Guide to Managing for Optimal Habitat Attributes:

Swift Fox (*Vulpes velox*)

June 2020

ACKNOWLEDGEMENTS

This guide was developed by Sue Michalsky, Carolyn Gaudet and Heather Peat Hamm with technical and editorial input from Dr. Axel Moehrenschlager, Dr. David Gummer, Dr. Shelley Pruss, Pat Fargey and Joel Nicholson.

The project was financially supported by the Department of the Environment of the Government of Canada (Environment and Climate Change Canada), through the Habitat Stewardship Program (HSP) funding granted to the Saskatchewan Prairie Conservation Action Plan (PCAP). Ce projet a été réalisé avec l'appui financier du gouvernement du Canada agissant par l'entremise du ministère fédéral de l'Environnement (Environnement et Changement climatique Canada).

Thank you to all the PCAP Partners and other organizations who provided support for this project: Montana Fish, Wildlife & Parks, Parks Canada – Grasslands National Park, Paskwa Consultants Inc., Ranchers Stewardship Alliance Inc., and Saskatchewan Conservation Data Centre and the Saskatchewan Ministry of Environment.

Many sources of information were used in compiling this document including expert opinions and both published and unpublished literature. References used in compiling this review are provided.

May, 2020

This project was undertaken with the financial support of the Government of Canada.
Ce projet a été réalisé avec l'appui financier du gouvernement du Canada

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ABOUT THIS GUIDE

A NEW APPROACH TO MANAGING FOR SPECIES AT RISK

The intent of this guide is to determine site and landscape-scale habitat features that are optimal for species at risk at different life stages, as well as important non-habitat related beneficial management practices. As habitat for species at risk declines and threats to populations increase in jurisdictions outside Canada, it becomes critical to provide optimal conditions on what habitat remains in Canada if we are to conserve or recover a species.

This First Approximation of the guide for Swift Fox should be considered a living or dynamic document that will continually evolve. As our knowledge of prairie species at risk improves with research and monitoring, this guide will need to be periodically revisited and updated.

WHO SHOULD USE THIS GUIDE?

Most grassland species at risk in Saskatchewan exist on working agricultural lands that often support grazing livestock and sometimes support annual or perennial crops. This guide provides habitat targets and non-habitat related beneficial management practices (BMPs) for land managers who may have the opportunity to aid in the conservation of species at risk on the land under their control. Additionally, the habitat targets and BMPs may be used by conservation organizations in designing results-based agreements with land managers.

The Environmental Benefit Index is designed to be used by any stakeholder to prioritize sites and/or projects for conservation and recovery programs, or by land managers to evaluate the value of their property for a particular species.

HOW TO USE THIS GUIDE

This guide is presented in two parts. The first part summarizes the important spatial and temporal needs of the species and presents habitat targets and non-habitat related BMPs. Habitat targets are presented at two major spatial scales: landscape and site. Landscape scale habitat targets are those attributes that an individual opts for when choosing a breeding location or home range. These targets are often land cover or topography-related, but may also include such factors as whether or not there are other individuals of the same species already in the area. Site scale targets are those attributes that the individual prefers at a certain time (e.g., breeding, brood rearing, hunting or foraging) or in a certain portion of their home range. Site habitat targets are most commonly physical vegetation, water, soil and/or topography parameters, but may also include such attributes as configuration of land cover, block size, presence/absence of human infrastructure, among others. The rationale for each target or BMP is also provided so land managers can readily understand the relationship between the target and use of habitat by the species.

Guides have been prepared for individual species. Habitat targets for individual species give the land manager the choice of species they wish to benefit. Managing for a single species may result in habitat that is undesirable for another species. Conflicts between species are addressed in the Environmental Benefit Index.

The second part of the guide presents an index (Environmental Benefit Index) that places values on the habitat targets and BMPs in combination with other considerations. An Environmental Benefit Index (EBI) is a compound index that considers multiple environmental factors when determining an ecological outcome. EBIs can be used to evaluate and prioritize opportunities for conservation programs. An EBI is of considerable importance in determining priority sites to invest in, particularly when funds are limited.

The overall goal of the EBIs for species at risk habitat is to ensure maximum environmental value for an investment in results-based conservation programming. The EBI has several potential uses including:

- To geographically target the most important locations,
- To evaluate and rank candidate properties or projects for their environmental benefit,
- To rank the environmental benefit of candidate properties or projects by cost (or bid), and
- To evaluate projects over time to determine if environmental values are being improved or maintained, or to evaluate the efficiency of the investment over time.

EBIs were identified as a method to target programming and prioritize participation in the design of the Prairie Beef & Biodiversity program (Commission for Environmental Cooperation, 2013). EBIs were subsequently developed for the Greater Sage-Grouse (Ranchers Stewardship Alliance Inc., 2014), Piping Plover (PCAP SK, 2017), Burrowing Owl (PCAP SK, unpublished), Northern Leopard Frog (PCAP SK, 2018a), Loggerhead Shrike (PCAP SK, 2018b), Baird's Sparrow (PCAP SK, 2019a) and Chestnut-collared Longspur (PCAP SK, 2019b).

