

# **USE OF REMOTE INFRARED CAMERA'S TO SURVEY FOR KIT FOX (*VULPES MACROTIS*) IN THE GRAND VALLEY, COLORADO**

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**March, 2014**

## Summary

Historic documentation of kit fox (*Vulpes macrotis*) in Colorado is minimal with records from 1960's in and around the Grand Valley, Mesa County and from McElmo Canyon, Montezuma County. After extensive live trapping efforts in the 1990's, researchers speculated that the Grand Valley population was not sustainable based on the lack of documented reproduction, low number of individuals captured and recaptured, lapse time between recaptures, and distance between captured foxes. More recent survey efforts incorporated several non-invasive techniques such as track plates and hair snares with the goal of simply detecting presence of kit fox, which they did not. The goal of this study was to utilize modern, state of the art remote infrared cameras to survey areas in the Grand Valley where kit foxes had previously been documented or where recent anecdotal observations had been made. Cameras identified 20 species from 443 photos (10,513 photos total). No kit foxes were photographed during this effort but interspecific competitors such as gray (*Urocyon cinereoargenteus*) and red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*) and domestic dogs (*Canis domesticus*) were prevalent. Presence of coyotes at over 80% of the sites we sampled, and red fox at 50%, suggests that interspecific competition may be suppressing existing kit fox populations or inhibiting their ability to recolonize after extirpation. The complete lack of detections using multiple techniques, continued urbanization, and documented presence of interspecific competitors suggest that kit fox may be extirpated from the Grand Valley. However, anecdotal observations from a wildlife officer and a trapper, along with documented kit fox in the Cisco Desert less than 20 miles west of the state line into Utah, suggest that a few widely spaced individuals could still exist. Techniques used in this study and others may not be able to detect extremely low populations if they do exist, making follow up investigations on all future anecdotal reports important to determining the final status of this species in the Grand Valley.

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## Introduction

The kit fox (*Vulpes macrotis*) is a small fox similar in appearance to the swift fox (*Vulpes velox*), but with larger ears, a more angular shape, and divided ranges (Armstrong 2011). Western Colorado is thought to represent part of the eastern fringe of the kit fox's range in North America with historic populations inhabiting portions of the Grand and Uncompahgre Valleys in Mesa, Rio Blanco, Delta, and Montrose Counties (Reed-Eckert 2009). A separate population within Colorado is considered possible further south in Montezuma County. Historic documentation of kit fox in Colorado is minimal with records from Colorado National Monument (Miller 1964), Rabbit Valley (Miller and McCoy 1965), and McElmo Canyon (Egoscue 1964). Boyle and Reeder (2005) suggested a historic range for kit fox upwards of 1.7 million hectares, based on suitable habitat and records of occurrence. The current range has likely declined considerably as this habitat was altered over the last century and new threats were introduced. Harvest reports from the Colorado Division of Wildlife reported kit fox in 9 years during the 1970's and 1980's (Fitzgerald 1984) but this data from that time could be erroneous given that species identification was not verified. An extensive survey effort by Fitzgerald (1996) trapped 46 kit foxes at 7 sites across the Grand and Uncompahgre Valleys between 1992 and 1995. This study speculated that the Grand Valley population was not sustainable based on the lack of documented reproduction, low number of individuals captured and recaptured, lapse time between recaptures, and distance between captured foxes.

Due to early findings in the Fitzgerald study (1996) the Colorado Wildlife Commission closed seasons on kit fox and implemented trapping restrictions in select areas in 1994. The kit fox was assigned the *species of special concern* status at that time with the population thought to have fallen below 100 individuals. In 1998 the status of the kit fox was changed to a state endangered species. Subsequent surveys by Beck (1999, 2000) and Seglund (2007) suggested that the population was continuing to decline. The Bureau of Land Management (BLM) in Colorado includes the kit fox on its list of sensitive species. Reasons for the decline include unregulated hunting and trapping, non-target carnivore poisoning, road/traffic collisions, and fragmentation, degradation, and loss of historic habitat through urbanization and land use practices (Boyle and Reeder 2005, Seglund 2007, Reed-Eckert 2010). Attempts to improve habitat for kit fox in the Grand Valley, by providing artificial dens, was undertaken by the BLM in 2005 but have not been successful in attracting foxes (Lambeth 2005). Meaney et al. (2006) suggested that interspecific competition with several other predatory species, including coyotes (*Canis latrans*) and red foxes (*Vulpes vulpes*), are likely influencing the current status of kit foxes in Colorado.

