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 This document was prepared as an addendum to the Species Conservation Assessment published by the USDA Forest Service - Rocky Mountain Region (Region 2), available at:

<http://www.fs.fed.us/r2/projects/scp/assessments/index.shtml>

It is intended to accompany that assessment, and to provide the reader with scientific findings and conclusions derived since the assessment's publication.
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Summary of Updates

Title of Assessment: Swift fox (*Vulpes velox*): a technical conservation assessment

Publication Date: 21 January 2005

Original Author(s): R. M. Stephens and S.H. Anderson

Reviewer(s): Gary P. Beauvais

Date of Review: 3 May 2006 - 30 June 2006

----- Addendum Summary

Distribution: Many of the references summarized below document recent swift fox (*Vulpes velox*) occurrence in portions of all states within the species' range. The species appears to still occupy most, if not all, of the areas previously assumed to be occupied. Swift foxes have been recently reintroduced at 2 sites in South Dakota (references 27, 28), and other reintroductions are ongoing or planned throughout the northern portion of the species' range (reference 28). Marsha Sovada at the Northern Prairie Wildlife Center is apparently compiling a new and comprehensive distribution map for swift fox in the U.S. and possibly Canada (reference 32). Such a map should be a central feature in an updated Technical Conservation Assessment; note that the distribution map in the current assessment is >10 years old.

Taxonomic Status: No changes to swift fox taxonomy were uncovered in this review. The assignment of swift fox and kit fox (*V. macrotis*) to separate species is apparently followed by all authors and contacts documented below. Donni Schwalm, a Ph.D. student at Texas Tech University, is apparently determining the genetic relationships of swift fox in various parts of their range, which should inform subspecies-level taxonomy (reference 32).

Agency Status: The swift fox has been designated a conservation priority species in the Comprehensive Wildlife Conservation Strategy of each of the 5 states in USDA Forest

Service Region 2 (references 4, 21, 25, 29, 30). This should bring more management and conservation resources to bear on swift fox and swift fox habitat.

Other: Much recent research has been directed at elucidating the dispersal ecology, spacing, and group structure of swift foxes (references 10, 11, 12, 14, 15, and 16).

Significance of change relative to original assessment: Commissioning an updated Technical Conservation Assessment is recommended in lieu of future addenda. Recent research and management documents have substantially changed the knowledge base, management context, and conservation context for swift fox throughout its range and in USDA Forest Service Region 2. The new publications outlined in references 18 and 26 are seminal documents that should underlie an updated assessment, as should the wealth of new information developed annually by the Swift Fox Conservation Team (references 8 and 28). A possible strategy would be to schedule an update to coincide with completion of the dissertation on swift fox genetics being conducted at Texas Tech University (reference 32), which is anticipated to occur within roughly 3 years of this addendum.

Reference 1:

Azevedo, F.C.C., V. Lester, W. Gorsuch, S. Larivière, A.J. Wirsing, and D.L. Murra. 2006. Dietary breadth and overlap among five sympatric prairie carnivores. *Journal of Zoology* 269:127-135.

Summary of new information:

This study compared diets and dietary overlap between 5 prairie carnivores (American badger [*Taxidea taxus*], coyote [*Canis latrans*], red fox [*Vulpes vulpes*], raccoon [*Procyon lotor*], and striped skunk [*Mephitis mephitis*]), NOT including swift fox (*Vulpes velox*). Diets of all species varied widely over time. The highest degree of dietary overlap occurred between coyote and red fox, and between raccoon and striped skunk, supporting the idea that prairie carnivores most similar in body size, life history, and habitat use will compete the most for food. The 2 species most likely to compete with and prey on swift fox, coyote and red fox, relied heavily on small mammals and birds, followed by insects.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

 Biology and Ecology

 Food Habits

 Community Ecology

Reference 2:

Beauvais, G.P., R. Thurston, and D. Keinath. 2003. Predictive distribution maps for 15 species of management concern in the Rocky Mountain Region of the USDA Forest Service. Wyoming Natural Diversity Database (University of Wyoming). Laramie, Wyoming, USA.

Summary of new information:

The distribution of swift fox (*Vulpes velox*) across all 5 states of USDA Forest Service Region 2 was modeled and mapped based on 512 documented sightings and 8 habitat variables. Modeling proceeded in a 2-stage fashion. First, the DOMAIN procedure was used to estimate an envelope of suitable bio-physical conditions in the region. Second, all landcover types unsuitable for swift fox (as identified by GAP Analysis teams in each state) were removed from that envelope. The final distribution map encompassed 92% of all documented swift fox observations in an independent (i.e., not used for model construction) dataset. The final distribution map suggests that (1) swift fox occupy more of western Kansas than previously assumed by USDI Fish and Wildlife Service, the Kansas Department of Fish, Wildlife, and Parks, and reference 23; (2) swift fox occupy more of western South Dakota than estimated by reference 25; (3) swift fox occupy slightly more of Wyoming than estimated by reference 30.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Distribution and abundance

Habitat

CONSERVATION

Management of the Swift Fox in Region 2

Tools and practices

Reference 3:

Bremner-Harrison, S., P.A. Prodohl, and R.W. Elwood. 2004. Behavioural trait assessment as a release criterion: boldness predicts early death in a reintroduction programme of captive-bred swift fox (*Vulpes velox*). *Animal Conservation* 7:313-320.

