

Current distribution of the swift fox (*Vulpes velox*) in Texas

by

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A Thesis

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Many graduate students experience the uncanny sensation that their life is not their own. Their thoughts are dominated with data analysis, project design, looming deadlines, glitches in the field schedule, supply acquisition/fabrication, and how they will possibly fix the Dodge's brakes, check traps, finalize a grant proposal, prepare a presentation and contact landowners simultaneously. Their activities no longer include personal interests; rather, their schedules are warped to include coursework, fieldwork, budgeting, grant writing, report preparation, data analysis, meetings, email. Only the very early and very late hours remain for pursuits generally considered *enjoyable*. Self medication via coffee and libations ensues. Mood swings veering from snappishness to sarcasm to relief to manic hilarity are experienced. Inanimate objects are sequentially damned then praised (the computer is an example, as are software programs and field vehicles). Are these students crazy? I submit that they are...married-to their project and those involved. What other relationship induces such dramatic emotional ups and downs, requires so much personal sacrifice, involves such complicated scheduling, is supposed to instill a sense of security but at times leaves you feeling inept and unloved? Here, if I had known I was about to be sold off for the figurative two goats and a bag of potatoes (two foxes and a bag of dead rabbits?), are the vows I would have given.

Dearly beloved, we are gathered today to celebrate the relationship between this graduate student, Doni Schwalm, and her beloved, the Acknowledged. Together they have pledged to work towards that blessed goal, the graduate degree. Doni has chosen to write her vows to reflect the unique and multifaceted nature of this relationship.

I, Doni Schwalm, pledge the following: To my longsuffering parents and sister, who have to explain to friends, family, and small town busybodies why their 30 year old daughter/sister is still in school and studying to become a ‘liberal hippie tree hugger’ at that, I pledge the infrequent phone call and even more infrequent visit home as well as my unwavering gratitude and awareness as to the true source of my strength and spirit. To those agencies which provide funding (NFWF, TPWD, the CH Foundation, Houston Zoo, the Houston Safari Club), I will make small but frequent funding requests via proposals submitted by the deadline, and will do my best to keep ORS off our collective backs. To my committee members, I will not hassle you with too many questions, meetings or poorly written manuscripts, and I will attempt to either win you over or send you into a sugary (and hopefully pliable) stupor by providing diverse, tasty treats when we do meet. With special regard to Warren Ballard and Heather Whitlaw, however, I must admit you will deal with me more frequently and in unexpected ways, such as the incessant borrowing of your steam cleaner, frequent crashing of holiday functions, and the inclusion of unflattering photos in my thesis defense. To my bright and budding field technicians (Amanda Bryant, Rachel Crowhurst, Andrew McDonnell, Erin Posthumus, Leslie Rucker, and Bill Stotts), I will initiate you mercilessly into the wonderful world of carnivore research which you are so convinced is your calling. Under my watchful eye, you will learn to discern between salvageable and unsalvageable roadkill (The hard way. Maggots included.) and master the ever so sensitive art of skunk whispering. Basically, I will destroy your sense of smell and gag reflex, but these are overrated. You will also experience my manic obsession with cleanliness and vehicle care, which will drive you a little crazy, but you will gain a stellar reference and true friend from the ordeal. To the

landowners who participated with this research (esp. Fred Pronger, the Poole family and one family who wished to not be named but fed me Mexican food often), I will not trap when its rainy and rut up your pastures, nor will I leave your gates open and release the fiendish herds of yearling Angus which insist on playing with my traps. Your willingness to allow a stranger onto your private property with the express purpose of searching for a potentially endangered species is much appreciated. And finally, to my cohorts, the graduate students. Where to begin?? I will serve as your social coordinator, choosing to organize Friday happy hour (or Tuesday happy hour for that matter) over more pressing tasks (example: this thesis). I will unfailingly chronicle our nights of debauchery with my digital camera. I will tolerate your many jibes at my age-and get you back by forcing you into slave labor-esque deck building situations at my home. I will do my best to teach you how to two step and Western swing (Ryan, Tony, Mike and Adam). I will laugh uproariously at your myriad tales (Dave, Richard and Caleb). And I will miss you all intensely as you each graduate and move on to the next step in your life. Kasi, Kate, and Nicole, I bestow upon you the special honor of having “Wild Thing” as your ring tone on my phone and the promise to always have a listening ear and a frozen cocktail ready. Lastly, Kara-I have known you the longest of any of my scientist friends and you have been my constant sounding board all these years; we started our careers together back in Wisconsin and now here we are, graduating and getting all...*grownup*. Thanks for being there. Always. When’s the next trip to Idaho???

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ABSTRACT

Distribution and abundance data suggest that the swift fox (*Vulpes velox*) has experienced range wide declines in distribution and density. Swift fox are associated with short grass and mixed grass systems in the Great Plains region. In Texas, these habitats have undergone extensive alteration, primarily as a result of agricultural development. Historic records indicated swift fox occurred in 79 counties in Texas. The current distribution of swift fox in the state is unknown, but surveys conducted in 1996 and 1997 indicated the species' range was considerably reduced. We used scat surveys and live trapping to assess the current distribution of the species. We established 93 scat survey transects, representing 550 survey kilometers, in 35 counties encompassing the majority of remnant mixed grass and short grass habitat in Texas. Transects were surveyed once per year between 07 July and 31 November in 2005 and 2006. Laboratory DNA analysis was conducted on scats to determine the identity of the depositing species. We collected 166 scats for both years combined. Of these, 9 were identified as swift fox scats. All swift fox scats originated from 1 of the 35 counties surveyed.