The objective of this study was to utilize a highly sensitive detection methodology that is non-invasive, such as remote infrared cameras, to determine if kit fox are still present in previously occupied areas of the Grand Valley (Fitzgerald 1996). Remote infrared cameras were used during efforts to monitor activity at previously identified kit fox den sites in hopes of documenting pups (Beck 1998). Seglund (2007) used cameras on a limited basis to verify

findings collected by track plates. Technological malfunctions inhibited the reliability of cameras used during this study and use of them at every survey site was cost prohibitive at that time. Given that kit fox are currently thought to be extremely rare or possibly extirpated in western Colorado, remote cameras were deemed a good tool for survey efforts as detection only requires a fox to pass by an open scent station rather than crawling into a trap, track plate, or hair snare station that might inhibit a shy individual. Stratman (2012) used cameras to evaluate the status of swift fox in eastern Colorado post recovery efforts and found the technique to be efficient while providing reliable estimates of swift fox occupancy. Starting in the fall of 2012 efforts to identify kit fox at previously occupied locations in the Grand Valley were conducted using remote infrared cameras. Additional locations based on anecdotal observations, from captures by a local trapper, sightings by a Colorado Parks and Wildlife District Wildlife Manager, a potential den site noted by the BLM, and a road kill in Colorado National Monument in 1998, were surveyed as well.

## Study Area

The study area encompassed the Grand Valley in west-central Colorado, bounded on the north and south by the Mesa County line, the Colorado-Utah state line to the west, and Grand Mesa to the east (Figure 1). Elevations at sites that were surveyed ranged from 1,409 m (4,650 ft) in Rabbit Valley to 1,892 m (6,244 ft) in Colorado National Monument with an average elevation of 1,433 m (4,700 ft) in the Grand Valley. Habitat consisted of semi-desert shrublands with rocky outcrops, often bordered by Pinyon pine (*Pinus edulis*) and one-seed juniper (*Juniper monosperma*) forest. Sagebrush (*Artemisia tridentata*), fourwing saltbush (*Atriplex canescens*), shadscale (*Atriplex confertifolia*), greasewood (*Sarcobatus vermiculatus*), and prickly-pear cactus (*Opuntia polyacantha*) are common plants composing this community. Several invasive plants including cheatgrass (*Bromus tectorum*), halogeton (*Halogeton glomeratus*) and Tamarisk (*Tamarix* spp) have become established throughout the Grand Valley over the last century. In general, the Grand Valley is composed of mesas with stony and loamy soils. The climate in the study area is characterized as high desert with an annual precipitation of just over 23.9 cm (9.4 in) and an average temperature of 12°C (53°F, 1981-2010 data, National Oceanic and Atmospheric Administration National Climatic Data Center 2014). Summer temperatures can reach highs of over 38°C (100 F) with winter lows falling below freezing.

## Methods

Initially, a total of 12 sites were selected based on locations where kit fox were previously documented using live traps in the Grand Valley on BLM lands, as noted by Fitzgerald (1986). Five additional locations were added based on credible reports of kit fox sightings or probable den sites made by CPW district wildlife managers, BLM biologists, a trapper, and a local rancher. A single camera was set up in Colorado National Monument near the location where a

kit fox was found dead on the road in 1998 (Table 1). A Global Positioning System (GPS) set to North American Datum 1983 Zone 12 was used to collect Universal Transverse Mercator (UTM) coordinates for each camera location. Surveys varied in duration by camera location but were run for a minimum of one month at each site.

Remote cameras (ReConyx HC600 HyperFire High Output Covert IR, Holmen, WI) were placed in a lockable security enclosure and typically mounted approximately 1 m (3.3 ft) off the ground on a t-post (Figure 2). A scent station baited with skunk lure was placed on a stick or rock approximately 3 m (10 ft) out in front of the camera. We typically checked cameras every 7 to 14 days at which time cards and batteries were swapped, and the scent lure refreshed. Towards the end of the survey a few sights were supplemented with canned mackerel as an additional bait to see if it would attract foxes to the site. Cameras were programmed to take photos on rapid fire when the infrared beam was broken at any time during a given 24 hour period. A time and date stamp, temperature, and moon phase were automatically appended to all photos. Photos were reviewed and the presence of any species, target or non-target, were noted. Occurrences of a species were tallied by day or, in other words, one count was added for every day a camera documented a given species at a given location as determination of different individuals was generally not considered possible.