Summary of new information:

Captive-raised swift fox (*Vulpes velox*) who were judged to be more bold (based on their responses to novel stimuli in captivity) died at a higher rate during the 6 months following their release into the wild than did captive-raised swift fox who were judged to be less bold. It is suggested that behavioral assessment of captive-raised swift fox can help identify those most likely to succeed in reintroduction programs.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

CONSERVATION

Management of the Swift Fox in Region 2
Tools and Practices
Inventory and Monitoring

Reference 4:

Colorado Division of Wildlife. 2005. Colorado's comprehensive wildlife conservation strategy. Colorado Division of Wildlife. Denver, Colorado, USA.

Summary of new information:

This document is the Comprehensive Wildlife Conservation Strategy for the state of Colorado, and is guided by the following principles: (1) encourage and support conservation actions that meet the needs of species of greatest conservation need; (2) manage for healthy key habitats and ecosystems so that all species of greatest conservation need will benefit; (3) create a strategy that will be flexible enough to incorporate new research findings and successful management innovations; (4) acknowledge the pivotal role that private landowners and local stakeholders play in conservation; (5) enhance, not replace, other planning efforts; and (6) maintain an atmosphere of cooperation among wildlife managers, landowners, private and public land managers, and other stakeholders. Swift fox (*Vulpes velox*) are identified as one of Colorado's species of greatest conservation need, and as such are described in this plan as to their distribution, status, habitat use, threats, and likely responses to particular management actions. The grasslands of eastern Colorado (i.e., swift fox range) are described as being in the poorest condition, and hence in most need of conservation attention, of all ecological systems in the state. This reference provides a long list of management recommendations for swift fox, both in its own text and by reference to existing swift fox-related management plans for the state of Colorado. This reference is probably best considered in the context of references 21, 25, 29, and 30.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Existing Regulatory Mechanisms, Mgmt Plans, and Conservation Strategies

Biology and Ecology

Distribution and abundance

Population trend

Habitat

CONSERVATION

Threats

Conservation Status of the Swift Fox in Region 2

Management of the Swift Fox in Region 2

Reference 5:

Federal Register. 2004. Endangered and Threatened Wildlife and Plants; Finding for the Resubmitted Petition To List the Black-Tailed Prairie Dog as Threatened. Federal Register 69:51217-51226.

Summary of new information:

Based on recent data that suggest the threats to black-tailed prairie dogs (*Cynomys ludovicianus*) are not as severe as previously assumed, the USDI Fish and Wildlife Service determined to not list the species as Threatened under the U.S. Endangered Species Act. Such a listing could have had significant management implications for swift fox (*Vulpes velox*); see references 17 and 24. Current estimates suggest about 1,842,000 acres are occupied by black-tailed prairie dogs in the U.S., with about 1,430,000 acres (78%) encompassed by the 5 states of USDA Forest Service Region 2. Mortality from infection by sylvatic plague was determined to be the most important rangewide threat to black-tailed prairie dogs, followed by deliberate poisoning.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

CONSERVATION

Threats

Poisoning

Reference 6:

Finley, D.J., G.C. White, and J.P. Fitzgerald. 2005. Estimation of swift fox population size and occupancy rates in eastern Colorado. *Journal of Wildlife Management* 69:861-873.

Summary of new information:

Two-hundred forty-one swift fox (*Vulpes velox*) were captured at 51 of 72 total (71%) trapping locations spread across eastern Colorado in 1995. Mean capture probability was estimated at 0.234 (SE = 0.022). Capture and detection probabilities were estimated to be at their highest between September and March. The relatively high capture success in this study was likely due to the deliberate positioning of trapping sites in areas dominated by shortgrass prairie (as indicated on statewide vegetation maps), suggesting the importance of that cover type to swift fox. This paper provides specific advice and guidelines for the amount of trapping effort needed to detect swift fox presence, and estimate population size and trends, by live-trapping.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology
Habitat

CONSERVATION

Management of the Swift Fox in Region 2

Implications and potential conservation elements

Tools and practices

Reference 7:

Gese, E.M., S.M. Karki, M.L. Klavetter, E.R. Schauster, and A.M. Kitchen. 2004. Serologic survey for canine infectious diseases among sympatric swift foxes (*Vulpes velox*) and coyotes (*Canis latrans*) in southeastern Colorado. *Journal of Wildlife Diseases* 40:741-748.

Summary of new information:

Between January 1997 and January 2001 89 swift fox (*Vulpes velox*) and 122 coyotes (*Canis latrans*) were captured in Las Animas County, Colorado. Blood samples revealed that populations of both species had been exposed to canine parvovirus, canine distemper virus, and sylvatic plague (*Yersinia pestis*). Coyotes, but not swift fox, also showed exposure to canine adenovirus (types 1 and 2) and *Francisella tularensis*. Disease exposure appeared higher for coyotes in most cases. It is suggested that coyotes may impact swift fox via disease transmission as well as competition and direct predation.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Community Ecology

CONSERVATION

Threats

Reference 8:

Grenier, M. and H. Whitlaw (editors). 2005. Swift fox conservation team 2003 annual report. Wyoming Game and Fish Department, Nongame Program. Lander, Wyoming, USA.