Surveying the entire 35 county area using live traps was logistically unfeasible. We selected counties which we believed had the highest likelihood of having resident swift fox based on proximity to known swift fox populations and total remnant grassland. We surveyed 7 counties during the 2005 and 2006 field seasons. Grassland fragments in each county were randomly selected and surveyed for 2 consecutive nights once per year. We captured 39 individual swift fox during both years

combined. We detected swift fox in 2 of the 35 counties surveyed. Our results indicated that the current swift fox distribution in Texas is significantly reduced from the historic species distribution.

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CHAPTER I

INTRODUCTION

Historically, the distribution of the swift fox (*Vulpes velox*) spanned the Great Plains from southern Canada to eastern New Mexico and northwestern Texas in close association with short grass and mixed grass prairies of the region (Egoscue 1979). Declines in the distribution and density of the species led to its temporary candidacy for threatened status under the Endangered Species Act from 1992 to 2001 (Allardyce and Sovada, 2003). Although it is not currently a candidate for federal protection, its status remains a point of contention (Forest Guardians et al., 2004, unpublished notice of intent to sue under the Endangered Species Act, Forest Guardians, Santa Fe, New Mexico) and the species receives considerable management effort in some parts of its range (e.g., Knowles et al., 2003; Kunkel et al., 2003; Zimmerman et al., 2003; Ausband, 2005). The swift fox is listed as endangered in Nebraska, threatened in South Dakota and a species of special concern in Colorado and Wyoming. It is listed as a furbearer with a closed season in Oklahoma, a furbearer with a restricted season in Kansas and New Mexico, and as a furbearer with an open season in Texas.

The estimated historic distribution of swift fox in Texas included approximately 79 counties (Fig. 1.1, J. K. Jones, Jr, et al. 1987, unpubl. report, Texas Tech University, Lubbock, Texas). K. Mote et al. (1998, unpubl. report, Texas Parks and Wildlife Department, Austin, Texas) conducted a survey for swift fox in Texas in 1997 and 1998 using a combination of track plates, live trapping, and spot light surveys. Surveys focused on counties in the Texas panhandle region which retained a relatively high

percentage of native grassland acreage. K. Mote et al. (1998, in litt.) indicated that swift fox were present in only 2 of the 35 counties they surveyed. These were Dallam and Sherman counties, which are located in the far northwest corner of the Texas panhandle (Fig. 1.1). The species has repatriated areas of its range outside of Texas via translocation efforts and natural dispersal (Smeeton and Weagel, 2000; Knowles et al., 2003, Zimmerman et al., 2003; K. Kunkel et al., 2004, unpubl. report, Turner Endangered Species Fund, Bozeman, Montana; Ausband, 2005). Work conducted by researchers at Texas Tech University has documented a continued but declining swift fox presence in Dallam and Sherman counties (Nicholson et al., 2006). The status of the Texas swift fox population has not been systematically assessed since the surveys of K. Mote et al. (1998, in litt.). Our goal was to determine the current distribution of swift fox in Texas. This is a necessary step for managers to develop and undertake appropriate activities for swift fox conservation, both at the state and regional levels. This may be especially imperative in the light of potential litigation to relist the species under the Endangered Species Act (Forest Guardians et al., 2004, in litt.).

Methods

Study Area

Surveys were conducted in 35 Texas counties encompassing the majority of extant short and mixed grass prairie (Fig. 1.2). The study area abuts the current swift fox distribution in New Mexico (Harrison et al., 2004) and Oklahoma (Schaughnessy, 2003). The landscape consisted of a matrix of native grassland fragments of varying sizes and connectivity levels interspersed in a matrix of agricultural development, Conservation

Reserve Program (CRP) lands, and a limited urban interface. Native grassland acreage was highest in the northern and western counties and decreased rapidly with the increase of agricultural development south of the Canadian river (United States Department of Agriculture, 2007).

Scat Surveys

We used the modified scat transect method described by Harrison et al. (2002) for two reasons. First, Harrison et al. (2002) reported 100% detection rates when testing the method in a known swift fox population. Second, the method is time and cost efficient. The method consisted of a 16 km transect which we surveyed at specific locations frequently characterized by patches of bare ground (e.g., road and fence intersections, cattle guards, gates). Transect locations were established to maximize contact with native grassland habitat while minimizing contact with unsuitable landcover types (e.g., cropland, CRP, urban development). We established 93 transects which accounted for 550 km of survey distance (Fig. 1.3). Not all transects were the full 16 km recommended by Harrison et al. (2002) because some grassland areas did not have sufficient access to develop a full length transect. Each transect was surveyed once per year between July and November in 2005 and again in July 2006. Survey order was reversed between years.

Observers may introduce a bias in detection probability via misidentification of scats in the field. In particular, overlap in size has been observed amongst the scats of various canid species (Green and Flinders, 1981; Danner and Dodd, 1982). To decrease observer bias, we collected all observed scats with a diameter ≤ 20 mm. Scats were

placed in individual paper bags and labeled with a unique identification code. In 2005, scats were frozen from the day of collection for as long as 6 months, then dried at 61.7 °C for one week. In 2006, scats were dried at 61.7 °C for one week beginning the day of collection. Scats were stored at room temperature in a dry location between drying and laboratory analysis.

