available at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/biocon

Swift fox reintroductions on the Blackfeet Indian Reservation, Montana, USA

David E. Ausband[a,*], *Kerry R. Foresman*[b]

[a]*Wildlife Biology Program, University of Montana, 311C Forestry, Missoula, MT 59812, USA*
[b]*Division of Biological Sciences, University of Montana, 104 Health Sciences, Missoula, MT 59812, USA*

ARTICLE INFO

Article history:
Received 30 August 2006
Received in revised form
6 October 2006
Accepted 8 December 2006
Available online 25 January 2007

Keywords:
Population growth
Success criteria
Restoration
Translocation
Tribe
Vulpes velox

ABSTRACT

Swift foxes (*Vulpes velox*) were once common prairie inhabitants throughout western North America and were integral components within ecosystems and some Native American tribal cultures. In response to extirpation from tribal lands, the Blackfeet Tribe and Defenders of Wildlife reintroduced 123 captive-raised swift foxes from 1998 to 2002 to the Blackfeet Indian Reservation, Montana, USA. We used two success criteria, a population growth rate $\geqslant 1.0$ and an index count $\geqslant 100$ foxes, to determine if the reintroduction was a short-term success.

We radiocollared and monitored swift foxes from 2003 to 2005 to estimate survival and fecundity. The swift fox population grew at a rate of 16% during 2003/2004 and 14% in 2004/2005. In addition, field crews observed 93 foxes in the summer of 2005.

The swift fox population reached one, and very nearly both, of our short-term success criteria. In light of swift fox sign in areas where we were unable to observe foxes despite being aware of their presence, we believe there were $\geqslant 100$ foxes present in 2005. Based on our success criteria and the discovery of swift foxes 110 km from the release site, we consider this reintroduction a short-term success with promise for long-term success. The Blackfeet Tribe and Defenders of Wildlife have attained their goal of restoring a culturally important species to Tribal lands and have initiated a comeback of swift foxes beyond the Reservation border to the Rocky Mountain Front in Montana. Collaborative projects between tribes and non-governmental groups can play a vital role in our effort to conserve biologically and culturally significant species.

1. Introduction

Swift foxes (*Vulpes velox*) were once common throughout the grasslands of western North America (Allardyce and Sovada, 2003) and coexisted, and presumably interacted, with a variety of prairie inhabitants (Carbyn, 1986; Herrero, 2003). In addition to their functions within the prairie ecosystem, swift foxes were an integral part of some Native American tribal cultures (McClintock, 1999). In fact, customs among the Blackfeet Tribe in Montana forbade the killing of swift foxes after a spiritual swift fox society was formed (McClintock, 1999; S. Momberg, personal communication). Despite the cultural importance swift foxes may have had for the Blackfeet, they were extirpated from Montana by the mid-1950s (Hoffmann et al., 1969). Just across the international border, the disappearance of swift foxes from their historic range led the Canadian government to list the animal as extirpated and begin reintroductions in Alberta and Saskatchewan (Carbyn et al., 1994). Canadian reintroductions of swift foxes from 1983 to 1997 appear to have been successful as judged by subsequent

* *Corresponding author:* Tel.: +1 406 243 4329; fax: +1 406 243 6064.
E-mail addresses: david.ausband@mso.umt.edu (D.E. Ausband), foresman@mso.umt.edu (K.R. Foresman).
0006-3207/$ - see front matter
doi:10.1016/j.biocon.2006.12.007

surveys (Moehrenschlager and Moehrenschlager, 2001) with some foxes recolonizing transborder habitats in north-central Montana (Zimmerman, 1998). In response to petitioning in the US, the Fish and Wildlife Service decided in 1995 that listing swift foxes under Endangered Species Act protections was warranted, but precluded and later rescinded their decision to unwarranted in 2001 (United States Fish and Wildlife Service, 1995, 2001).

In light of the United States Fish and Wildlife Service's 1995 ruling, the Blackfeet Tribe, a sovereign nation, and Defenders of Wildlife, a non-governmental wildlife conservation and advocacy group, began swift fox reintroductions on the Blackfeet Reservation, Montana. From 1998 to 2002, 123, mostly juvenile (89%), captive-raised swift foxes (54% F, 46% M), obtained from Cochrane Ecological Institute, Canada, were released on tribal lands (Fig. 1). Waters et al. (In Review) describe release methods in detail. Subsequent monitoring located natal dens and wild-born kits every year from 1999 to 2002.