Summary of new information:

This document summarizes the 2003 activities, findings, and decisions of the Swift Fox Conservation Team, which was established in 1994 by affected state agencies following the release of the petition to list the swift fox (*Vulpes velox*) as Threatened under the U.S. Endangered Species Act in 1992. It is one of a series of annual documents; any update to the Technical Conservation Assessment for swift fox should rely heavily on the latest document in this series (see reference 28), but also review all previous such documents to

ensure a comprehensive review of relevant findings. These annual reports cover a rather broad range of swift fox ecology and management issues, summarized below as section titles taken directly from the 2003 report:

- Protocol for swift fox specimen submission for long-term storage of genetic and other materials
- Captive swift fox populations: an update on their future within the American Zoo and Aquarium Assoc.
- Analysis of swift fox funding and expenditures
- Swift fox investigations in Kansas 2003
- Swift fox investigations in Oklahoma 2003
- Monitoring population status of swift fox in Montana
- Nebraska swift fox report 2003
- 2003 New Mexico swift fox completion report
- Detection of swift fox (*Vulpes velox*) in furbearer surveys in Fall River County, South Dakota
- 2003 annual report: status of swift fox in Texas
- Swift fox in Wyoming completion report 2003
- Status of swift fox on National Park Service Lands
- Summary of swift fox information for the National Grasslands 2003
- Swift fox track survey methods and analysis - guidelines for implementation
- Swift fox reintroductions on the Blackfeet Indian Reservation, Montana: determining success
- Turner Endangered Species Fund summary of swift fox activities on the Bad River Ranches, South Dakota, 2003
- Swift fox conservation team annual meeting (summary)

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

This document is relevant to many sections in the TCA

Reference 9:

Harrison, R.L., P.G.S. Clarke, C.M. Clarke. 2004. Indexing swift fox populations in New Mexico using scats. *American Midland Naturalist* 151:42-49.

Summary of new information:

Swift fox (*Vulpes velox*) scats were found on 79 of 99 (79.8%) road transects located in the shortgrass prairie of eastern New Mexico. This paper provides specific advice and guidelines for the amount of sampling effort needed to detect swift fox presence, and estimate population size and trends, via scat surveys. Road-based scat surveys show promise as an effective and efficient swift fox monitoring technique.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

CONSERVATION

Management of the Swift Fox in Region 2

Implications and potential conservation elements

Tools and practices

Reference 10:

Kamler, J.F., W.B. Ballard, E.M. Gese, R.L. Harrison, and S.M. Karki. 2004. Dispersal characteristics of swift foxes. *Canadian Journal of Zoology* 82:1837-1842.

Summary of new information:

From 1997 to 2001 the movements of 109 adult and 114 juvenile swift fox (*Vulpes velox*) were monitored by radio telemetry in Colorado, New Mexico, and Texas. More male than female juveniles dispersed, and dispersal of juveniles of both sexes peaked in September–October and January–February. Adults dispersed less frequently than juveniles, although adult males were a more important dispersal cohort than previously assumed. It is speculated that adult male dispersal reduces inbreeding (e.g., fatherXdaughter breeding). More male than female adults dispersed, and adults tended to disperse evenly throughout the year with adult males often dispersing after the death of their mate. Only 40% of dispersing juveniles settled into new territories; 60% died. In contrast, 89% of dispersing adults settled into new territories, and only 11% died. Similar percentages (50%) of non-dispersing and dispersing juvenile females reproduced as yearlings, raising questions over the benefits of dispersal for this cohort. Predation by coyotes (*Canis latrans*) was by far the largest source of mortality for radio-collared swift fox in this study. This reference is probably best considered in the context of references 11, 12, and 15.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Activity patterns and movements

Breeding biology

Demography (including matrix modeling)

Community ecology

Reference 11:

Kamler, J.F., W.B. Ballard, E.M. Gese, R.L. Harrison, S. Karki, and K. Mote. 2004. Adult male emigration and a female-based social organization in swift foxes, *Vulpes velox*. *Animal Behaviour* 67:699-702.

Summary of new information:

Information from 3 separate studies in Colorado, New Mexico, and Texas was combined to elucidate the social structure of the swift fox (*Vulpes velox*). More males than females dispersed following the death of their mates. In the 2 cases where an adult female of a breeding pair died, the males abandoned their litters; all pups in the litters died. In the 4 cases where an adult male of a breeding pair died, the females remained with their litters; all pups in the litters survived to at least 6 months of age. A synthesis of all information suggests that swift fox in this region have a female-based social organization, the first such organization reported for any canid species. It is speculated that a high degree of insectivory allows adult females to successfully rear litters without much male assistance (in the form of territorial defense or, especially, provisioning the den with vertebrate prey

captured elsewhere). This reference is probably best considered in the context of references 10, 12, and 15.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Activity patterns and movements

Breeding biology

Demography (including matrix modeling)

Reference 12:

Kamler, J.F., W.B. Ballard, P.R. Lemons, and K. Mote. 2004. Variation in mating system and group structure in two populations of swift foxes, *Vulpes velox*. *Animal Behaviour* 68:83-88.