Laboratory analyses were conducted by Wildlife Genetics International (Nelson, British Columbia, Canada). DNA was extracted from scat samples using QIAGEN'S QIAamp Mini Stool Kit (QIAGEN Inc.- USA, Valencia, California) as per the manufacturer's instructions. A test to identify the depositing species was then conducted using a sequence based analysis of the 16S rRNA mitochondrial genome (i.e., Johnson and O'Brien, 1997). A dedicated room for handling and storing amplified DNA was used during analysis to control for contamination. Contamination was routinely monitored by including negative controls, and positive controls with every analysis.

Live Trapping

Live trapping is an effective means of surveying readily captured species such as swift fox (Finley et al., 2005); however, it is expensive and time consuming (Harrison et al., 2002; Schauster et al., 2002). We were unable to survey all 35 counties due to logistic and financial constraints. Instead, we selected counties based on proximity to known swift fox populations and total amount of available grassland. We think these characteristics were predictors of swift fox presence. We identified native grassland fragments in the chosen counties using Landsat 7 Thematic Mapper imagery. We ranked each fragment via a computer generated random number, and the first 50 fragments were

selected as potential survey sites. In some instances, we were unable to gain access to a given fragment. In these instances, the inaccessible fragment was replaced by the next highest ranked fragment. We surveyed a total of 36 fragments from the original pool of 50 fragments. Because of changes in landowner participation, not all fragments were surveyed both years. Each fragment was surveyed for 2 consecutive nights using live traps (Tomahawk Live Trap, Tomahawk, Wisconsin) set along fence lines, trails and secondary roads. Traps were spaced 0.4 to 0.8 km apart. Traps were baited with a piece of black-tailed prairie dog (*Cynomys ludovicianus*), black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audubonii*), mule deer (*Odocoileus hemionus*) or pronghorn (*Antilocapra americana*). Canned mackerel and O’Gorman Powder River Scene Lure (Minnesota Trapline Produces, Pennock, Minnesota) were used individually or in concert as a long distance scent lure. We opened traps 1 to 2 hours prior to sunset, checked them at sunrise the following morning, and then closed them until the following evening. Traps which were robbed of bait, closed without a capture, or which captured nontarget species were excluded from our estimate of total trap nights. Captured swift fox were removed from the trap and hand restrained. Processing time was typically < 20 minutes and involved insertion of a microchip for individual identification and collection of morphometric data and 4 mm tissue sample from the ear for related research. We released swift fox at their capture site after processing. We released nontarget captures without handling. Our protocol was approved by the Animal Care and Use Committee (Protocol No. 05019-04) at Texas Tech University.

We estimated relative abundance using the catch-per-unit-effort method described by Schauster et al. (2002). We compared relative abundance estimates between years and counties using Fisher's exact test in SPSS (SPSS Inc, Chicago, Illinois).

Results

Scat Surveys

We collected 102 scats in 2005 and 64 scats in 2006. At least one scat was collected in 22 of the 35 (62.9%) counties surveyed in 2005 and in 20 of the 35 (57.1%) counties surveyed in 2006. In 2005, 2 of 102 (1.9%) scats collected were identified as swift fox scats (Table 1.1). In 2006, 6 of 64 scats (9.4%) were identified as swift fox scats. We detected swift fox in one of 35 (2.9%) counties surveyed using scat transects (Fig. 1.4, Dallam county).

Live Trapping

We conducted live trapping in 6 counties in 2005 (i.e., Dallam, Deaf Smith, Hartley, Parmer, Roberts, and Sherman Counties). We resurveyed Dallam, Deaf Smith, Parmer, and Sherman counties, ceased surveys in Roberts and Hartley counties, and added Moore county in 2006. Thus, 5 counties were surveyed in 2006. We completed 991 and 1557 trap nights in 2005 and 2006, respectively. We excluded an additional 221 and 154 trap nights from the per-year trap night totals because of non-target capture, bait theft, or other malfunction. We captured 12 nontarget species, including 8 mammal species, 2 bird species and 2 reptile species (Table 1.3). We captured 18 (10 male, 8 female) individual swift fox in 2005 and 21 (12 male, 9 female) individual swift fox in 2006. Two foxes were captured but escaped prior to processing in 2006. These foxes

were not included in the capture totals, but were included in abundance estimates. Of the 39 individual foxes captured, 37 were adults and 2 were juveniles. We detected swift fox in 2 of 7 counties surveyed using live trapping (Fig 1.5, Dallam and Sherman counties).

Relative abundance estimates for Dallam ($P = 0.56$) or Sherman ($P = 1.0$) county were not significantly different between years (Table 1.4). Relative abundance estimates for 2005 ($P = 0.78$) and 2006 ($P = 0.19$) did not differ significantly between counties. We did not detect a significant difference in the estimated relative abundance of swift fox in Dallam and Sherman for both years combined ($P = 0.23$).

Discussion

Our results documented swift fox presence in only 2 of the 35 (5.7%) counties surveyed. It is clear that the current distribution of swift fox in Texas is significantly reduced from the historic distribution. Likewise, the low number of individuals captured indicates low population densities in areas where swift fox remain. We think the area surveyed encompasses the region most likely to support swift fox in Texas. We think it is unlikely the species exists in Texas outside of our survey area. The low population densities observed combined with the restricted species distribution reported place the species at risk of local extirpation. This possibility is further supported by the lack of increase in the species' distribution in Texas during the past 10 years (i.e., K. Mote, 1998, in litt.) and a reported extirpation from a study site within the current distribution in Texas (Nicholson et al., 2006).