## Results

Cameras were run for a total of 2,028 days (average 113, range 34 to 140) over the fall and winter of 2012 - 2013 (Table 1). A total of 10,513 photos were downloaded and reviewed from cameras with 20 species identified from 443 of those photos (Tables 1 and 2). Photos at two sites (1 and 12) were inordinately high due to initial incorrect camera settings and weather events, such as wind, rain, and snow, triggering the cameras motion sensors. Camera 14 had high numbers of photos as well but many of these were tied to repeated visits by two species, cottontails (*Sylvilagus spp*) and coyotes (*Canis latrans*), triggering the camera repeatedly over time (Tables 1 and 3).

No kit foxes were photographed during this effort but interspecific competitors such as gray (*Urocyon cinereoargenteus*) and red foxes (*Vulpes vulpes*), coyotes and domestic dogs (*Canis domesticus*) were documented (Table 2). Other predator species noted include badger (*Taxidea taxus*), and bobcat (*Lynx rufus*). Coyotes were the most broadly dispersed species in our study area, noted at 15 of the 18 camera locations (83%) followed by cottontails (12), and red fox (9, Table 2). Species richness varied by camera with two sites, # 8 (Rabbit Valley) and # 13 (Cheney Reservoir), accounting for a high of 10 species each (Table 3). On average, cameras identified 5 species per location (range 2 to 10).

## Discussion

Although no kit foxes were detected during these surveys we feel use of remote infrared cameras is a suitable tool for detecting their presence if they have not been extirpated from the Grand Valley of western Colorado already. Deployment and monitoring of these systems was easy and efficient making these noninvasive surveys feasible. Similar cameras were used to evaluate the status of swift fox in eastern Colorado post recovery and found to be efficient while providing reliable estimates of swift fox occupancy (Stratman 2012). In addition, photographs were captured for non-target species (443), including multiple canids and other predators, indicating that the lure was drawing curious animals in and cameras were capturing their visits (Tables 2 and 3). We were surprised by how well species identification could be discerned from the majority of photographs taken by these cameras. We focused our survey efforts near locations where Fitzgerald (1998) caught kit fox in live traps or where incidental observations such as sightings and more recently trapped animals had been reported in an attempt to maximize likelihood of detecting foxes. However, cameras could have been moved to new locations more regularly as was done by Stratman (2012) to maximize portions of the study area covered and should be considered if future surveys using this technique are pursued.

Documentation of the high number of species across all sites suggests that cameras were doing a good job of capturing visitors to the scent stations. Cameras proved highly sensitive to movement regardless of the size of animals with several small mammalian (rodent) and avian (songbird) species documented. In addition, the skunk lure enticed a wide range of species in to investigate the odor with notable surprises including cottontails, ground squirrels, and deer. Inordinately high numbers of photos were taken by three cameras but the numbers of photos actually containing wildlife are similar to other sites. The additional photos appear to be the result of motion sensors tripped by vegetation movement, likely due to wind, and from other weather events such as rain and snow.

In a technical conservation assessment of kit fox by Meaney et al. (2006), interspecific competition with several other predatory species, including coyotes (*Canis latrans*) and red foxes (*Vulpes vulpes*), was suggested as a likely stressor influencing the current status of kit foxes in Colorado. Presence of coyotes at over 80% of the sites we sampled, and red fox at 50%, suggests that interspecific competition may be suppressing existing kit fox populations or inhibiting their ability to recolonize after extirpation. All 18 sites where cameras were set documented at least one competitive species (coyote, domestic dog, gray fox, and red fox) and 9 cameras (50%) captured photos of at least two of these species (Table 3). Coyotes were the most widespread predator documented during the study with over twice as many occurrences by day and an equal amount of camera locations where they were documented as all three of the other competitive species combined (Table 2).

Interestingly, of the three cameras that documented gray foxes, only one had coyotes, which supports the suggestion by Armstrong (2011) that this native fox is somewhat sensitive to

changes in predator balances, as is the kit fox. Conversely, red fox overlapped with coyote at 7 sites and at 2 of the 4 sites that domestic dogs were documented at suggesting a higher degree of tolerance by this fox for other canid species. Such findings support the expansion of red fox range seen in many western states (Armstrong 2011).