Summary of new information:

The mating systems and group structures of 2 populations of swift fox (*Vulpes velox*) - one high density, and one low density - were studied and compared in northwestern Texas. The populations were separated by only 40 km, and were positioned in areas of apparently similar vegetation and prey availability. Polygynous groups, communal denning, and nonbreeding females occurred in the area of high density; only monogamous pairs occurred in the area of low density. Further, adult annual survival was 66% in the high density population and 44% in the low density population, with predation by coyotes (*Canis latrans*) as the main source of mortality. Such predation was significantly higher on the low density site. Swift foxes appear to be rather flexible in mating system and group structure. This reference is probably best considered in the context of references 10, 11, and 15.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Activity patterns and movements

Breeding biology

Demography (including matrix modeling)

Community ecology

Reference 13:

Kintigh, K.M. and M.C. Andersen. 2005. A den-centered analysis of swift fox (*Vulpes velox*) habitat characteristics in northeastern New Mexico. *American Midland Naturalist* 154:229-239.

Summary of new information:

Several habitat measurements were compared between 21 swift fox (*Vulpes velox*) dens in northeastern New Mexico and randomly-located points in the same area. Den sites had higher values for road density within 1 km, road density within 2 km, and an elevation index (percent of points within 500m with elevations less than the target point); and lower values for distance to prairie dog (*Cynomys* spp.) towns, residential density within 1 km, and residential density within 2 km. Further, dens were associated with heavier-textured (i.e., finer-grained) soils more than would be expected if they were placed randomly with respect to soil texture. These results can clearly inform management by allowing mapping of suitable and unsuitable swift fox habitat across rather large areas.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Habitat

CONSERVATION

Threats (relevant to several subheadings)

Management of swift fox in Region 2 (relevant to almost all subheadings)

Reference 14:

Kitchen A.M. 2004. Social and spatial ecology of the swift fox (*Vulpes velox*) in southeastern Colorado. Ph.D. dissertation, Utah State University, Logan.

Summary of new information:

This reference was not directly reviewed given the difficulty of its acquisition. However, references 7, 15, and 16 are publications produced by this dissertation, and are assumed to summarize its major findings. A complete update of the Technical Conservation Assessment should involve acquisition and review of this dissertation to ensure all relevant findings are incorporated.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

As outlined in references 7, 15, and 16:

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Community Ecology

Activity patterns and movements

Breeding biology

Demography (including matrix modeling)

CONSERVATION

Threats

Reference 15:

Kitchen, A.M., E.M. Gese, S.M. Karki, and E.R. Schauste. 2005. Spatial ecology of swift fox social groups: from group formation to mate loss. *Journal of Mammalogy* 86:547-554.

Summary of new information:

One-hundred eighty-eight swift fox (*Vulpes velox*) were studied in Las Animas County, Colorado, with special attention to social group formation, movement, denning, home-range use, and response to the death of mates. Foxes remained closer to their mates during the breeding season, and during daylight hours, than at other times. Mated foxes shared dens more frequently early in the breeding season, and less frequently later in that season. Females concentrated their movements in the core of the home range, whereas males concentrated their movements along range boundaries. All females maintained their territory in the event of mate death, but 50% of males emigrated from their range upon mate death. It is hypothesized that swift fox reliance on small and evenly-distributed prey (e.g., small mammals and large insects) reduces the need for strong pair bonding and proximity, even during the breeding season. This reference is probably best considered in the context of references 10, 11, and 12.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

- Activity patterns and movements

- Breeding biology

- Demography (including matrix modeling)

Reference 16:

Kitchen, A.M., E.M. Gese, L.P. Waits, S.M. Karki, and E.R. Schauster. 2005. Genetic and spatial structure within a swift fox population. *Journal of Animal Ecology* 74:1173-1181.

Summary of new information:

One-hundred eighty-eight swift fox (*Vulpes velox*) were studied in Las Animas County, Colorado, with special attention to spatial positioning and genetic relatedness (using DNA microsatellite measurements). Closely related foxes clustered together; i.e., neighbours were significantly more related than non-neighbours. Female kin clusters were more extensive than those of males, which is consistent with previous observation noting that although most swift fox engage in short-range dispersals, males tend to disperse farther than females. The more closely related neighbours were, the more home-range overlap they tolerated (greatest observed home range overlap was 55%); neighbours also occasionally engaged in concurrent den sharing. Finally, relatedness influenced the likelihood that an individual would inherit a newly vacated home range - range inheritors were more related to previous range owners than to other foxes. Kin

clustering, sociality, and short-range dispersal are hypothesized to have greater selective advantage to swift fox than strict territoriality, neighbour-neighbour aggression, and long-range dispersal.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Activity patterns and movements

Breeding biology

Demography (including matrix modeling)

Reference 17:

Lomolino, M.V. and G.A. Smith. 2004. Terrestrial vertebrate communities at black-tailed prairie dog (*Cynomys ludovicianus*) towns. *Biological Conservation* 115:89-100.

Summary of new information:

Species richness and composition of non-volant mammals, reptiles, and amphibians were measured at 36 black-tailed prairie dog (*Cynomys ludovicianus*) towns and 36 paired sites in Oklahoma from 1997-1999. While species richness was not necessarily higher in towns, significantly more rare and imperiled species, including swift fox (*Vulpes velox*), occurred in towns relative to paired, non-town sites. Results support the general contentions that prairie dogs are keystone species/ ecosystem engineers in grassland landscapes, and that swift fox are positively associated with prairie dog towns. These findings conflict with those of reference 24. The influence of prairie dogs and prairie dog towns on swift fox needs to be addressed in any update to the Technical Conservation Assessment; however, it appears that the issue has not clearly resolved at this point.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Habitat

Community ecology

CONSERVATION

Threats

Poisoning

Management of swift fox in Region 2 (relevant to almost all subheadings)

Reference 18:

Macdonald, D.W. and C. Sillero-Zubiri (editors). 2004. *The biology and conservation of wild canids*. Oxford University Press, New York, New York, USA.