It is unclear exactly what factor or combination of factors is contributing to the limited distribution and density of swift fox in Texas. Two potential causes include

coyote (*Canis latrans*) related mortality and habitat loss (Egoscue, 1979; Scott-Brown et al., 1987; Knowles et al., 2003). In our study area McGee et al. (2006) reported a coyote related swift fox mortality rate of 70%. This rate is within the reported range for coyote related swift fox mortalities (63 to 85%, Covell, 1992; Anderson et al., 2003). However, Kamler et al. (2003b) reported different coyote related swift fox mortality rates when the same study area was split into two separate regions, one with a high coyote density and one with a low coyote density. More swift fox were killed by coyotes in the high coyote density area (89% of recorded deaths) than in the low coyote density area (27% of recorded deaths). These two rates are outside the previously cited range for coyote related swift fox mortalities. Coyote related swift fox mortalities in the region with a low coyote density were considerably lower than the reported range. Conversely, the mortality rate in the region with high coyote densities was higher but similar to the upper limit of the range.

Grassland systems in the Great Plains region have undergone rapid and extensive alteration through urbanization, infrastructure development, alteration of historic grazing and fire regimes, and conversion for agricultural purposes (Samson and Knopf, 1994; Allardyce and Sovada, 2003). Estimates indicate that less than 30% of the mixed grass prairie remains, and of that, most exists in fragments (Samson and Knopf, 1994). Sovada et al. (1998) and Matlack et al. (2000) detected swift fox using both rangeland and cropland habitats in Kansas, thus agricultural development does not automatically result in the exclusion of swift fox. However, Kamler et al. (2003a) found that swift fox avoided croplands within our study site. It is unclear why swift fox do not use croplands

equally between Kansas and Texas study areas. Variation in crop types, agricultural practices, and total cropland acreage between the two locations are all possible causes, but these factors require quantification before any conclusions can be made.

Regardless of the cause, the status of the swift fox in Texas warrants increased research and management efforts if extirpation is to be avoided. Several tools are available which could be employed to increase swift fox survival and density within the species' current distribution. Kamler et al. (2003b) reported increased survival, density and juvenile recruitment in a swift fox population after coyotes were removed. McGee et al. (2006) found that the creation of artificial escape cover increased survival and relative abundance, as well as increased the species' distribution within our study area. The technique described by McGee et al. (2006) is cost effective with a limited time investment, thus it may provide managers with a tool for increasing swift fox distribution and density in Texas at limited cost. Finally, translocation has proven to be an effective means of increasing the species' distribution in many areas (Smeeton and Weigel, 2000; Knowles et al., 2003; Zimmerman et al., 2003; Ausband, 2005). Using a combination of these methods to manage the current swift fox population in Texas may be necessary to increase the population's robustness and likelihood of long-term viability.

We surveyed several areas of grassland in Texas which historically supported swift fox and appeared suitable but found no evidence of presence. We have no data to explain their absence. The majority occurred south of Dallam and Sherman Counties in Deaf Smith, Oldham and Randall Counties. The Canadian River separates this area from the current swift fox distribution in Texas and may pose an impenetrable dispersal

barrier, especially in light of the inhospitable habitat that surrounds the river on both sides. It is also possible that these areas are uninhabited by swift fox because of currently unquantified factors such as coyote densities, prey availability, habitat connectivity, habitat quality, and agricultural development. These areas may be suitable for swift fox translocation efforts. However, a suitability assessment including prey surveys, predator surveys, habitat availability, habitat quality and habitat connectivity is necessary before this activity can be undertaken.

TABLE 1.1--Species identified via DNA analysis of scats collected in Texas during 2005 and 2006.

Number of scats per species detected													
	<i>Vulpes</i>	<i>Vulpes</i>	<i>Urocyon</i>	<i>Canis</i>	<i>Canis</i>	<i>Taxidea</i>	<i>Mephitis</i>	<i>Procyon</i>	<i>Sus</i>	<i>Lynx</i>	<i>Felis</i>		
Year	<i>velox</i>	<i>vulpes</i>	<i>cinereoargenteus</i>	<i>latrans</i>	<i>sp.</i>	<i>taxus</i>	<i>mephitis</i>	<i>lotor</i>	<i>scrofa</i>	<i>rufus</i>	<i>catus</i>	Unknown	Total
2005	3	0	0	41	1	4	3	1	1	1	0	47	102
2006	6	2	1	31	0	6	0	0	0	3	2	13	64

TABLE 1.2--Total trap nights and individual swift fox captured per county surveyed using live traps in Texas during 2005 and 2006.

2005			2006		
County	Number of trap nights	Number of swift fox captured	County	Number of trap nights	Number of swift fox captured
Dallam	519	13	Dallam	705	13
Sherman	168	5	Sherman	322	8
Deaf Smith	38	0	Deaf Smith	283	0
Parmer	20	0	Parmer	67	0
Hartley	95	0	Moore	181	0
Roberts	151	0	-	-	-
TOTAL	991	18	TOTAL	1,557	21

TABLE 1.3--Nontarget species captured during 2005 and 2006 live trapping surveys for swift fox in Texas.