Efforts to identify kit fox in western Colorado over the last decade have utilized several different non-invasive survey techniques but failed to yield a confirmed detection (Seglund 2007, and Reed-Eckert 2010, this study). The lack of detections, continued urbanization, and documented presence of interspecific competitors suggest that kit fox may already be extirpated from the Grand Valley. Fitzgerald (1998) speculated that the Grand Valley population was not sustainable over a decade ago based on the lack of documented reproduction, low number of individuals captured and recaptured, lapse time between recaptures, and distance between captured foxes. However, anecdotal observations from a CPW District Wildlife Manager, and a trapper, along with documented kit fox in the Cisco Desert less than 20 miles west of the state line into Utah, suggest that a few widely spaced individuals could still exist. Techniques used in this study and others may not be able to detect extremely low populations if they do exist, making follow up investigations on all future anecdotal reports important in determining the final status of this species in the Grand Valley.

## **Acknowledgements**

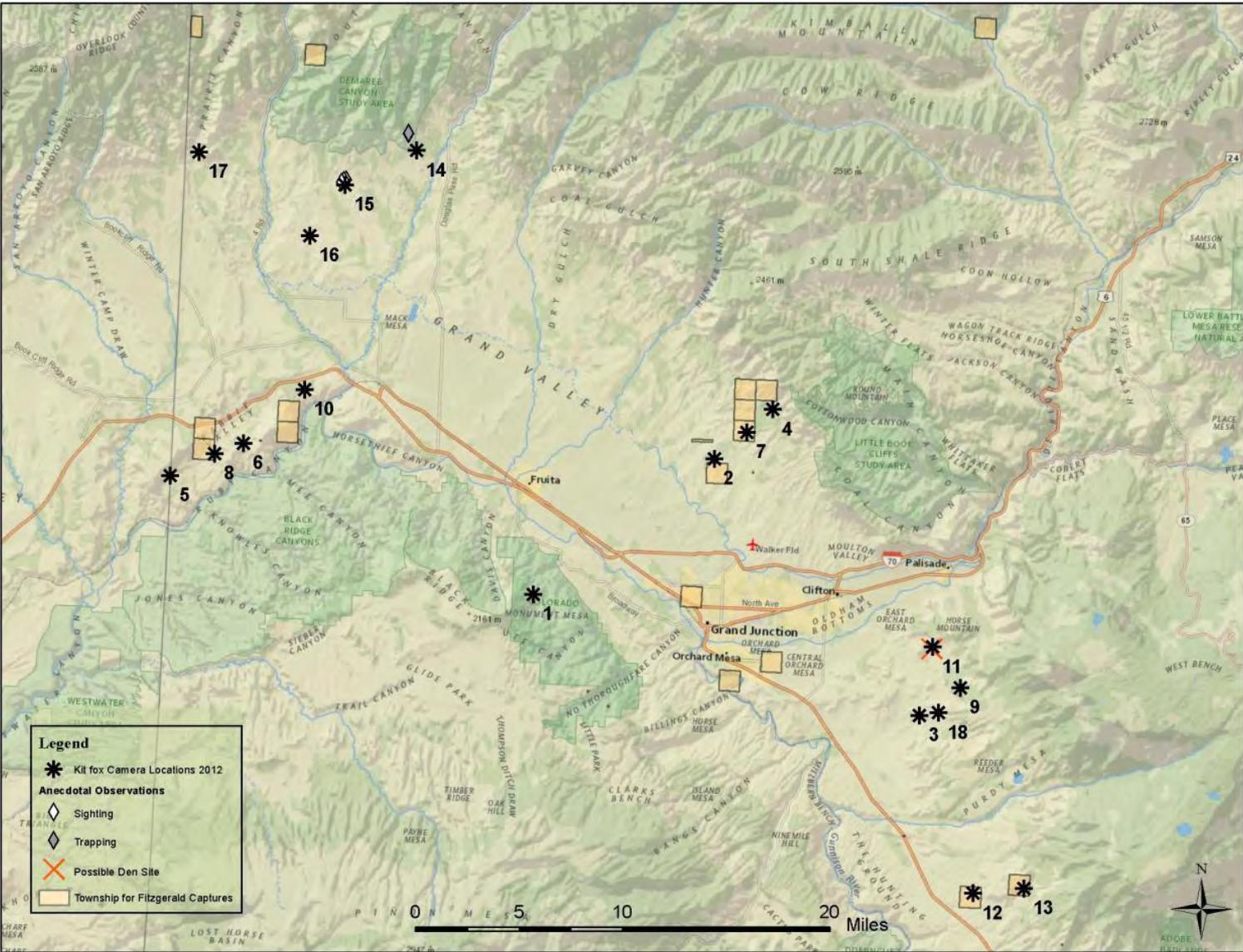
We are grateful to Brad Petch and Amy Seglund for their logistical and financial support of this survey effort. Marty Stratman shared his expertise with remote infrared camera setups and provided skunk lure. We thank Kellen Keisling and Abby Tobin for their dedicated assistance with collection of data in the field. We are grateful to all those who reported field sightings of foxes and potential den locations including Paul Creeden, Frank McGee, Heidi Plank, and John Toolen. Kim Hartwig provided assistance in gaining a permit to sample the location inside Colorado National Monument. Access to private land was generously granted by Don Lombardi to Colorado Parks and Wildlife while conducting the surveys along Whitewater Creek.

