeeper (Ashley Bowen – long history working with swift foxes)

-new project to get zookeepers to help assist with field work (trapping, setting up cameras, etc.). If you're interested in getting some help, contact Tracy who will be keeping a list of interested zookeepers. Would be a great resource for citizen science.

New Chair and Co-chair:

Heather Harris (MT) and Nichole Bjornlie (WY)

New state rep for Colorado will go to Mark Vieira

Committee Assignments – will remain the same:

Educational Committee – Eileen Dowd-Stukel (SD)

Monitoring Committee – Kristy Bly (WWF)

Meeting location in 2020:

Kansas

Action Items from 2018 meeting:

- States will compile work and findings in relation to the SF Conservation Assessment.
- Define suitable habitat (still working on getting reliable sagebrush layers from different states)
- Doni will talk to Dave Nagle about building sagebrush layer.
- Spring of 2019 – Bob Inman with Montana will put together biennial report for (2017-18)
- Explore multi-state research on energy development and/or disease with Bill Van Pelt (WAFWA grassland coordinator).