Species	Total captures
Mammals	
<i>Mephitis mephitis</i>	68
<i>Sylvilagus audubonii</i>	15
<i>Neotoma sp.</i>	6
<i>Felis catus</i>	5
<i>Procyon lotor</i>	2
<i>Taxidea taxus</i>	2
<i>Canis familiaris</i>	1
<i>Diadelphus virginiana</i>	1
Birds	
<i>Athene cunicularia</i>	1
<i>Sturnella neglecta</i>	1
Reptiles	
<i>Terrapene ornata</i>	3
<i>Crotalus atrox</i>	1

TABLE 1.4--Swift fox relative abundance estimates (number of swift fox per 100 trap nights) for currently inhabited counties in Texas based on live trapping results in 2005 and 2006.

County	2005	2006	Both Years Combined
Dallam	2.5 (1.3, 4.2)	2.0 (1.1, 3.3)	2.2 (1.5, 3.2)
Sherman	3.0 (1.0, 6.8)	3.4 (1.7, 6.0)	3.3 (1.9, 5.2)
Both Counties	2.6 (1.6, 4.1)	2.4 (1.6, 3.6)	2.5 (1.8, 3.4)

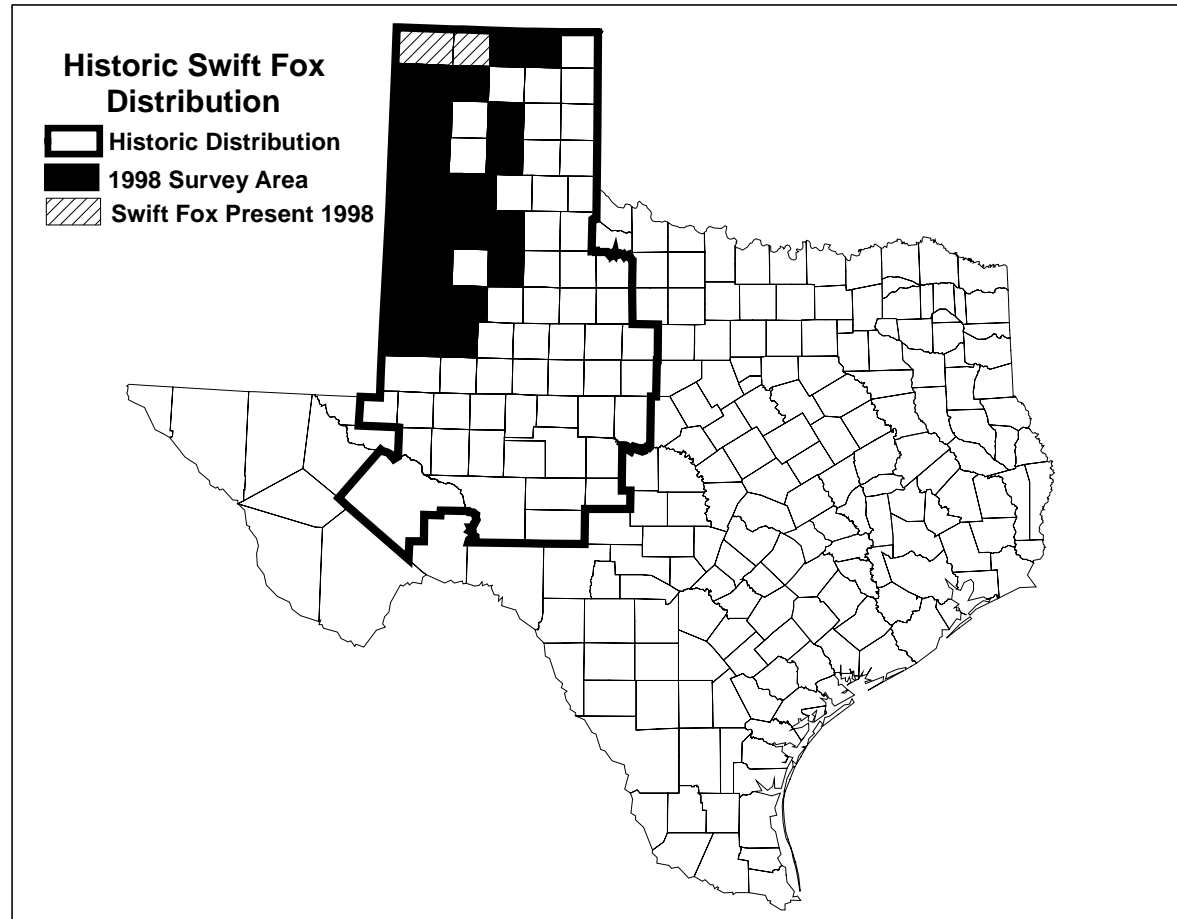


FIG. 1.1--Estimated historic distribution of swift fox in Texas. The most recent distribution estimate for swift fox in Texas is also shown (from Mote et al. 1998).