SWIFT FOX MODULE

SWIFT FOX IDENTIFICATION

Swift Fox are small, about the size of a jack rabbit or a large house cat. Their small size and black-tipped tail distinguishes them from the red fox. They are named for their speed, as they can run up to 60 km/hr.

COSEWIC status: Threatened
S-Rank for Saskatchewan: S3 (Vulnerable/Rare to Uncommon)

Size – Length 32” (80 cm), including tail (about 11” (28 cm)), Height at shoulder: 12” (30cm); Weight – female average 4.8 lbs (2.2 kg); male average 5.5 lbs (2.5 kg)

Features – Small, slender, tawny-coloured fox; large ears; black tip on bushy tail, fast (up to 60 km/hr)

Similar species – Red fox. Swift Fox is smaller, more slender, and normally has lighter coloured fur. Red Fox has white tip on tail.

WHERE DO SWIFT FOX LIVE?

Swift Foxes are a small canid endemic to North America, ranging from southern Canada to Texas and New Mexico and from the western side of the Dakotas to the Rocky Mountains. They are found in a variety of landscapes, including shrub steppe, agricultural, rangeland and native short and mixed-grass prairie. The current distribution in North America represents about 40% of their historic range.

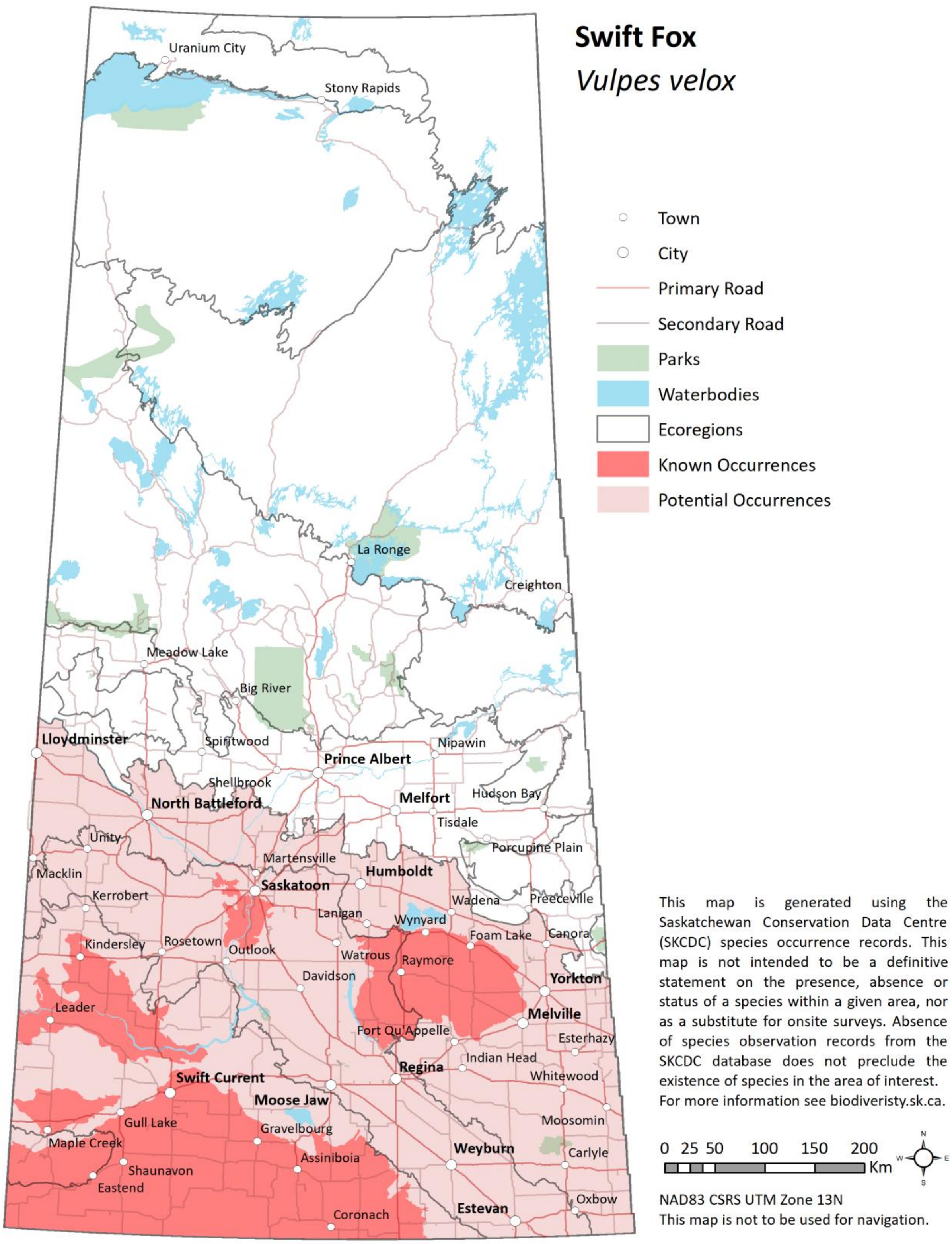

Figure 1: Range map of known occurrences of Swift Fox (Saskatchewan Conservation Data Centre, 2019).