After the fifth year of releasing swift foxes, the Blackfeet Tribe and Defenders of Wildlife wanted to determine if the reintroduction was successful. Although reintroductions have been used widely around the globe for a variety of species (Richards and Short, 2003; Vandel et al., 2006), previous studies provide little guidance in determining success criteria. In fact, 47% of species reintroductions had no determination of project success at the time of publication (Fischer and Lindenmayer, 2000). Furthermore, success criteria vary widely throughout reintroductions that do determine success (Sarrazin and Barbault, 1996; Sanz and Grajal, 1998; Fischer and Lindenmayer, 2000; Ostermann et al., 2001). Despite the disparities between reintroduction success criteria, we wanted to develop a priori definitions of short-term success.

Because the nearest swift fox population is 240 km away, the opportunity for foxes immigrating to the Blackfeet Reservation is small, thus at a minimum, the Blackfeet swift fox population can be considered self-sustaining only if it has a long-term growth rate (λ) $\geqslant$ 1.0. Furthermore, a small population can have a positive growth rate yet be vulnerable to even moderate perturbations or catastrophes, therefore we thought it was necessary to include a target count of foxes in the success criteria.

We considered the reintroductions a short-term success if $\lambda \geqslant 1.0$ in both 2004 and 2005, an index count was $\geqslant$100 foxes, and population projections based on our empirical data were indicative of a growing, or stable, population (20 year $\lambda \geqslant 1.0$). We define success as not needing to release more animals at the present time and intense research, such as capturing and radiocollaring individuals, can cease and limited resources can be diverted to implementing a less invasive long-term monitoring program.

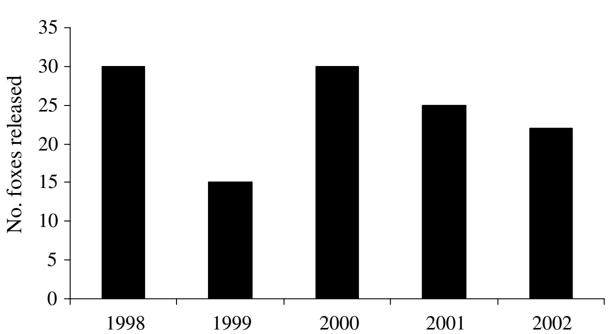

Fig. 1 – Number of captive-raised swift foxes released on Blackfeet Indian Reservation Montana from 1998 to 2002.

2. Methods

2.1. Study area

This study occurred on the Blackfeet Indian Reservation, Glacier County, Montana. This land was retained by the Blackfeet people under the Treaty of 1855. Later court decisions declared that this treaty also meant that the federal government recognized the tribe as a sovereign nation, therefore all decisions regarding non-threatened or non-endangered species of wildlife on tribal lands are autonomously dictated by the Blackfeet Fish and Wildlife Department and the Tribal Business Council. The Blackfeet Reservation is 607000 ha of mostly grassland habitat lying on the eastern flank of the Rocky Mountains adjacent to Glacier National Park. Blackfeet lands are bordered on the north by Alberta, Canada, on the south by Birch Creek, to the west by Glacier National Park, and partially bordered on the east by Cut Bank Creek. Grazing predominates land use on the Reservation with cropland comprising much of the remaining land area. All swift foxes were released on a 3200 ha tribally owned ranch located along the Two Medicine River approximately 30 km southeast of Browning, Montana.

Data loggers placed at the release site recorded temperatures ranging from −40 °C in January to 41 °C in July. Yearly precipitation averages 31.8 cm and elevation of the grasslands on the Reservation averages 1200 m. Short-grass prairie vegetation including needle and thread grass (*Stipa comata*), blue grama (*Bouteloua gracilis*), and thread-leaf sedges (*Carex filifolia*) dominate much of the Reservation. Similar grassland habitat lies to the south of the Reservation.

2.2. Data collection

We live-trapped adult and juvenile swift foxes in box-traps, $109 \times 39 \times 39$ cm, and fitted them with radiocollars and transponders. Box-traps were lined with wood and wire mesh to decrease the chance of injury to trapped animals (Moehrenschlager et al., 2003).

Adults were trapped opportunistically year-round with the exception of the summer months if kits were present. We visually monitored adults discovered without kits twice a day for a minimum of 7 days. After this time, we approached the location and looked for signs of kit presence (kit scat, tracks, tufts of ventral hairs clinging to vegetation, trampling, "fanning" of dirt, multiple entrances). If none of the above signs were observed, we then trapped at the site. Juveniles were trapped at natal dens in late August prior to dispersal by placing traps near (<0.5 km) the late-summer natal den. We set traps at 2200 h and returned at 0600 h and did not trap at temperatures below −20 °C, above 32 °C, or under other severe weather conditions.

Captured swift foxes were removed from the trap, placed in a sack and weighed. One observer held and restrained the fox while the second observer placed a sock over the animal's eyes and muzzle, attached a radiocollar, implanted a transponder between the shoulder blades, determined sex, checked ears for tattoos (to determine wild-born versus captive-reared), and recorded tooth wear to estimate age. These handling methods were approved under IACUC protocol number 036-04KFDBS-043005.