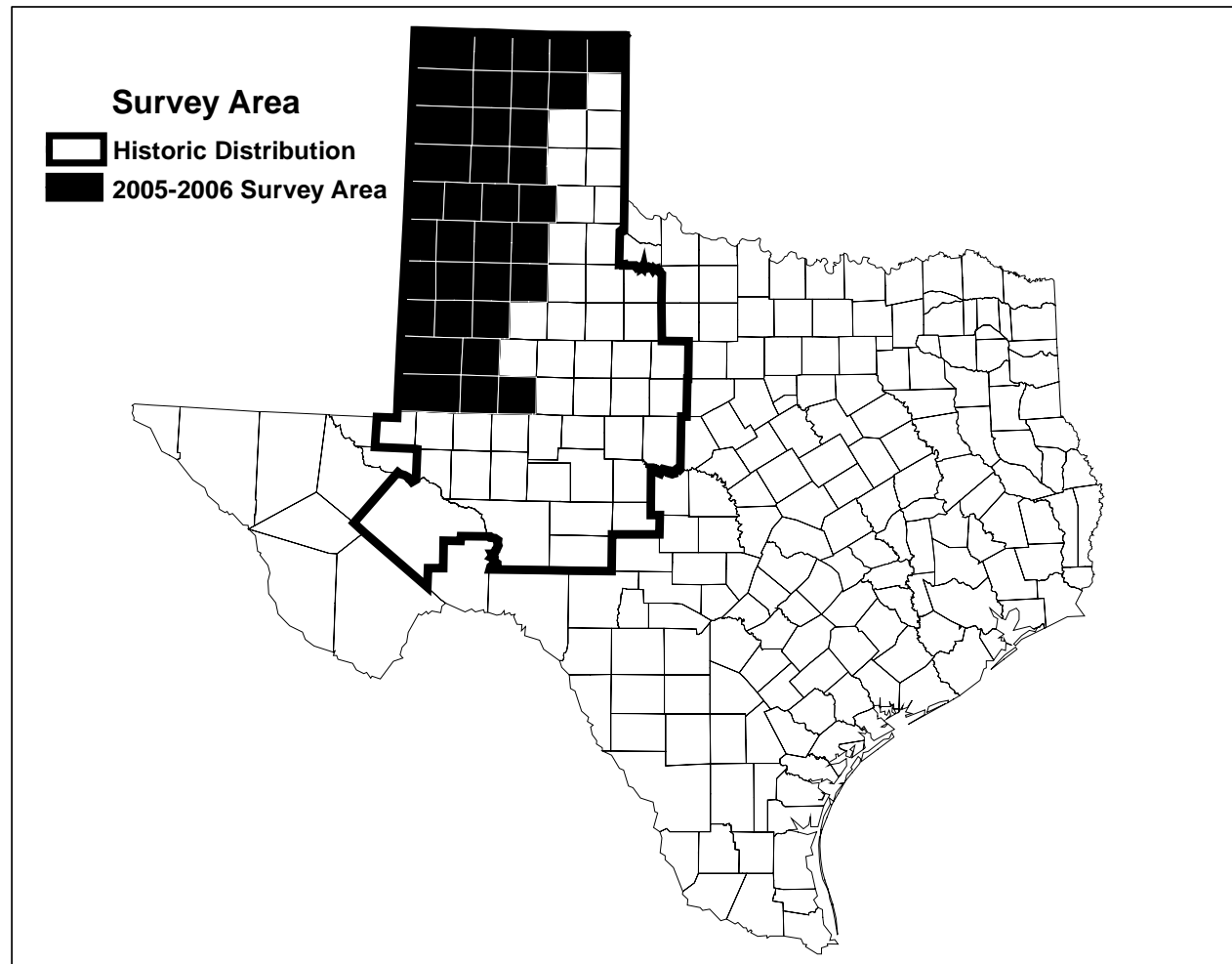


FIG. 1.2--Area surveyed for swift fox in Texas during 2005 and 2006 using scat transects and live trapping surveys.