Summary of new information:

As indicated by its title this reference is directly relevant to many aspects of swift fox (*Vulpes velox*) ecology, management, and conservation. Several chapters pertain to canids in general, with many direct references to swift fox. These chapters provide very good context for almost all swift fox issues, and include:

- Ch. 2 - Ancestry
- Ch. 3 - Population genetics
- Ch. 4 - Society
- Ch. 5 - Management
- Ch. 6 - Infectious disease
- Ch. 7 - Tools

Chapter 10 (“Swift and kit foxes”) summarizes current knowledge of almost all aspects of swift fox ecology and management, and presents it in comparison to similar knowledge for kit fox (*V. macrotis*). Chapter 11 (“Conservation”) synthesizes the information presented in all preceding general and species-specific chapters into a discussion of canid conservation. Updates to the Technical Conservation Assessment should be solidly grounded to this reference, as it will likely serve as the state-of-the-science for canid ecology, management, and conservation for quite some time.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

This document is relevant to several sections in the TCA

Reference 19:

McGee, B.K. 2005. Swift fox ecology in northwest Texas. Ph.D. dissertation, Texas Tech University, Lubbock, Texas.

Summary of new information:

This reference was not directly reviewed given the difficulty of its acquisition. Reference 20 is one publication produced by this dissertation; it is assumed that more are in preparation. A complete update of the Technical Conservation Assessment should involve acquisition and review of this dissertation to ensure all relevant findings are incorporated. A dissertation abstract was obtained and reviewed as follows: from 2002 - 2004 94 swift fox (*Vulpes velox*) were captured and tracked on 2 study sites in northwest Texas. Attempts to quantify fecundity were complicated by inadequate observation techniques (see reference 20). Swift fox dens were distinguished rather well by dirt tailings, and it is suggested that aerial surveys can not only identify dens but also assess active vs. abandoned dens by tailings appearance. Swift foxes carried prairie dog fleas, and are likely capable of transmitting sylvatic plague (*Yersinia pestis*) to uninfected areas without developing clinical illness. In areas with high coyote (*Canis latrans*) abundance, artificial escape dens increased swift fox survival and abundance. In areas with few coyotes, artificial escape dens had little effect.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Community Ecology

CONSERVATION

Threats

Management of the Swift Fox in Region 2

Implications and potential conservation elements

Tools and practices

Reference 20:

McGee, B.K., M.J. Butler, M.C. Wallace, W.B. Ballard, and K.L. Nicholson. 2005. From the field: a comparison of survey techniques for swift fox pups. *Wildlife Society Bulletin* 33:1169-1173.

Summary of new information:

This small-scale study compared 4 techniques for monitoring swift fox (*Vulpes velox*) fecundity at dens: (1) direct visual observation of den entrances; (2) observation of den entrances with night-vision technology; (3) closed-circuit cameras on den probes; and (4) automated video monitoring of den entrances. Specifications and devices for each technique are outlined in detail. Direct den observation and observation with night-vision technology failed to document any swift foxes, either adult or juvenile, at dens known to be occupied. The den-probing camera produced some observations of swift fox pups, but counts were incomplete; it is suggested that den spatial complexity limited the penetration depth of the probe system. Additionally, the probe system cost \$12,000 U.S. Automated video monitoring of den entrances appeared to be the most successful technique, producing the most observations of both adults and pups. The cost of the automated system was \$1,600 U.S.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

CONSERVATION

Management of the Swift Fox in Region 2

Implications and potential conservation elements

Tools and practices

Reference 21:

Schneider, R., M. Humpert, K. Stoner, and G. Steinauer. 2005. The Nebraska natural legacy project: a comprehensive wildlife conservation strategy. Nebraska Game and Parks Commission. Lincoln, Nebraska, USA.

Summary of new information:

This document is the Comprehensive Wildlife Conservation Strategy for the state of Nebraska, and has as its major goals (1) reversing the decline of at-risk species (and avoiding the need for state or federal listing as threatened or endangered), (2) recovering currently listed species and allowing for their de-listing, and (3) keeping now-common species common in the future. Swift fox (*Vulpes velox*) are identified as a “Tier 1 At-Risk” species for Nebraska, and as such are described in this plan as to their distribution, status, habitat use, threats, and likely responses to particular management actions. Suitable habitat is generally described as short- or mixed-grass prairie in the western 1/3 of the state. This reference provides a long list of habitat management recommendations for swift fox, and is probably best considered in the context of references 4, 25, 29, and 30.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

- Existing Regulatory Mechanisms, Mgmt Plans, and Conservation Strategies
- Biology and Ecology
 - Distribution and abundance
 - Population trend
 - Habitat

CONSERVATION

- Threats
- Conservation Status of the Swift Fox in Region 2
- Management of the Swift Fox in Region 2

Reference 22:

Pence, D.B., J.F. Kamler, and W.B. Ballard. 2004 Ectoparasites of the Swift Fox in northwestern Texas. *Journal of Wildlife Diseases* 40:534-547.