We located radiocollared foxes weekly by vehicle using a magnetic, roof-mounted antenna for approach and an H-antenna for triangulation. We also conducted telemetry flights as needed to locate missing collars.

We estimated survival of radiocollared juveniles and adults separately using a staggered-entry Kaplan-Meier formula (Pollock et al., 1989). This staggered-entry procedure allowed for animals to be entered into the survival analysis as we captured them at different times throughout the study. No swift foxes died within 2 weeks of capture, therefore we did not include a handling acclimation period and used all available data (Winterstein et al., 2001). Animals that we lost radio contact with were excluded from sample sizes and subsequent analyses as though they were never radiocollared.

Preliminary analyses showed that survival rates differed at different times of the year for juveniles, but not adults. We calculated juvenile survival for September, October, November, December, and January to 1 June and used the multiplicative product to obtain a 9-month survival rate from September 2003 to June 2004 and September 2004 to June 2005. We estimated adult survival from June 2003 to June 2004 and June 2004 to June 2005. Juveniles that were marked in September 2003 and survived to be adults in June 2004 were included in the 2004–2005 adult sample. We estimated kit survival by counting the number of kits observed at a natal den upon emergence (typically late May/early June) compared to the number of kits observed at the same den in late August during both 2004 and 2005. We used repeated counts in both early and late-summer to increase the accuracy of this visual estimation method. We did not include natal dens discovered after 1 July in our estimate of kit survival because of the potential that kits that died before 1 July would not be detected and counted, and therefore would inflate survival estimates.

We defined fecundity as the product of litter size and proportion of adult females reproducing annually. Because we did not handle all kits, we assumed a sex ratio of 1:1. We obtained the variance for fecundity from estimates of fecundity on the Blackfeet Reservation plus reproductive data from studies of swift foxes in Canada (Moehrenschlager et al., 2004) and Wyoming (Olson and Lindzey, 2002) and one long-term study of kit foxes (*Vulpes macrotis*), a closely related species, in California (Cypher et al., 2000). Data from the additional studies were used to encompass more variance in fecundity. Litter size was calculated as the number of kits observed at the natal den upon emergence. As with kit survival, we did not include natal dens discovered after July 1 in our estimate of litter size because of the increased potential for kit mortality later in summer as kits began short forays away from the natal den site. We defined a natal den as a breeding pair and their kits, regardless of how many times they moved in a given summer.

We used criteria similar to Disney and Spiegel (1992) to determine the cause of mortality for radiocollared foxes. Mostly, we considered puncture wounds to the skull and an uneaten carcass to indicate coyote (*Canis latrans*) predation, unless we discovered the carcass in a badger (*Taxidea taxus*) hole or badger tracks at the kill site. In addition, we defined a fox as having been killed by a raptor if feathers were present at the kill site, the carcass had been fed upon extensively, skin and fur were peeled back, tufts of fur were scattered about, the fox had been eviscerated and there were no puncture wounds on the skull.

Potential swift fox habitat on the Reservation is extensive with large tracts that are difficult to access. Furthermore, we had a limited timeframe and resources with which to conduct this study over such a vast area. Therefore, to facilitate our ability to locate and count foxes, we placed informative signs with a photograph and description of a swift fox annually in the same local businesses ($N = 4$) and government buildings ($N = 5$) on and around the Blackfeet Reservation in an attempt to collect reports from the public. We also placed advertisements with a photo, description, and den reward information in a local newspaper bi-weekly during both years. Defenders of Wildlife offered rewards of $100 (US) for reports that led to active, previously undiscovered swift fox natal dens. In addition, we designed and staffed an informative booth annually at the North American Indian Days pow-wow in Browning, Montana in an attempt to reach more of the public and familiarize them with swift foxes, the reintroductions, and our den reward system. We developed an informative pamphlet to hand out at North American Indian Days and for use in field work when talking with local landowners.

We included a swift fox in a given year's count if it was present on 1 June and was not discovered after 30 August because we assumed 30 August was the date after which juveniles may have dispersed from their natal area and thus would have the potential to be counted twice in our annual total. We report only the number of individual swift foxes observed by field crews, therefore our count is conservative and the numbers reported should not be viewed as an estimation of total fox abundance.

2.3. Statistical methods

We wanted to determine if there were any differences in survival or cause of mortality between sexes and among age classes. To accomplish this we arcsine-transformed survival rates and used a z-test to examine differences in survival rates between years for adults, juveniles, and kits. We used χ^2 analyses to test for differences in juvenile survival by season and to test for differences in adult mortality by sex. We also used arcsine-transformed data and a z-test to examine differences between raptor predation on juveniles and adults.

Once we estimated survival rates from monitoring radiocollared individuals we then used a matrix-based approach to obtain population growth rate estimates.