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# Figures

**Figure 1.** Study area for remote infrared camera kit fox surveys conducted in the Grand Valley 2012 – 2013. Sections where Fitzgerald (1986) trapped kit fox are depicted in tan, along with camera locations and anecdotal observations.



**Figure 2.** Remote infrared camera setup and skunk lure bait station used for kit fox surveys conducted in the Grand Valley in 2012 – 2013.



## Tables

**Table 1.** Locations, deployment and retrieval dates, total number of days run, and total number of photos taken for cameras deployed across the Grand Valley for kit fox surveys in 2012 – 2013. Total number of photos includes images where the camera was triggered but no animal can be discerned. All coordinates were collected in UTM NAD 83, Zone 12.

Camera	General Location	Easting	Northing	Date	Date	# Days Run	Total # Photos
				Deployed	Retrieved		
1	Colorado National Monument	697074	4328312	12/18/2012	3/20/2013	92	1,303
2	25 Road	710406	4339741	10/19/2012	2/11/2013	115	495
3	Whitewater Creek	727622	4320912	2/12/2013	3/18/2013	34	739
4	25 Road	714686	4343868	10/25/2012	2/11/2013	109	130
5	Rabbit Valley	668386	4335672	10/23/2012	3/12/2013	140	247
6	Rabbit Valley	673890	4338528	10/23/2012	2/11/2013	111	73
7	25 Road Area	712780	4341985	10/19/2012	2/26/2013	130	359
8	Rabbit Valley	671688	4337577	10/23/2012	3/12/2013	140	978
9	Horse Mountain	730660	4323257	10/24/2012	2/28/2013	127	836
10	Rabbit Valley	678320	4343017	10/23/2012	2/11/2013	111	195
11	Horse Mountain	728293	4326274	10/24/2012	2/28/2013	127	500
12	Cheney Reservoir	732688	4307391	10/20/2012	2/28/2013	131	1,186
13	Cheney Reservoir	736606	4308017	10/20/2012	2/28/2013	131	958
14	Mitchell Road	685792	4362103	10/16/2012	2/28/2013	135	1,910
15	Mitchell Road	680397	4359086	10/24/2012	2/11/2013	110	117
16	Mitchell Road	677952	4354968	10/24/2012	2/26/2013	125	144
17	Prairie Canyon	668946	4360869	10/23/2012	2/26/2013	126	140
18	Whitewater Creek	729085	4321207	2/12/2013	3/18/2013	34	203
Total						2,028	10,513

**Table 2.** The total number of days each species was photographed across all camera sets ( $T_{pic}$ ) and number of camera sets a species was documented at ( $C_{sp}$ ) during remote infrared camera surveys for kit fox in the Grand Valley during fall and winter of 2012 - 2013.