The species was extirpated in Canada in the 1930s. As part of a reintroduction program, over 900 individuals were released in Alberta and Saskatchewan between 1983 and 1997. Their COSEWIC status was examined a few times since they were designated extirpated and were down-listed to Threatened in 2009.

The average Swift Fox home range size in the region is 32.9 km^2 (Moehrenschlager et al. 2007), which is substantially larger than home ranges across the southern portion of their range (Olson and Lindzey 2002; Thompson and Gese 2012). Moehrenschlager et al. (2007) hypothesized that exceptionally large home ranges observed in Canada are due to low burrow density and rodent abundance, which along with insects and birds, are the most frequently consumed food item for Swift Foxes in this region. In Colorado, home range size was related to vegetative structural elements that enhance rodent prey availability (Thompson and Gese 2012).

Despite having sufficient time since reintroduction to disperse into new suitable habitat, genetic research by Cullingham and Moehrenschlager (2019) has demonstrated that they have not done so. Their work also showed that there was limited evidence that cropland was a barrier to dispersal, but that steep slopes and rugged terrain may reduce dispersal capacity.

BEHAVIOUR AND HABITAT USE IN CANADA

Great Plains habitats of the Swift Fox have been generally described as open and flat to gently rolling prairies with sparse vegetation dominated by grasses, particularly wheatgrasses (*Agropyron* and *Pascopyrum* spp.), blue grama (*Bouteloua gracilis*), spear grass (*Stipa comata*), fescue (*Festuca*, spp.), and pasture sage (*Artemisia frigida*) (Kilgore 1969, Hillman and Sharps 1978, Uresk et al 2003).

Swift Fox are known to avoid topographic features such as canyons, steep hills, dense shrub, forests, and coulees (Whitaker-Hoagland 1997). Swift Foxes do not appear to require open water sources near their dens (Golightly and Ohmart 1984, Pruss 1999). They occur less frequently in areas with high shrub density and tall grass, but they appear to tolerate small patches of short shrubs, such as silver sagebrush. During the growing season, crop fields grow taller than the average height of a Swift Fox (30 cm, Kamler et al. 2003) and can inhibit Swift Fox predator detection, but Swift Foxes were present in fallow or harvested fields, which enhanced visual predator detection. Figure 2 illustrates the key habitat features for Swift Fox in Canada.

Swift Foxes use burrows or dens throughout the year, making them the most den-dependent of the canids. Swift Foxes often modify burrows such as badger (*Taxidea taxus*) and ground squirrel (*Spermophilus* spp.) holes, using them as natal and rearing den sites and to escape predators throughout the year (Herrero et al. 1986, Pruss 1999). Swift Foxes are capable of digging their own dens (Kilgore 1969), but how commonly this occurs in Canada is unknown. Swift Fox use multiple dens throughout their home range and throughout the year. Swift Foxes preferentially choose natal den sites on the tops of hills with a gradual slope, which may help reduce the mortality risk from predators. Availability of suitable escape and natal den sites is thought to be one of the most important factors influencing the maintenance and expansion of viable Swift Fox populations (Egoscue 1979, Russell 1983, Pruss 1999, Harrison and Whittaker-Hoagland 2003).