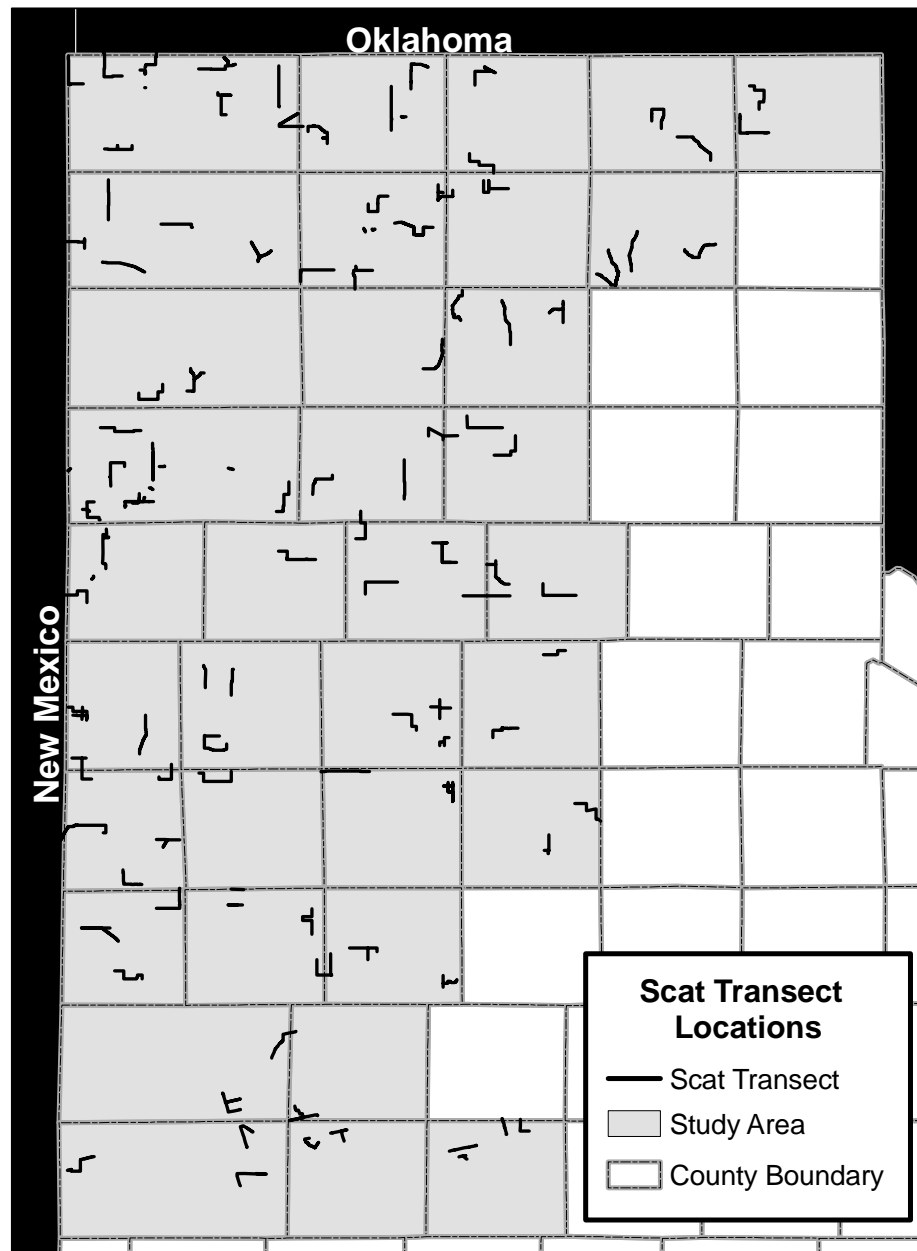


FIG. 1.3--Location of scat transects in Texas counties surveyed for swift fox during 2005 and 2006.

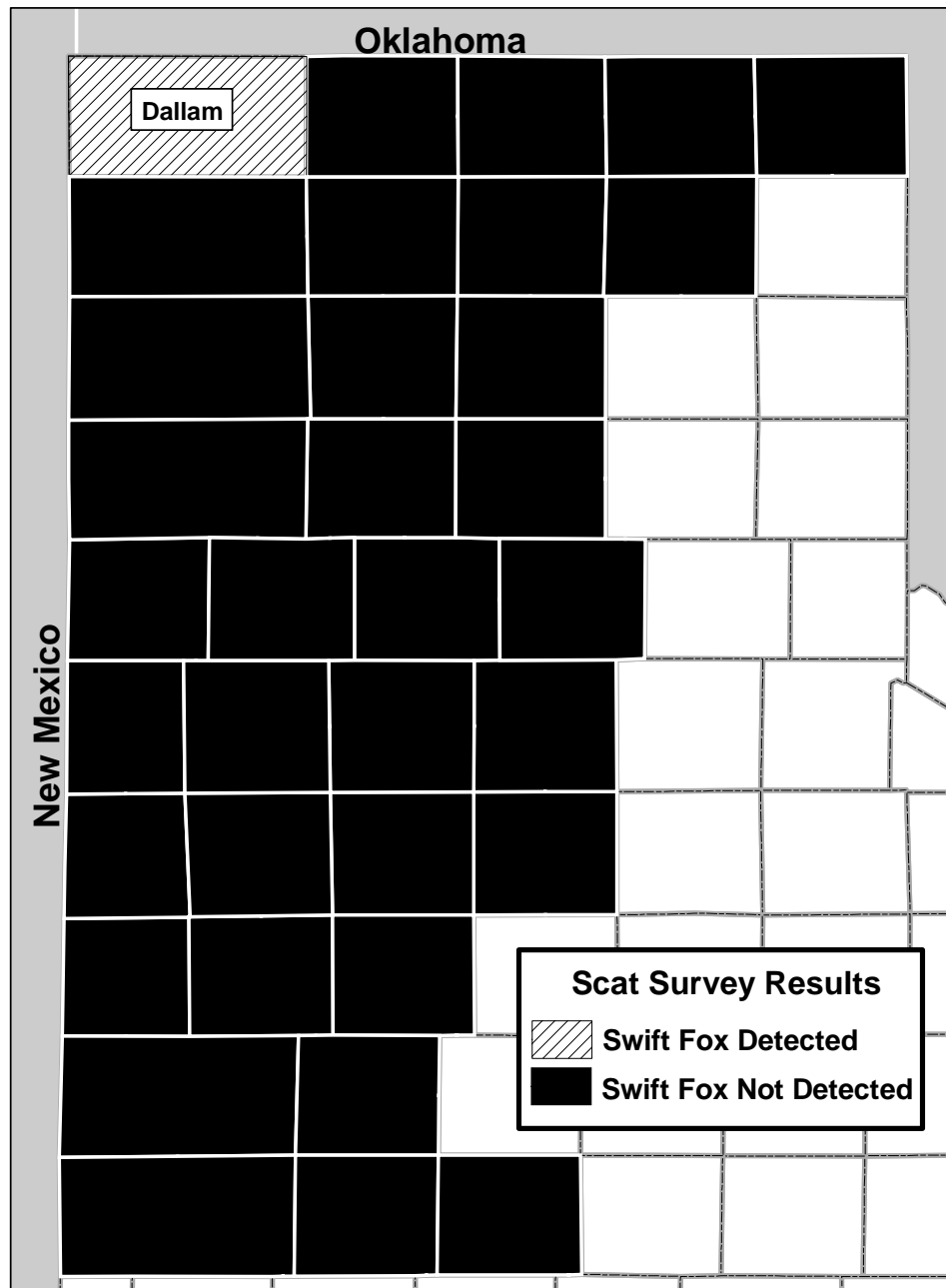


FIG. 1.4--Results of scat surveys for swift fox conducted in Texas during 2005 and 2006.