We developed a post-birth pulse matrix model based on vital rates obtained from radiocollared animals (Fig. 2) and estimated asymptotic λ for both 2003/2004 and 2004/2005 using Matlab® 6.0 and the function "eigenall" (Morris and Doak, 2002). We then used the delta method to construct a 95% CI

$$\begin{bmatrix} S_k \times S_j \times F_1 & S_a \times F_2 \\ S_k \times S_j & S_a \end{bmatrix}$$

Fig. 2 – Post-birth pulse matrix for swift foxes on the Blackfeet Indian Reservation, Montana where S = survival, F = fecundity. Subscripts represent age classes defined as *k* = kits (June–August), *j* = juveniles (September–June), *a* = adults (Jun_{200X}–Jun_{200X+1}), 1 = first year adult breeders, 2 = 2+ year adult breeders.

for λ (Lande, 1988; Caswell, 2001). The delta method also uses vital rate sensitivities in its calculation and these were obtained using Matlab and running a modified version of the program file vitalsens. (Morris and Doak, 2002).

We also used Matlab to project swift fox population growth to 2025 for 100 replicates, with each replicate 20-year projection being equally likely. A modified version of program file limitsens.m (Morris and Doak, 2002) in Matlab allowed us to randomly construct matrices for each year of a 20-year projection by choosing vital rates from a uniform distribution that was based on the upper and lower bounds of our estimated vital rate confidence intervals for 2005. Choosing from a range of possible vital rate values simulated environmental stochasticity in the population projections. For example, if the program chose the lower bounds of our adult survival and juvenile survival confidence intervals the resulting λ would simulate a poor year for fox growth. Projections did not account for correlation among vital rates between years and because this was a large region recently uninhabited by foxes we assumed there was a dearth of vacant habitat and by using a short 20-year interval we excluded density dependent effects to population forecasts. The swift fox population on the Reservation was also large enough to exclude potential effects of demographic stochasticity in our projections (Morris and Doak, 2002).

3. Results

3.1. Vital rates and mortality

Field crews captured and radiocollared 23 adult (12 F, 11 M) and 35 juvenile (16 F, 19 M) swift foxes between 2003 and 2005. Three of the adult foxes were ear-marked indicating they were captive-reared. Survival rates for adults were mostly constant throughout seasons and annual rates did not differ between years ($z = 1.01$, $P = 0.16$) (Table 1). Juvenile survival was lower in autumn (September–December) during both years ($\chi^2_3 = 10.9$, $P = 0.01$), but did not differ between years ($z = 0.49$, $P = 0.31$) (Table 1). Survival rates did not differ between years for kits ($z = -1.07$, $P = 0.14$) (Table 1).

Four of six over 2-year-old adult females that survived to 1 June reproduced in 2004, whereas 5 of 5 that survived to 1 June bred in 2005 (Table 2). One of 2 juvenile, or first year, adult females reproduced in 2004, whereas 3 of 6 reproduced in 2005 (Table 2). Average litter size for 2+ year adults was 3.6 in 2004 and 4.1 in 2005. First year breeders averaged 4.0 and 3.3 kits per litter in 2004 and 2005, respectively.

Predation accounted for 26 of 33 (78.8%) swift fox mortalities (Fig. 3). Vehicle collisions were the cause of 5 mortalities and we were unable to determine the cause of death for 2 foxes. Causes of mortality were roughly equivalent between age classes with the exception that predation by raptors was slightly higher for adults (38.9%) than for juveniles

Table 1 – Mean survival and 95% CI for swift fox adults, juveniles and kits on the Blackfeet Indian Reservation, Montana

Age class/year	N marked	N censored	$\bar{x}$ survival	95% CI
Adults				
2003 June–2004 June	14	2	0.73	0.52–0.94
2004 June–2005 June	24	3	0.60	0.44–0.76
Juveniles				
2003 September–2004 June	13	4	0.56	0.32–0.80
2004 September–2005 June	22	1	0.47	0.32–0.62
Kits				
2004 June–2004 September	29	0	0.69	0.55–0.83
2005 June–2005 September	39	0	0.77	0.65–0.89

Table 2 – Swift fox reproductive estimates and number of natal dens observed on the Blackfeet Indian Reservation, Montana (2003–2005)

Year	Proportion reproducing			Litter size	
	F (1 year)	F (2+ years)	Number of natal dens[a]	$\bar{x}$	SE
2003	N/A	N/A	8	4.8	0.6
2004	0.50	0.67	14	4.0	0.4
2005	0.50	1.00	13	3.9	0.4

a Number of natal dens includes both collared and uncollared animals.