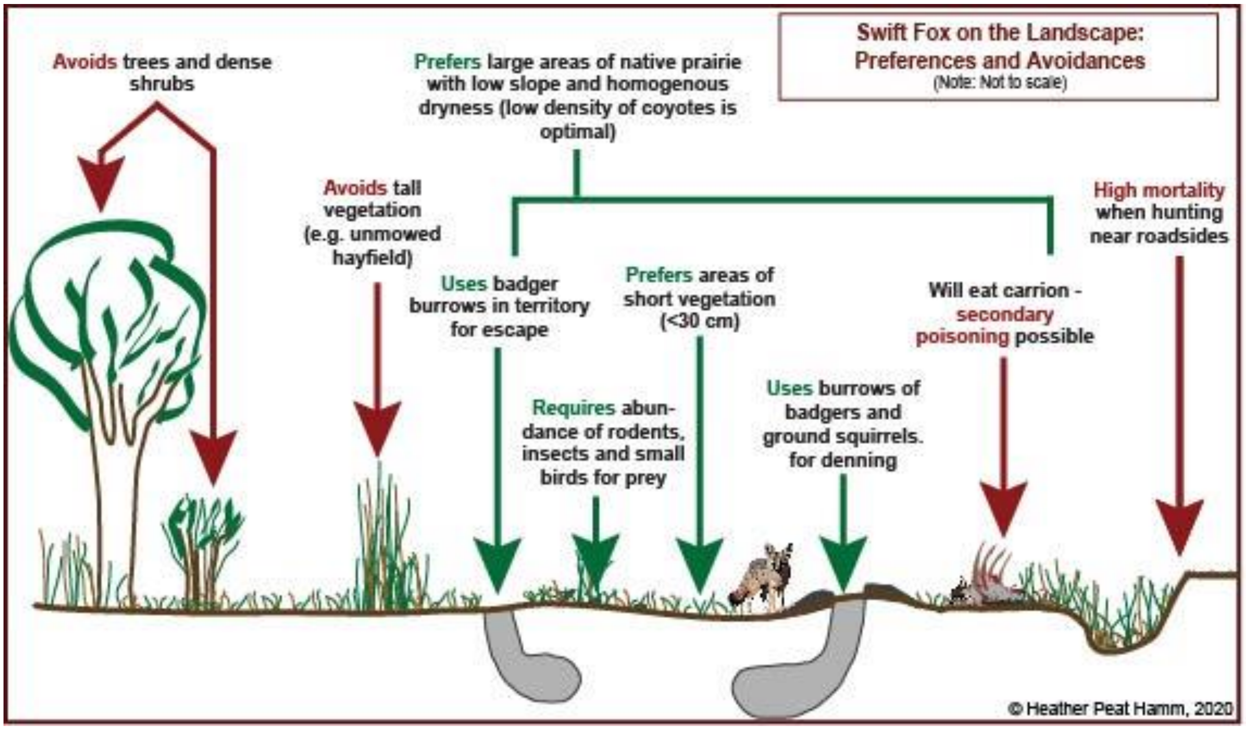

Figure 2: Habitat diagram for Swift Fox.

Characteristics of den sites are different from those of foraging sites with vegetation surrounding the den being denser, which may relate to use of screening cover for burrow entrances or places where foxes could loiter outside the den with greater security. Visual obstruction of den sites (11.7 +/- 1.4) is greater than on randomly selected sites (9.5+/-0.6), and visual obstruction of foraging sites (11.9 =/-0.7) is likewise greater than random sites (9.5 =/-0.6) (Uresk et al. 2003). The visual obstruction readings represent the height-density that completely obstructs view. Both denning and foraging sites had significantly greater horizontal visual obstruction than that of random sites (Uresk et al. 2003).

Swift Fox do prefer areas that have low potential for human interaction. Swift Fox can coexist with humans within a native landscape where the primary land use is extensive livestock production. Ranching is compatible with Swift Fox because of native prairie retention, permanent perennial grass cover, and grazing that will keep vegetation below ~ 30 cm in height. In rangeland, the lack of human disturbance and the control of the coyote population through shooting may make Swift Fox occurrence more likely. However, the relationship between Swift Foxes and coyotes is complex; coyotes may be responsible for keeping red foxes from displacing Swift Foxes through competitive exclusion. There is currently no information on the density of coyotes that would preclude red fox presence without negatively affecting Swift Fox abundance (Pruss *et al*., 2007).

According to a habitat model, developed for the South of the Divide Action Plan, Swift Fox avoid habitats that have a high proportion of cropland, high average wetness, high standard deviation in wetness, and high average terrain slope, which supports the conclusion that Swift Fox have an affinity for intact dry-prairie landscapes that are relatively homogeneous and gradually sloping (Environment and Climate Change Canada, 2016).

Swift Foxes opportunistically forage for a variety of foods, eating mammals, birds, bird eggs, insects, plants, and carrion (Kilgore 1969, Pruss 1994, Uresk and Sharps 1986, Solvada et al 2001). On a seasonal basis, ground squirrels (*Spermophilus* spp.) and grasshoppers (*Melanoplus* spp.) are important food resources in the summer while in winter, mice and voles, and potentially lagomorphs, are an important resource. Swift Fox are known to cache food (Sovada et al 2001), which may help with food scarcity in the winter months. The Swift Fox diet fulfills their water requirements and they do not require a water source nearby (Pruss 1999).

THREATS TO SWIFT FOX IN CANADA

HABITAT LOSS AND DEGRADATION

Habitat loss, degradation, and fragmentation, due to unsuitable agricultural practices or industrial development, may be primary threats to Swift Fox populations (Pruss *et al*., 2007). As Swift Fox are primarily prairie specialists, grassland conversion to cropland has been one of the most important factors for the loss of Swift Fox habitat (Kamler *et al*., 2003). Recent estimates suggest that 86% or more of the native prairie landscape has been converted for agricultural use. In the past 25 years, southern Saskatchewan has lost 3.3 million acres of native grassland. Fragmentation also continues to occur with roads, trails, towns and industry.

PREDATION AND COMPETITIVE INTERFERENCE / EXCLUSION BY COYOTES AND RED FOXES

Swift Fox movement into suitable habitat may be limited by coyotes and red fox, as they compete with and are predated by coyotes. Predation of Swift Fox by coyotes has consistently been identified as the primary cause of Swift Fox mortality (Carbyn et al. 1994, Sovada et al. 1998, Moehrenschlager et al. 2007). Coyotes will kill Swift Fox without eating them to reduce competition for common prey species (Sovada et al. 1998, Moehrenschlager et al. 2007). Avian predators, such as Golden Eagle and Great Horned Owls, also contribute to Swift Fox mortality (COSEWIC 2000, Moehrenschlager et al. 2007).

DIRECT AND INDIRECT HUMAN INDUCED MORTALITY

Vehicle collisions: In some places, Swift Foxes have been found to use dens within 1 or 2 km of roads, or closer to roads than expected by random chance. In certain landscapes, the dense roadside vegetation may have better prey availability but in Canada, Swift Fox may avoid roads when tall vegetation, such as invasive tame forages, grows taller than 30 cm. Collisions with vehicles can be major source of mortality for juvenile foxes, especially as they disperse to their own home range. New roads may be created in otherwise large tracts of native prairie because of oil and gas development, which could potentially contribute to an increased risk of collisions.