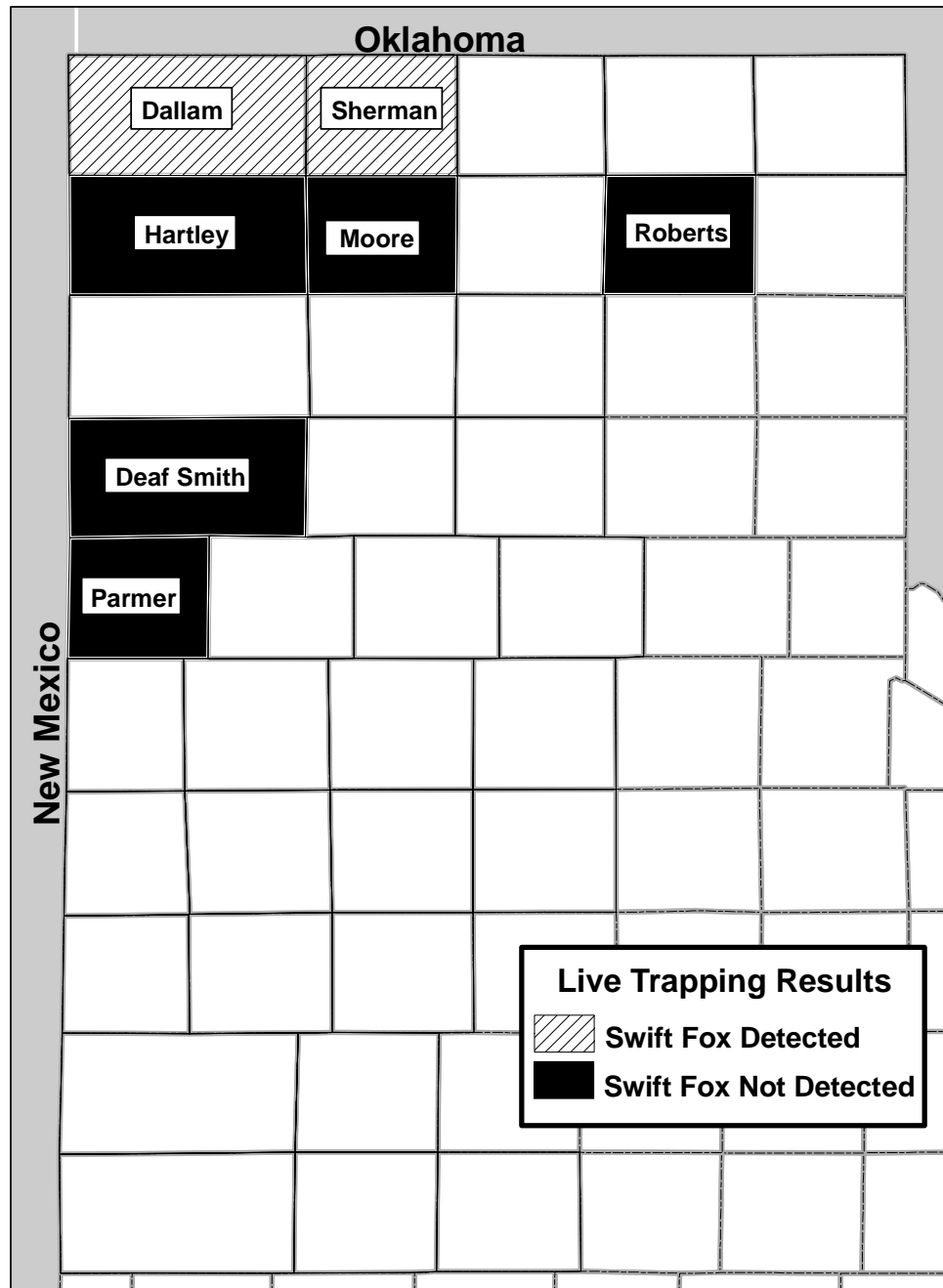


FIG. 1.5--Results of live trapping surveys for swift fox conducted in Texas during 2005 and 2006.

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APPENDIX A

LIST OF COUNTIES INCLUDED IN THE SURVEY AREA

Andrews	Randall
Armstrong	Roberts
Bailey	Sherman
Briscoe	Swisher
Carson	Terry
Castro	Yoakum
Cochran	
Crosby	
Dallam	
Dawson	
Deaf Smith	
Floyd	
Gaines	
Hale	
Hansford	
Hartley	
Hockley	
Howard	
Hutchinson	
Lamb	
Lipscomb	
Lubbock	
Lynn	
Martin	
Moore	
Ochiltree	
Oldham	
Parmer	
Potter	

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