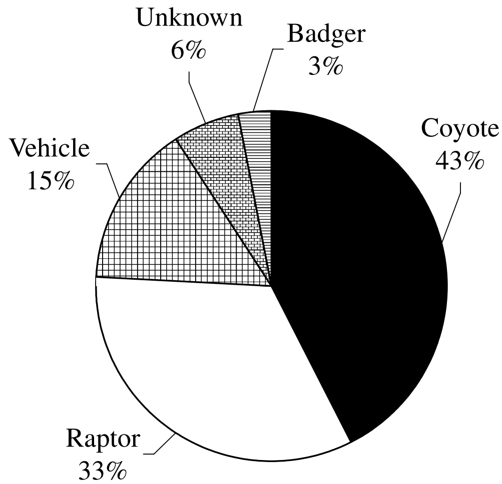

Fig. 3 – Cause of radiocollared swift fox mortalities from 2003 to 2005 on the Blackfeet Indian Reservation, Montana (*N* = 33).

(26.7%), but this trend was not significant (z = 0.78, P = 0.22). Although the sex ratio of foxes did not differ, significantly more radiocollared adult females died than males over the 2 years ($\chi^2_1 = 4.17$, P = 0.04).

3.2. *Fox index count and population growth*

The number of swift foxes observed increased every summer with 62 in 2003, 86 in 2004, and 93 individuals counted in 2005. We received 19 natal den reports from the public in 2004 and 14 reports in 2005. Five of the 19 reports in 2004 were separate swift fox natal dens, 8 were red fox (*Vulpes vulpes*) dens, and we were unable to confirm an additional two reports, although based on habitat we believe these reports were likely red fox dens. In 2005, 4 of the 14 reports were swift fox natal dens, although only 1 of these was previously undiscovered by field crews. Seven of the 14 reports were red fox and 1 was a coyote natal den. We were unable to confirm 2 of the 14 reports in 2005, but based on habitat features we believe these were red fox dens.

We estimated a λ of 1.16 ± 0.39 (mean ± 95% CI) from June 2003 to June 2004 and 1.14 ± 0.34 from June 2004 to June 2005. Population projections based on empirical vital rates indicated growth over 20 years for all 100 replicates, each equally likely to occur. The arithmetic mean λ for all 100 replicates was 1.072 ± 0.06 and no 20-year replicate had a $\lambda_G < 1.0$ (Fig. 4). All 100 replicates had an initial population size of 93 foxes. Mean abundance in year 2025 was 427 ± 50 ($\bar{x}_G = 365$) and no replicate went extinct.

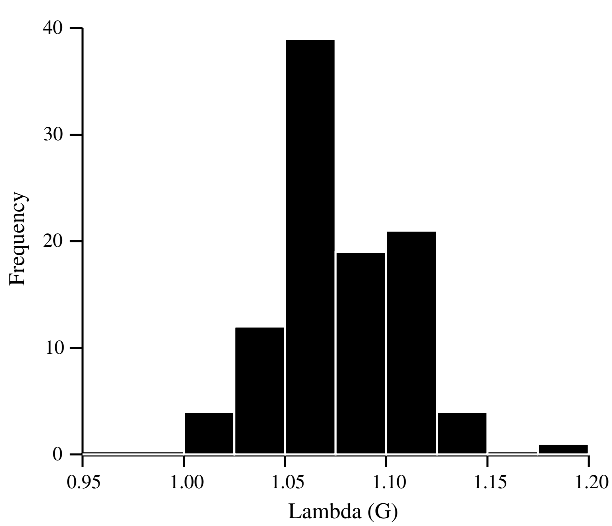

Fig. 4 – Histogram of λ_G values generated from 100 replicates of 20-year swift fox population growth projections.

4. Discussion

4.1. *Vital rates and mortality*

Survival rates were comparable to, or higher than, what is reported from several recent studies on swift fox (Sovada et al., 1998; Olson and Lindzey, 2002; Kamler et al., 2003b; Moehrenschlager et al., 2004). Many studies have estimated litter size and average litter sizes on the Blackfeet Reservation compare favorably with data from summary papers on swift fox ecology (Moehrenschlager et al., 2004; Stephens and Anderson, 2005). In addition to litter size, another component of fecundity is the proportion of adult females that breed annually. Again, this metric was comparable to, or higher than, what is reported by Olson and Lindzey (2002) (0.79, adults), Moehrenschlager and Macdonald (2003) (0.33 and 0.60, adults (2+ years) and adults (1 year), respectively), and estimates from Moehrenschlager et al. (2004).