Poisoning and trapping: Swift Fox have been reported becoming increasingly rare after Canada was settled because they were easily trapped, poisoned, and caught by dogs (Bailey, 1926). Poison campaigns for wolves, prairie dogs, and coyotes are thought to have contributed to the decline in Swift Fox numbers.

Poison bait, including strychnine and Rozol, can be used for controlling ground squirrels, and Swift Fox may inadvertently consume the poison bait, either directly or by secondary poisoning. Compound 1080 is prohibited from use in Saskatchewan within primary Swift Fox range (Townships 1 through 7 and Ranges 1 through 30 West 3rd) and is used only by the Saskatchewan Ministry of Environment in a buffer zone around primary range (SK Ministry of Environment 2012).

Disease: Exposure of the small population of Swift Fox to canid diseases could make them vulnerable. Young kits may die from contracting diseases such as distemper and parvo-virus. While adults tend to survive such infections, reproductive capacity could be impacted.

Climate change: Changes in the climate could result in current habitat becoming unsuitable for Swift Fox. An assessment of potential impacts of climate change on species in Alberta rated Swift Fox as medial in terms of vulnerability. Changes in temperature and precipitation may change predator density and food/prey availability (Shank and Nixon 2014). This report predicts that a range shift is likely for Swift Fox under currently predicted climate change scenarios.

HABITAT REQUIREMENTS OF SWIFT FOX IN CANADA

Swift Fox are solitary hunters and their activity varies by season. They are nocturnal in the winter and become more diel in the summer. Swift Fox are monogamous and likely pair for life, unless a mate dies. They are mostly likely to live in pairs but will occasionally live in groups of 1 to 2 males and 2 to 3 females where there is 1 breeding female and non-breeding helpers. Breeding begins in March and pups are primarily born in May. In September, pups will disperse from the den and family. The critical dates related to the various life stages of the Swift Fox are listed in Table 1.

Table 1: Important dates for Swift Fox in Canada

Life stage	Important Dates
Pup-rearing	May-August
Dispersal	September to November
Pair formation	December to March

LANDSCAPE SCALE FEATURES

On a landscape scale, suitable Swift Fox habitat is primarily a function of land cover, topography and wetness (Table 2). Large blocks of unfragmented native grassland constitute the most suitable land cover for Swift Fox. Although they tolerate some cropland within their home ranges, it is considered poor habitat and they tend either to avoid it or move through it quickly.

Topographically, Swift Fox habitat should be homogeneously flat, with very low slope and very little variation in terrain ruggedness. Wetness is an index of vegetation density and soil moisture content. Swift Fox tend to avoid areas of high wetness or any substantial variation in wetness, preferring homogenously dry habitat. The biophysical attributes of Swift Fox habitat on a landscape scale are as follows:

- Large tracts of intact (i.e. native) prairie
- Preference for limited cropland (<30%)
- Level or gently sloping terrain (<4^{o} or 7%)
- Low variation in terrain roughness (few topographic features such as river valleys, steep hills, or coulees)
- Low wetness (i.e., dry, well- drained sites)
- Low variation in wetness (i.e., homogenously dry sites)

Figure 3 shows predicted highly suitable habitat on the landscape scale for Swift Fox in Saskatchewan and Alberta, as well as the current distribution of reintroduced foxes. This map represents the available structural habitat on a landscape scale, using landscape habitat features derived from satellite imagery, where Swift Foxes might be able to expand their range.

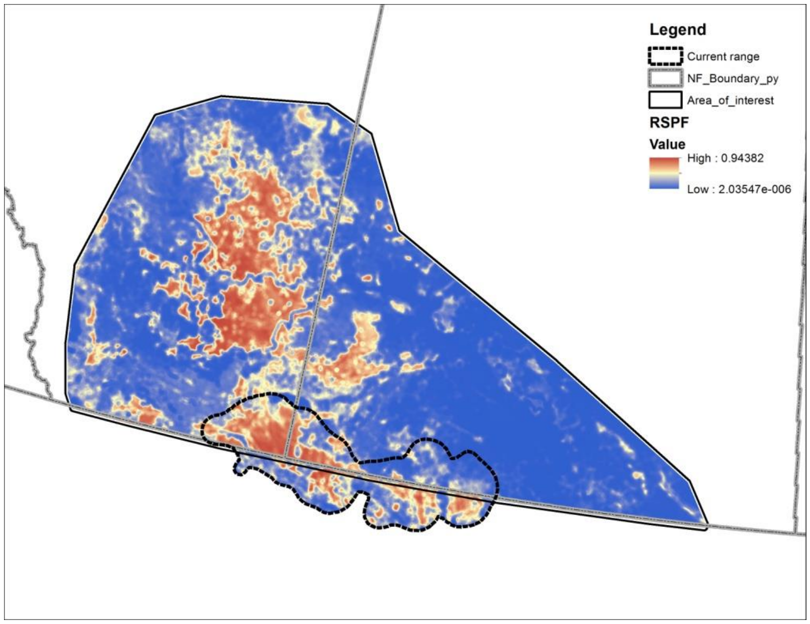

Figure 3. Predicted potential Swift Fox habitat using suitable landscape habitat features (source: Parks Canada 2019)

SITE SCALE FEATURES

Suitable site scale habitat must support prey species, escape burrows, and low abundances of predator and competitor species (Table 2). Suitable winter habitat is likely the most critical requirement for Swift Fox (Butler et al. 2019). Swift fox are dependent on a sufficient prey base and adequate numbers of burrows to provide natal dens and allow foxes to escape predators and competitors. Burrow density is thought to be the most critical site habitat feature with higher densities of burrows allowing foxes to more readily escape coyotes (responsible for a large percentage of Swift Fox mortality) and other predators/competitors and thermal extremes.