Summary of new information:

Three species of flea (*Pulex irritans*, *Dactylopsylla percernis*, *Euhoplopsyllus affinis*) and one species of tick (*Ixodes sculptus*) were found on swift fox (*Vulpes velox*) in the Texas panhandle. *Pulex irritans* was the only abundant ectoparasite; otherwise, this swift fox population had a depauperate ectoparasite fauna. This study primarily informs the biogeography and taxonomy of ectoparasites, and only secondarily informs swift fox biology and management.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

- Biology and Ecology
 - Community ecology

Reference 23:

Sargeant, G.A., M. A. Sovada, C.C. Slivinski, D.H. Johnson. 2005. Markov chain Monte Carlo estimation of species distributions: a case study of the swift fox in western Kansas. *Journal of Wildlife Management* 69:483–497.

Summary of new information:

A systematic survey performed 1997-1999 detected swift fox (*Vulpes velox*) in 173 of 359 (48%) Townships in western Kansas. Detection rate averaged 0.69 (95% Bayesian confidence interval = 0.60 - 0.77). This data was modeled using Markov chain Monte Carlo (MCMC) image restoration to produce a swift fox distribution map for the region. Such distribution modeling does not require habitat information, but does require presence/ absence data from systematic surveys (which, if performed for several years in a row, can also yield population trend estimates). The final distribution map suggests that swift fox occupy more of western Kansas than previously assumed by USDI Fish and Wildlife Service and the Kansas Department of Fish, Wildlife, and Parks. It approaches, but is not quite as extensive as, the distribution of swift fox in western Kansas predicted by reference 2. The map produced here is also coarser in resolution than the one produced by reference 2.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

- Biology and Ecology

- Distribution and abundance

CONSERVATION

- Management of the Swift Fox in Region 2

- Tools and practices

Reference 24:

Shaughnessy, M.J. Jr., and R.L. Cifelli. 2004. Influence of black-tailed prairie dog towns (*Cynomys ludovicianus*) on carnivore distributions in the Oklahoma panhandle. *Western North American Naturalist* 64:184-192.

Summary of new information:

Carnivore occurrence was documented at black-tailed prairie dog (*Cynomys ludovicianus*) towns and non-prairie dog town paired sites in the Oklahoma Panhandle from 1995 - 1997. Canids showed no significant preference for prairie dog towns or paired sites, although there was a slight indication that coyotes (*Canis latrans*) preferred prairie dog towns and swift fox (*Vulpes velox*) avoided them. It is suggested that any avoidance of prairie dog towns by swift fox may actually be an avoidance of coyotes. The presumption that prairie dogs are "keystone species" for many grassland vertebrates (especially threatened, endangered, or generally rare species) may not be as clear as previously thought. These findings conflict with those of reference 17. The influence of prairie dogs and prairie dog towns on swift fox needs to be addressed in any update to the

Technical Conservation Assessment; however; it appears that the issue has not clearly resolved at this point.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Habitat

Community ecology

CONSERVATION

Threats

Poisoning

Management of swift fox in Region 2 (relevant to almost all subheadings)

Reference 25:

South Dakota Department of Game Fish and Parks. 2005. South Dakota comprehensive wildlife conservation plan. South Dakota Department of Game Fish and Parks. Pierre, South Dakota, USA.

Summary of new information:

This document is the Comprehensive Wildlife Conservation Strategy for the state of South Dakota, and serves as (1) a strategic vision and plan of action for statewide wildlife conservation and funding, (2) a declaration of wildlife conservation goals and how to achieve them, (3) a guide for prioritization of resources and activities to prevent the future decline of species and ecosystems, (4) a framework for monitoring and research to improve the information available on species and ecosystems, (5) a means for guiding, influencing and achieving coordination in public and private decision-making, and (6) a means for collaboration among diverse interests that helps achieve the goals of maintaining or enhancing South Dakota's ecosystems and wildlife resources. Swift fox (*Vulpes velox*) are identified as one of South Dakota's species of greatest conservation need, and as such are described in this plan as to their distribution, status, habitat use, threats, and likely responses to particular management actions. Swift fox are mapped as occurring in 2 disjunct areas of South Dakota, one in the state's southwestern quarter and the other in the center of the state. This is a much more restricted distribution than estimated by reference 2. Suitable habitat is generally described as short- or mixed-grass prairie on gently rolling topography, usually with abundant prairie dog or other ground squirrel colonies. This reference provides a long list of habitat and non-habitat management recommendations for swift fox, and is probably best considered in the context of references 4, 21, 29, and 30.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Existing Regulatory Mechanisms, Mgmt Plans, and Conservation Strategies

Biology and Ecology
 Distribution and abundance
 Population trend
 Habitat

CONSERVATION

Threats
 Conservation Status of the Swift Fox in Region 2
 Management of the Swift Fox in Region 2

Reference 26:

Sovada, M.A. and L. Carbyn (editors). 2003. The swift fox: ecology and conservation of swift foxes in a changing world. Canadian Plains Research Center. Regina, Saskatchewan, Canada

Summary of new information:

Technically, this is not a new reference; several chapters are cited in the Technical Conservation Assessment, indicating that the original authors had at least some access to the reference. However, the chapters are cited as *in press*, indicating that the reference had not yet been published in final form and raising the possibility that the original authors did not have access to the entire volume. The reference appears to be so relevant to any swift fox (*Vulpes velox*) assessment that it is listed here to ensure that assessment updates re-evaluate it in its published form and incorporate all appropriate information.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

This document is relevant to several sections in the TCA

Reference 27:

Sovada, M.A., G. Schroeder, B.C. Kenner, and J. Jenks. 2005. Experimental reintroduction of swift foxes in Badlands National Park. USDI Geological Survey Project Report. Northern Prairie Wildlife Research Center. Jamestown, North Dakota, USA.