Coyotes were the primary cause of mortality for swift foxes on the Reservation. Coyotes have been implicated as a major source of swift fox and kit fox mortality in numerous other studies as well (Cypher and Scrivner, 1992; Sovada et al., 1998; Olson and Lindzey, 2002; Kamler et al., 2003a). Researchers even suggest that coyotes may have a large enough impact on swift and kit foxes that they suppress population growth (Cypher and Scrivner, 1992; Kamler et al., 2003a). A substantial proportion of swift foxes on the Reservation were presumed to be killed by raptors (33%). Other studies have recorded sporadic and negligible amounts of raptor predation on swift foxes (Covell, 1992; Olson and Lindzey, 2002), and we have not discovered another study with the same level of raptor predation we observed. While it is possible that some of these foxes may have died from other causes and were only then fed upon by raptors, most raptor species observed on the Reservation do not typically eat carrion (Elphick et al., 2001).

We found more radiocollared adult females died than expected had mortality been constant across sexes. Survival between sexes of adults was roughly equivalent during the first year of the study, however, from June 2004 to June 2005 adult females had a survival rate of 0.38 ± 0.18 whereas adult males had a survival rate of 0.80 ± 0.22 for the same time period. Moehrenschlager and Macdonald (2003) note that survival for females was lower in translocated foxes and suggest swift fox reintroduction projects should release more females than males to compensate for differential survival. We are unsure what would create differential survival in a sample of mostly wild-born adult foxes, particularly during just one year of our study. Two of the adult females that died during the 2004/2005 year were old as judged by severely worn teeth and ear tattoos that indicated one animal was from the original 1998 release. If these two female deaths are excluded from the survival analysis, average adult female survival increases to 0.54 ± 0.22. Identifying factors that would lead to differential mortality between sexes during 1 year is difficult because survival rate equations can be sensitive to any changes due to the relatively small sample sizes being analyzed.

When coupled with our estimate of population growth, it seems that swift fox populations can sustain a high proportion of mortalities from raptor and coyote predation and yet continue to grow.

4.2. *Fox index count and population growth*

Coupled with our outreach efforts, providing monetary rewards for reports of natal dens was effective in obtaining additional swift fox locations. Although some time was spent confirming den reports that were actually red fox or coyote, the benefit of discovering previously unknown swift fox natal dens outweighed the cost of resources used on misidentifications. In 2004, 5 of 14 natal dens discovered were from public reports. Although only 1 of the 13 natal dens discovered in 2005 was from a report, some of the radiocollared foxes ($N = 5$) that produced litters in 2005 were discovered via reports in 2004.

In 2005, the lone report that led us to a previously undiscovered den in 2005 was from the town of Augusta, Montana, 110 km south of the release site. This pair of swift foxes produced two kits in 2005, both of which were female. A large expanse of cropland (240 km) separates Augusta from the only other known swift fox population in the state near Havre, Montana. In contrast, grassland is contiguous along the Rocky Mountain Front from the release site on the Reservation to Augusta. Based on habitat features, these swift foxes are likely to have been derived from the Blackfeet Reservation population and it is likely swift foxes occupy, at least in part, the habitat between Augusta and the southern Reservation boundary. However, we did not include these four confirmed foxes in our abundance count on the Reservation.

Our estimate of swift fox population growth admittedly has a wide associated confidence interval. However, when comparing individual vital rates to vital rates obtained from other studies where swift foxes are considered stable or growing the Blackfeet vital rate estimates are comparable or higher. In addition, population projections, each equally likely, based on vital rates obtained from radiocollared foxes provided a range of 377–478 swift foxes present in the year 2025 and no replicate had a $\lambda_G < 1.0$. While these population projections simulated environmental stochasticity we should note that the abundance projections are sensitive to initial population size and are based on a minimum number of foxes present in 2005. It is likely more swift foxes were present in 2005 than were detected by field crews. Furthermore, we do not know the true process variance in this system and the estimated growth rates are based solely on sample variance, which may or may not encompass all variance in the vital rates over time. The projections presented are merely a rough sketch of what could be expected given the vital rates we measured from radiocollared foxes over 2 years. These projections do not include habitat or territoriality factors, hence, we used a relatively short, 20-year projection interval.

5. Conclusion

Based on our explicitly defined success criteria, we believe this reintroduction of swift foxes has been a short-term success with a promising outlook for long-term success. The swift fox population on the Reservation is growing, therefore, the first criterion defining success was met. Field crews also very nearly reached the second success criterion of 100 foxes by counting 93 in 2005. This minimum number of foxes does not include the Augusta, Montana swift foxes. Again, the index count of 93 swift foxes is not an estimate of total fox abundance on the Reservation, it is merely a minimum number of swift foxes alive during the summer of 2005. We feel confident there were at least 100 swift foxes on the Reservation during the summer of 2005 based on potential habitat that was not surveyed, reports from the public, and swift fox sign in areas where we were unable to observe swift foxes.