Vegetation height and density (measured as visual obstruction reading) is also important. Ideally, vegetation needs to be high and dense enough to hide a moving Swift Fox from ground predators, but not so high and dense that they are unable to see escape burrows, approaching predators, or to detect larger prey.

Proximity to roads and to water are also site scale features that impact the quality of habitat. Highways and busier grid roads pose a relatively high risk of mortality for Swift Fox. Less busy grid roads and dirt roads pose a much lower risk and may even be beneficial by either supporting more prey or allowing Swift Foxes to more easily detect prey. Swift Foxes avoid waterbodies, even small waterbodies such as dugouts. The riparian vegetation is denser and lusher than Swift Foxes tolerate, and it is possible that Swift Foxes avoid waterbodies because these sites attract coyotes.

The biophysical attributes of Swift Fox habitat on a site scale are as follows:

- High density of burrows created by fossorial mammals: optimal suitable burrow density: >2/ha; suboptimal suitable burrow density: 0.6 - 2/ha

- Short (< 30 cm high), sparse, and relatively homogeneous vegetation
- Low cover of woody vegetation: cover of trees and shrubs > 1m high less than or equal to 2%; cover of shrubs < 1m high less than 30%
- Visual obstruction reading: optimal 11 – 12 cm
- Distance to roads: No roads, or only two-track trails and roads smaller than grid roads within 2 km of area of consideration.
- Distance to water: optimal: No water bodies within a 1 km radius of area of consideration; suboptimal: No water bodies within a 500 m radius of area of consideration.

Table 2: Optimal habitat targets for Swift Fox for landscape and site scale habitat features.

HABITAT FEATURE	HABITAT TARGET
Landscape Scale	
Land Cover	Semi-arid mixedgrass
	Natural, homogenous grassland
	Limited cropland (Optimal <15%; suboptimal 15-30%)
Area required for home range	31.9 ± 4.8 km^2
Topography	Open, flat to gently rolling: Optimal <2^o (3.5%); Suboptimal 2 – 4^o (3.6 – 7%)
Wetness	Dry sites with low variability in moisture
	Wetness: Optimal -.31 to -.38; Suboptimal -.25 to -.31
	Standard deviation of wetness: Optimal <.04; Suboptimal 0.041 – 0.6
Site Scale	
Ecosites	*Saskatchewan:* Badlands, Clay, Dry Meadow, Gravelly, Loam, Overflow, Saline Dry Meadow, Sand, Solometzic, and Thin *Alberta*: Badlands/Bedrock, Blowouts/Solonetzic, Choppy Sandhills, Clayey, Gravel, Limy, Loamy, Overflow, Saline Lowland, Sandy, Shallow to Gravel, Subirrigated and Thin Breaks
Patch Size	Suitable grassland habitat within 20 km of occupied habitat
Woody vegetation	Low cover (<2%) of trees or shrubs > 1 m high. Cover of shrubs < 1m high <30%
Burrow Density	Optimal suitable burrow density: >2/ha Suboptimal suitable burrow density: 0.6 - 2/ha
Vegetation height	<30 cm
Visual Obstruction Reading	Optimal: 11 - 12 cm; Suboptimal: 9 – 11 cm
Distance to Roads	No roads, or only two-track trails and roads smaller than provincially numbered grid roads within 2 km of area of consideration.
Distance to Water	Optimal: No water bodies within a 1 km radius of area of consideration. Suboptimal: No water bodies within a 500 m radius of area of consideration.

OTHER OPTIMAL MANAGEMENT PRACTICES FOR SWIFT FOX

There are numerous management issues unrelated to the characteristic of the landscape or site that should be taken into consideration when managing for Swift Fox. These beneficial management practices are:

- Restrict traffic speeds to ≤80 kmph on roads through native rangeland from dusk until dawn.
- Avoid constructing built-up, gravel roads through native rangeland and if a new road needs to be built, revegetate roadsides with native vegetation or fine, mid-height tame forages.
- Avoid applying ground squirrel toxicants to native rangelands.
- Shoot coyotes in areas of high topography or heavy shrub cover, avoiding areas of open grassland with low slope. Avoid trapping and snaring.
- Do not reduce American Badger populations.
- Vaccinate domestic dogs against canine distemper and parvovirus to avoid the spreading of the diseases.
- Avoid the use of insecticides on native rangelands.
- Avoid planting woody vegetation on native rangelands.
- Remove old buildings, shelterbelts and other perching structures which support aerial predators of Swift Fox.