Common Name	Scientific Name	$T_{pic}$	$C_{sp}$
Badger	<i>Taxidea taxus</i>	9	3
Bobcat	<i>Lynx rufus</i>	4	3
Cattle	<i>Bos primigenius</i>	9	4
Coyote	<i>Canis latrans</i>	98	15
Cottontail	<i>Syvilagus species</i>	164	12
Domestic dog	<i>Canis domesticus</i>	7	4
Elk	<i>Cervus canadensis</i>	12	1
Gray fox	<i>Urocyon cinereoargenteus</i>	13	3
Human	<i>Homo sapien</i>	15	4
Mule deer	<i>Odocoileus hemionus</i>	25	6
Ord's kangaroo rat	<i>Dipodomys ordii</i>	9	4
Red fox	<i>Vulpes vulpes</i>	18	9
Rock squirrel	<i>Spermophilus variegatus</i>	4	3
Striped skunk	<i>Mephitis mephitis</i>	2	1
White-tailed antelope squirrel	<i>Ammospermophilus leucurus</i>	29	4
American robin	<i>Turdus migratorius</i>	3	2
Black-billed magpie	<i>Pica hudsonia</i>	11	4
Common raven	<i>Corvus corax</i>	3	2
Dark-eyed junco	<i>Junco hyemalis</i>	4	2
Pinyon jay	<i>Gymnorhinus cyanocephalus</i>	4	1
Total		443	

\* Count was not totaled by day for one site.

**Table 3.** Numbers of days photographs were collected by species from remote infrared cameras for kit fox surveys at 18 locations in the Grand Valley during the fall and winter of 2012 - 2013. Occurrences for species were tallied by day with one count added for every day a camera documented a given species at a given location.

Species <sup>†</sup> /Camera #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Badger					1		4	4										
Bobcat									2	1				1				
Cattle			<i>n*</i>			1		1					6			1		
Coyote		1		2		1	6	10	14	2	8	13	11	16	2	4	1	7
Cottontail	2	32	3		17		5	40	3			38	6	11	6	1		
Domestic dog				1			1	4		1								
Elk													12					
Gray fox	6				1			6										
Human				1			9	3		2								
Mule deer			2					6					8	6			2	1
Ord's kangaroo rat				1							1	6	1					
Red fox			1		1	2	2	3	1		5			1		2		
Rock squirrel	1				1								2					
Striped skunk																		2
White-tailed antelope squirrel					8			4				1	16					
American robin									1				2					
Black-billed magpie												1	1	8			1	
Common raven														1		2		
Dark-eyed junco									3			1						
Pinyon jay									4									
Total # of Species	3	2	4	4	6	3	6	10	7	4	3	6	10	7	2	5	3	3

<sup>†</sup> Scientific names provided in Table 2.

\* Count was not totaled by day for one site.

**Appendix.** Select photos captured during kit fox camera surveys during the fall and winter of 2012 to 2013.

**Appendix.** Select photos captured during the camera surveys



Gray fox photographs at Camera 1 (Colorado National Monument).



Cottontail rabbit photographed at Camera 2 (25 Road).

**Appendix.** Select photos captured during the camera surveys



Domestic dog photographed at Camera 4 (25 Road).



Gray fox photographed at Camera 5 (Rabbit Valley).

**Appendix.** Select photos captured during the camera surveys



Red fox photographed at Camera 5 (Rabbit Valley).



Red fox photographed at Camera 5 (Rabbit Valley).

**Appendix.** Select photos captured during the camera surveys



Domestic dog and humans photographed at Camera 7 (25 Road).



Humans photographed at Camera 7 (25 Road).

**Appendix.** Select photos captured during the camera surveys



Badger photographed at Camera 8 (Rabbit Valley).



Domestic dog photographed at Camera 8 (Rabbit Valley).

**Appendix.** Select photos captured during the camera surveys



Domestic dogs photographed at Camera 8 (Rabbit Valley).



Coyotes photographed at Camera 8 (Rabbit Valley).

**Appendix.** Select photos captured during the camera surveys



Coyote photographed at Camera 9 (Horse Mountain).



Red fox photographed at Camera 11 (Horse Mountain) with food.

**Appendix.** Select photos captured during the camera surveys



Coyote photographed at Camera 11 (Horse Mountain) rubbing on scent rock.



Coyote photographed at Camera 11 (Horse Mountain) urinating on scent rock.

**Appendix.** Select photos captured during the camera surveys



Coyote photographed at Camera 11 (Horse Mountain) with missing leg.



Coyotes photographed at Camera 14 (Mitchell Road).

**Appendix.** Select photos captured during the camera surveys



Coyote photographed at Camera 14 (Mitchell Road).



Bobcat photographed at Camera 14 (Mitchell Road).

**Appendix.** Select photos captured during the camera surveys



Magpies and a raven photographed at Camera 14 (Mitchell Road).



Striped skunk photographed at Camera 18 (Whitewater Creek).