At this early stage, our term "success" merely represents one hurdle in a long series of hurdles for this population to be considered fully recovered. Of course, we fully realize that this population is still quite small and vulnerable. However, to direct limited funds to where they are needed most, we think our approach is valid provided a strong monitoring program is implemented. While tribes and non-governmental organizations can play a vital role in species conservation because they can often act more quickly than a government agency, they are also more prone to the vagaries associated with ephemeral resources and changing administrative priorities. Furthermore, some members of the Blackfeet Tribe prefer non-invasive wildlife research techniques, therefore, we were encouraged to mark only enough individuals to reasonably answer our scientific questions. In addition, most non-governmental organizations take great care to ensure limited resources are going toward projects they deem most critically important at the time and superfluous releases of animals are not in their best interest if it can be reasonably predicted that the population will continue to expand without human intervention. Our empirically-based population growth projections demonstrate such long-term promise for this population. We think a population of approximately 100 animals that is growing and through population projections appears likely to continue to grow, is sufficient for us to not actively release more large cohorts of foxes. However, in the absence of genetic data related to this population Ausband (2005) recommended a conservative approach of releasing 5–6 adults every second year until concerns related to inbreeding are assuaged.

Our species reintroduction was unique because it did not rely on a government agency to spearhead efforts. Rather this reintroduction relied on the sovereignty of the Blackfeet Nation and cooperation from Defenders of Wildlife to achieve initial success. Collaborative projects between tribes and non-governmental groups can play a vital role in our effort to conserve biologically and culturally significant species.

Acknowledgements

We received funding for this research from Defenders of Wildlife, a Tribal Wildlife Grant through the Blackfeet Tribe, a State Wildlife Grant through The University of Montana, and a grant from Sigma Xi. We extend sincere thanks to all who helped with field work and study logistics. We also thank D. Pletscher, L.S. Mills, and K. Hodges for early manuscript reviews. Anonymous reviewers contributed greatly to the strength of this manuscript and we thank them.

REFERENCES

Allardyce, D., Sovada, M.A., 2003. A review of the ecology, distribution, and status of swift foxes in the United States. In: Carbyn, L.N., Sovada, M.A. (Eds.), The Swift Fox: Ecology and Conservation of Swift Foxes in a Changing World. Canadian Plains Research Center, University of Regina, Canada, pp. 3–18.

Ausband, D.E., 2005. Assessing the success of swift fox reintroductions on the Blackfeet Indian Reservation, Montana. Thesis, University of Missoula, Missoula, Montana.

Carbyn, L.N., 1986. Some observations on the behaviour of swift foxes in reintroduction programs within the Canadian prairies. Alberta Naturalist 16, 37–41.

Carbyn, L.N., Armbruster, H.J., Mamo, C., 1994. The swift fox reintroduction program in Canada from 1983 to 1992. In: Bowles, M.L., Whelan, C.J. (Eds.), Restoration of Endangered Species. Cambridge University, United Kingdom, pp. 247–271.

Caswell, H., 2001. Matrix Population Models. Sinauer, Sunderland, MA, USA.

Covell, D.F., 1992. Ecology of the swift fox (*Vulpes velox*) in southeastern Colorado. Thesis, University of Wisconsin, Madison, WI.

Cypher, B.L., Scrivner, J.H., 1992. Coyote control to protect endangered San Joaquin kit foxes at the Naval Petroleum Reserves, California. In: Borrecco, J.E., Marsh, R.E. (Eds.), Proceedings of the 15th Vertebrate Pest Conference. University of California, Davis, CA, USA, pp. 42–47.

Cypher, B.L., Warrick, G.D., Otten, M.R.M., O'Farrell, T.P., Berry, W.H., Harris, C.E., Kato, T.T., McCue, P.M., Scrivner, J.H., Zoellick, B.W., 2000. Population dynamics of San Joaquin kit foxes at the Naval Petroleum Reserves in California. Wildlife Monographs No. 145.

Disney, M., Spiegel, L.K., 1992. Sources and rates of San Joaquin kit fox mortality in western Kern County, California. Transactions of the western section of The Wildlife Society 28, 73–82.

Elphick, C., Dunning Jr., J.B., Sibley, D.A., 2001. The Sibley Guide to Bird Life and Behavior. Knopf, New York.

Fischer, J., Lindenmayer, D.B., 2000. An assessment of the published results of animal relocations. Biological Conservation 96, 1–11.

Herrero, S., 2003. Canada's experimental reintroduction of swift foxes into an altered ecosystem. In: Carbyn, L.N., Sovada, M.A. (Eds.), The Swift Fox: Ecology and Conservation of Swift Foxes in a Changing World. Canadian Plains Research Center, University of Regina, Canada, pp. 33–38.

Hoffmann, R.S., Wright, P.L., Newby, F.E., 1969. The distribution of some mammals in Montana. I. Mammals other than bats. Journal of Mammalogy 50, 579–604.