ENVIRONMENTAL BENEFIT INDEX FOR SWIFT FOX HABITAT

CRITERIA AND SCORING

The Environmental Benefit Index (EBI) was developed by compiling comprehensive categories of criteria based on available knowledge, such as Swift Fox population and habitat research, expert opinion and species recovery documents.

The EBI begins with three screening criteria. These criteria are either met, in which case the user continues to the next criterion, or not met, in which case the property or potential project is eliminated from further consideration. The remaining criteria are grouped into landscape and site scale habitat features.

A scoring system was devised for the EBI. Each criterion is weighted out of 300, 200, or 100, based on relative importance to the species.

The total scores are calculated based on the following formula:

EBI= ((1)(2)(3)((4.1+4.2+4.3)+(5.1+5.2+5.3+5.4+5.5+5.6)+6))

where the numbers refer to the following sections.

The EBI result may then be divided by the costs of the proposed project or the bid for the project to determine cost-effectiveness. The cost to achieve the habitat requirements could include added management, added infrastructure or inputs, or lost opportunities.

The range of possible scores for candidates that pass the screening criteria is quite wide. The lowest possible total score is 100 and the highest possible score is 1400. When evaluating candidate properties for a project or program, it may be possible to divide the scores into more general High, Moderate and Low priorities. There are many uses for a general ranking. For example, a more general ranking could be used to determine the total cost of implementing results-based programming on all high priority sites.

SCREENING CRITERIA

To date, Swift Foxes have not expanded to occupy suitable landscapes distant from reintroduction sites. Individuals commonly disperse up to 20 km from the home range where they were born, but some (especially males) have been known to disperse up to 100 km (Cullingham and Moehrenschlager 2019). Mortality rates are very high (>50%; Moehrenschlager et al. 2007, Olson and Lindzey 2002), so the capacity of a site is usually able to support juvenile foxes into adulthood. There are also structural features that limit dispersal of Swift Fox including rough terrain, steep slopes and river valleys.

1. The landscape is topographically flat or gently rolling with slopes under 9 % (5 degrees). **Yes=1, No=0.**

2. The landscape is comprised of at least 70% native grassland within at least 3 km of the area of consideration. **Yes=1, No=0.**

3. Swift Fox occupy habitat within 20 km of the area of consideration. **Yes=1, No=0.**

4. Some of the landscape-scale features listed below are thought to be inter-dependent and should not be evaluated separately. These attributes likely include slope, Terrain Ruggedness Index, wetness and greenness. Various risks and threats associated with Swift Fox recovery may be outside the decision-making capability of a single land manager, but because of location and proximity to certain landscape features, environmental benefits can be impacted.

    4.1. Land cover is the most critical landscape feature predicting potential habitat for Swift Fox. Generally, the more native prairie a landscape supports, the more attractive it will be to Swift Fox. It is likely attractive because it supports more burrows that can function as dens and escape refugia, and possibly also supports more prey species than other cover types. Swift Foxes will travel through cropland but tend not to use it. Less is known about the suitability of tame grassland for Swift Foxes. The relationship to cropland is relevant up to a 3 km radius around known Swift Fox occurrences. **(Max 100 points)**

Land Cover

100	0 - 15% cropland within 3 km of area of consideration
50	16 - 30% cropland within 3 km of area of consideration

    4.2. Swift Fox prefer flat to gently rolling grassland. The slope values below are derived from digital elevation models in habitat known to be used by Swift Fox (Parks Canada unpublished data adapted from Moehrenschlager et al. 2007). It should be noted that substantial topographic variation can occur locally between the intervals derived by the digital elevation model used for the analysis of slope.
    (Max 100 points)

Topography - Slope

100	Slopes mainly less than 2 degrees (3.5%)
50	Slopes mainly 2 – 4 degrees (3.6 – 7%)

    4.3. Wetness, measured from infrared light reflectance on satellite imagery, provides an index that estimates soil moisture content and vegetation density. Areas with substantial woody vegetation cover would have a high wetness index and be less suitable for Swift Foxes. Parks Canada (unpublished data adapted from Moehrenschlager et al. 2007) found that Swift Foxes preferred somewhat drier soils and lower vegetation density than what was generally available within their current range.

Standard deviation of wetness represents the variability of wetness within an area. Swift Foxes tend to prefer areas that consistently have lower wetness values (i.e., homogenous dryness).
(Max 100 points)

Habitat Quality – Wetness

100	Optimal -.31 to -.38 wetness index; < 0.04 standard deviation of wetness
50	suboptimal -.25 to -.31 wetness index; 0.041 – 0.6 standard deviation of wetness

SITE LEVEL CRITERIA

5. Site scale targets for Swift Foxes are those attributes that the individual prefers when selecting their home range or territory. They also include habitat attributes that maximize productivity of the species. Swift Foxes have a broad ecological niche. They eat a wide variety of prey species and carrion. Habitat features at the site scale are primarily features that make habitat more functional by enabling them to catch prey, and escape or avoid predators and competitors.