Summary of new information:

This paper outlines a recent reintroduction of swift fox (*Vulpes velox*) to Badlands National Park (BNP), which was thought to be unoccupied by the species prior to the project but is within its historic range. Suitability of habitat for swift fox (including areas of high and low use by coyotes [*Canis latrans*]) in BNP was assessed and mapped prior to swift fox release in an attempt to increase the program's success. Eighty-eight swift fox (41 male, 47 female) were selected from a total of 162 swift fox captured in eastern Colorado, and released into BNP between 2003-2005. Annual survival rates for first-release animals (2003 releases) was 39%. Annual survival of first- and second-release (2003 + 2004 releases) animals combined was 51%. Four mated pairs produced 3 litters in 2004; 13 mated pairs produced 13 litters in 2005. Evaluation, monitoring, and research projects are ongoing. Although most information collected to-date suggests that

the reintroduction has been successful, the authors caution against declaring overall success at this stage. Note that this reference is included as a section in reference 8.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Biology and Ecology

Distribution and abundance

CONSERVATION

Management of the Swift Fox in Region 2

Tools and practices

Reference 28:

Stuart, J.N. and S. Wilson (editors). 2006. Swift Fox Conservation Team: Annual Report for 2004. New Mexico Department of Game and Fish, Santa Fe, New Mexico. Nebraska Game and Parks Commission, Lincoln, Nebraska.

Summary of new information:

This document summarizes the 2004 activities, findings, and decisions of the Swift Fox Conservation Team, which was established in 1994 by affected state agencies following the release of the petition to list the swift fox (*Vulpes velox*) as Threatened under the U.S. Endangered Species Act in 1992. It is one of a series of annual documents; any update to the Technical Conservation Assessment for swift fox should rely heavily on the latest document in this series, but also review all previous such documents to ensure a comprehensive review of relevant findings (see reference 8). These annual reports cover a rather broad range of swift fox ecology and management issues, summarized below as section titles taken directly from the 2004 report:

- Monitoring swift fox populations in eastern Colorado
- Swift fox investigations in Kansas, 2004
- Swift fox monitoring activities in Montana
- Nebraska swift fox report, 2004
- Swift fox research in New Mexico: 2004 update
- North Dakota swift fox annual report, 2004
- Swift fox investigations in Oklahoma, 2004
- South Dakota swift fox report, 2004
- Texas swift fox report 2004
- Wyoming swift fox completion report (15 April 2004 – 14 April 2005)
- Report of APHIS Wildlife Services nontarget take of swift fox and kit fox
- Swift fox in National Park Service units
- Summary of swift fox information for the National Grasslands, 2004
- Pawnee National Grassland swift fox survey for 2004
- 2004 swift fox survey: Fall River Ranger District, Buffalo Gap Nat'l Grassland, Nebraska Nat'l Forest
- Ensuring restoration of swift fox on the Ft. Peck Indian Reservation and in northeastern Montana
- Swift fox reintroduction on the Blackfeet Indian Reservation, Montana: determining success
- Update on Kainai (Blood Tribe) Reintroduction Programme
- Swift fox reintroduction feasibility study – Lower Brule Sioux Tribe

- The influence of habitat fragmentation on swift fox (*Vulpes velox*) distribution, habitat utilization and genetic diversity in Texas
- Importance of artificial escape cover for increasing swift fox populations in northwest Texas
- Swift fox (*Vulpes velox*) occurrences in black-tailed prairie dog (*Cynomys ludovicianus*) towns in the northwestern panhandle of Texas
- Minutes from the 2005 Annual Meeting, Swift Fox Conservation Team

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

This document is relevant to several sections in the TCA

Reference 29:

Wasson, T., L. Yasui, K. Brunson, S. Amend, and V. Ebert. 2005. A future for Kansas wildlife: Kansas' comprehensive wildlife conservation strategy. Dynamic Solutions Inc. in cooperation with Kansas Department of Wildlife and Parks. Topeka, Kansas, USA.

Summary of new information:

This document is the Comprehensive Wildlife Conservation Strategy for the state of Kansas, and serves as a strategic plan that identifies broad priorities of species habitats, management and conservation issues, and, by inference, management and conservation strategies. Swift fox (*Vulpes velox*) are identified as a “Tier 2” priority species in Kansas, and as such are described in this plan as to their distribution, status, habitat use, threats, and likely responses to particular management actions. Suitable habitat is generally described as short- or mixed-grass prairie on gently rolling topography, usually with abundant prairie dog or other ground squirrel colonies. This reference provides a long list of habitat and non-habitat management recommendations for swift fox, and is probably best considered in the context of references 4, 21, 25, and 30.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

- Existing Regulatory Mechanisms, Mgmt Plans, and Conservation Strategies
- Biology and Ecology
 - Distribution and abundance
 - Population trend
 - Habitat

CONSERVATION

- Threats
- Conservation Status of the Swift Fox in Region 2
- Management of the Swift Fox in Region 2

Reference 30:

Wyoming Game and Fish Department. 2005. A comprehensive wildlife conservation strategy for Wyoming. Wyoming Game and Fish Department. Cheyenne, Wyoming, USA.