Kamler, J.F., Ballard, W.B., Gilliland, R.L., Lemons II., P.R., Mote, K., 2003a. Impacts of coyotes on swift foxes in northwestern Texas. Journal of Wildlife Management 67, 317–323.

Kamler, J.F., Ballard, W.B., Fish, E.B., Lemons, P.R., Mote, K., Perchellet, C.C., 2003b. Habitat use, home ranges, and survival of swift foxes in a fragmented landscape: conservation implications. Journal of Mammalogy 84, 989–995.

Lande, R., 1988. Demographic models of the northern spotted owl (*Strix occidentalis caurina*). Oecologia 75, 601–607.

McClintock, W., 1999. The old north trail. Life Legends and Religion of the Blackfeet Indians. Bison Books, University of Nebraska, Lincoln, Nebraska.

Moehrenschlager, A., Macdonald, D.W., 2003. Movement and survival parameters of translocated and resident swift foxes *Vulpes velox*. Animal Conservation 6, 199–206.

Moehrenschlager, A., Moehrenschlager, C., 2001. Census of swift fox (*Vulpes velox*) in Canada and Northern Montana: 2000–2001. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 24. Edmonton, Alberta.

Moehrenschlager, A., Macdonald, D.W., Moehrenschlager, C., 2003. Reducing capture-related injuries and radio-collaring effects on swift foxes. In: Carbyn, L.N., Sovada, M.A. (Eds.), The Swift Fox: Ecology and Conservation of Swift Foxes in a Changing World. Canadian Plains Research Center, University of Regina, Canada, pp. 107–113.

Moehrenschlager, A., Cypher, B.L., Ralls, K., List, R., Sovada, M.A., 2004. Swift and kit foxes: comparative ecology and conservation of swift and kit foxes. In: MacDonald, D.W., Sillero-Zubiri, C. (Eds.), The Biology and Conservation of Wild Canids. Oxford University, United Kingdom, pp. 185–198.

Morris, W.F., Doak, D.F., 2002. Quantitative Conservation Biology: Theory and Practice of Population Viability Analysis. Sinauer, Sunderland, MA.

Olson, T.L., Lindzey, F.G., 2002. Swift fox survival and production in southeastern Wyoming. Journal of Mammalogy 83, 199–206.

Ostermann, S.D., Deforge, J.R., Edge, W.D., 2001. Captive breeding and reintroduction evaluation criteria: a case study of peninsular Bighorn Sheep. Conservation Biology 15, 749–760.

Pollock, K.H., Winterstein, S.R., Bunck, C.M., Curtis, P.D., 1989. Survival analysis in telemetry studies: the staggered entry design. Journal of Wildlife Management 53, 7–15.

Richards, J.D., Short, J., 2003. Reintroduction and establishment of the western barred bandicoot *Perameles bougainville* (Marsupialia: Peramelidae) at Shark Bay, Western Australia. Biological Conservation 109, 181–195.

Sanz, V., Grajal, A., 1998. Successful reintroduction of captive-raised Yellow-shouldered Amazon Parrots on Margarita Island, Venezuela. Conservation Biology 12, 430–441.

Sarrazin, F., Barbault, R., 1996. Reintroduction: challenges and lessons for basic ecology. Trends in Ecology and Evolution 11, 474–478.

Sovada, M.A., Roy, C.C., Bright, J.B., Gillis, J.R., 1998. Causes and rates of mortality of swift foxes in western Kansas. Journal of Wildlife Management 62, 1300–1306.

Stephens, R.M., Anderson, S.H., 2005. Swift Fox (*Vulpes velox*): A Technical Conservation Assessment. Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, Wyoming. Available from: <http://www.fs.fed.us/r2/projects/scp/assessments/swiftfox.pdf> (accessed April 2005).

United States Fish and Wildlife Service, 1995. Endangered and Threatened wildlife and plants; 12-month finding for a petition to list the swift fox as Endangered. Federal Register 60, 31663–31666.

United States Fish and Wildlife Service, 2001. Endangered and Threatened wildlife and plants; annual notice of findings on recycled petitions. Federal Register 66, 1295–1300.

Vandel, J.M., Stahl, P., Herrenschmidt, V., Marboutin, E., 2006. Reintroduction of the lynx into the Vosges mountain massif: from animal survival and movements to population development. Biological Conservation 131, 370–385.

Winterstein, S.R., Pollock, K.H., Bunck, C.M., 2001. Analysis of survival data from radiotelemetry studies. In: Millspaugh, J.J., Marzluff, J.M. (Eds.), Radio Tracking and Animal Populations. Academic Press, San Diego, CA, pp. 351–380.

Zimmerman, A.L., 1998. Reestablishment of swift fox in North-Central Montana. Thesis, Montana State University, Bozeman, Montana.