5.1. Swift Foxes in Canada require large areas to support a sufficient prey base (Moehrenschlager et al. 2007). Home ranges in Canada average 32.9 km^2. Juvenile foxes will commonly disperse up to 20 km from their natal home range in fall. Therefore, the best opportunity for successful colonization of new suitable habitat depends on suitable habitat being available within 20 km of occupied habitat.
(Max points 200)

Patch Size

200	Candidate area supports suitable grassland habitat contiguous to occupied habitat.
50	Candidate area supports suitable grassland habitat not contiguous, but up to 20 km away from occupied habitat.

5.2. Swift Fox are relatively intolerant of woody vegetation taller than 1 m in height. However, this may be more related to habitat preferred by badgers and ground squirrels that provide the burrows on which Swift Foxes depend. Swift Foxes do tolerate some silver sage and greasewood under 1 m in height. Adams et al. (2013) provide a range of woody vegetation found in plant communities in the Dry Mixedgrass Natural Subregion in Alberta. Cover of low shrubs in upland communities was as high as 30% but averaged much lower.

(Max points 100)

Habitat Quality – Woody Vegetation

100	Cover of trees and shrubs taller than 1m < 2% AND Cover of shrubs less than 1 m high <30%
0	Cover of trees and shrubs taller than 1m > 2% OR Cover of shrubs less than 1 m high >30%

5.3. Visual obstruction readings are a combined measurement of vegetation height and density. The values used here are measured using a Robel pole. Visual obstruction is a measurement that can be related to foraging efficiency and predation risk for Swift Foxes. Lower visual obstruction is thought to enhance foraging efficiency, although dense vegetation often produces more prey. The relationship between visual obstruction and predation risk depends on how the predator hunts. Swift Foxes prefer to have patches of taller/denser vegetation to hide entrances to dens but seem to have no preference in vegetation structure for foraging.

(Max points 200)

Habitat Quality – Visual Obstruction

200	Visual obstruction between 11 and 12 cm AND Vegetation height < 30 cm
100	Visual obstruction between 9 and 11 cm AND Vegetation height < 30 cm
0	Visual obstruction under 9 cm OR over 12 cm OR Vegetation height > 30 cm

5.4. A suitable burrow has been defined as having a hole ranging from 10 - 30 cm in diameter with a continuous tunnel of at least 2 m (Moehrenschlager et al. 2007). Suitable burrows for swift fox in Canada have been found to average 0.9/ha +/-0.3; while suitable burrows for kit fox in Mexico were 3.7/ha +/-1.4 (Moehrenschlager et al. 2007). In addition, these authors also found that Swift Fox home ranges in Canada were about 3 times as large as kit fox home ranges in Mexico.

Burrows dug by American badger are the most common source of suitable burrows available to Swift Fox, but badger home ranges in Canada are 4 times larger than badger home ranges in the US (Hoodicoff 2003) which may explain why burrow densities are so much lower in Canada. Badger home range size is thought to be correlated with prey density, especially in core areas of their home range where they contract to during winter. Therefore, ground squirrel densities, which comprise the majority of badger prey in Canada, may be lower in Canada than further south. It is therefore unlikely that land managers would be able to increase burrow densities substantially by simply assuring that badgers are not killed. Increasing burrow density would depend on increasing the density of ground squirrels.

(Max points 300)

Habitat Quality – Burrow Density

300	Optimal suitable burrow density: >2/ha
150	Suboptimal suitable burrow density: 0.6 - 2/ha
0	Suitable burrow density <0.6/ha

5.5. There is evidence that Swift Foxes may be attracted to roads and trails. Proximity to roads may mean fewer encounters with coyotes and/or higher prey density. However, highways and grid roads pose a high risk of mortality from vehicle collisions, making them potential sink habitat. Trails and roads smaller than provincially numbered grid roads may have a beneficial effect for Swift Foxes.

(Max points 100)

Distance to Roads

100	No roads, or only two-track trails and roads smaller than grid roads within 2 km of area of consideration.
50	No roads, or only two-track trails and roads smaller than grid roads within 1 km of area of consideration.
0	A highway or provincially numbered grid road within 1 km of area of consideration

5.6. Swift Foxes do not require a source of drinking water as they are able to obtain all their moisture requirements from their prey. They tend to avoid both large and small bodies of water (including dugouts), especially in the selection of natal dens. Avoiding water may be a method of avoiding coyotes, which are attracted to water, or it may simply be a function of the preference to place natal dens on the top of slopes for better drainage, while water bodies and their associated riparian areas occur at the base of slopes.

(Max points 100)

Distance to Water

100	No water bodies within a 1 km radius of area of consideration.
50	No water bodies within a 500 m radius of area of consideration.
0	A water body(ies) within a 500 m radius of area of consideration.

OTHER CRITERIA

6. Interaction with other species at risk (SAR): Other SAR may exist in the area. The presence of optimal Swift Fox habitat may have a positive, negative, or neutral effect on the other SAR found in the area of consideration. For example, optimal habitat for Swift Fox may reduce the suitability of habitat for some endemic grassland birds.
   (**Max points 100**)

Interaction with other Species at Risk

100	Swift Fox habitat contributes positively to other area SAR.
0	Swift Fox habitat has no impact on other area SAR.
-100	Swift Fox habitat has a negative impact on other area SAR.

EBI= ((1)(2)(3)((4.1+4.2+4.3)+(5.1+5.2+5.3+5.4+5.5+5.6)+6))

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