Summary of new information:

This document is the Comprehensive Wildlife Conservation Strategy for the state of Wyoming. Its intent is to serve as a central “hub” for all existing and future management plans and conservation strategies in Wyoming, and to guide the combined efforts of government agencies at all levels, non-profits, academia, non-governmental organizations, tribes, and individuals to conserve all Wyoming wildlife. Swift fox (*Vulpes velox*) are identified as one of Wyoming’s species of greatest conservation need, and as such are described in this plan as to their distribution, status, habitat use, threats, and likely responses to particular management actions. The grasslands of eastern Wyoming (i.e., swift fox range) are described as being the least intact, and hence in most need of conservation attention, of all ecological systems in the state. Swift fox are mapped as occurring in the eastern ca. 40% of the state; this is somewhat more restricted than the distribution estimated by reference 2. Suitable habitat is generally described as short- or mixed-grass prairie on gently rolling topography, usually with abundant prairie dog or other ground squirrel colonies. This reference provides a long list of habitat and non-habitat management recommendations for swift fox, and is probably best considered in the context of references 4, 21, 25, 29, and 31.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

- Existing Regulatory Mechanisms, Mgmt Plans, and Conservation Strategies
- Biology and Ecology
 - Distribution and abundance
 - Population trend
 - Habitat

CONSERVATION

- Threats
- Conservation Status of the Swift Fox in Region 2
- Management of the Swift Fox in Region 2

Reference 31:

Wyoming Game and Fish Department. 2006. Draft: a plan for bird and mammal species of greatest conservation need in eastern Wyoming grasslands. Wyoming Game and Fish Department. Cheyenne, Wyoming, USA.

Summary of new information:

This draft plan recognizes that grasslands are the most imperiled natural system in North America, and although Wyoming grasslands are in good condition relative to those in other states they also represent the least intact natural systems in Wyoming. Its goal is to

formalize strategies that will help the Wyoming Game and Fish Department (WGFD) work cooperatively with landowners, other agencies and the public to conserve healthy grassland ecosystems in Wyoming, and enable the WGFD to address the conservation needs of Wyoming's grasslands and associated wildlife in a proactive manner. Swift fox (*Vulpes velox*) are recognized as a Wyoming grassland species-of-concern, and are described as to their distribution, status, habitat use, threats, and likely responses to particular management actions. However, most of this information appears very similar to that presented by reference 30. This reference may be best considered as an "extension" of reference 30.

Relevant sections in the Technical Conservation Assessment (following the original table of contents):

MANAGEMENT STATUS AND NATURAL HISTORY

Existing Regulatory Mechanisms, Mgmt Plans, and Conservation Strategies

Biology and Ecology

Distribution and abundance

Population trend

Habitat

CONSERVATION

Threats

Conservation Status of the Swift Fox in Region 2

Management of the Swift Fox in Region 2

Reference 32:

Personal communications with individual biologists and land managers in Region 2 regarding swift fox ecology, management, and conservation.

Summary of new information:

Most personal communications generated responses of "I know of no significant new information regarding swift fox". Such responses are not tallied or summarized below. Similarly, some personal communications generated references to published documents, and although these personal communications are not listed below, any relevant documents identified through them are tallied and summarized above.

Doug Keinath (Lead Zoologist, Wyoming Natural Diversity Database - University of Wyoming; dkeinath@uwyo.edu; 307 766-3023). The Wyoming Natural Diversity Database is currently working with the Wyoming Game and Fish Department to compile a complete set of all known swift fox sightings in the state. Preliminary indications are that there has been no substantial range expansion or contraction in the state relative to previous distribution maps for this species. This dataset will be available upon request.

John Sovell (Zoology Team Leader, Colorado Natural Heritage Program - Colorado State University; jsovell@lamar.colostate.edu; 970 492-6052). In fall 2005 the Colorado Natural Heritage program updated its database with recent swift fox sightings in the state.

Although the new records do not substantially expand the known distribution of the species in the state, they do “fill in” some gaps within the range boundaries. This dataset is available upon request.

Sam Wilson (Nongame Mammal Program Manager, Nebraska Game and Parks Commission; sam.wilson@ngpc.ne.gov; 402 471-5174). A 2003 swift fox survey by the Nebraska Game and Parks Commission (NGPC) documented swift fox in one township in Sioux County, Nebraska, that had no previous records. NGPC is working with Donni Schwalm, a Ph.D. student at Texas Tech University, in determining the genetic relationships of swift fox in various parts of their range. The work has just begun, and it may be several years before it is complete. Also, Hugh Genoways (former Mammalogist, University of Nebraska, Lincoln, Nebraska; 402-472-2012) may be a good contact for anyone seeking recent information on swift fox.

Matt Peek (Kansas Department of Wildlife and Parks; mattp@wp.state.ks.us). The Swift Fox Conservation Team (SFCT) website (http://southdakotafieldoffice.fws.gov/swift_fox_main.htm) is a good site to monitor for recent information and contacts relevant to swift fox. Also, the SFCT is currently rewriting the Conservation Assessment and Conservation Strategy for Swift Fox in the U.S., a document that will be clearly relevant to any update of the Technical Conservation Assessment. Marsha Sovada at the Northern Prairie Wildlife Research Center is compiling a complete distribution map for swift fox throughout its range; her contact information can be found on the SFCT website.