

**Infrared-Triggered Photography of Mammals in the
Rincon Mountain District of Saguaro National Park, Arizona**

Final Report
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Saguaro National Park
and
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EXECUTIVE SUMMARY

Medium and large mammals are important natural resources and of great interest to visitors are in national parks. However, long-term monitoring of overall diversity and individual species is often too expensive for parks because so many species are difficult to live-trap or cannot be reliably confirmed by observational methods. This report summarizes the results of a species inventory of mammals using infrared-triggered photography in the Rincon Mountain District of Saguaro National Park, Arizona. The present study is part of a larger inventory of mammals in the Rincon Mountain District of Saguaro National Park that is scheduled to be completed in 2003. During 2001 we established 3 camera stations at 15 randomly selected locations in the Rincons below 1650 m (5400 ft) and set out cameras for a total of 891 camera-nights. We obtained 559 photographs of 16 targeted species at random locations, out of a total of 21 species believed to occur in the study area. In this report we provide distribution maps based on photos of each species and discuss the use of infrared-triggered photography in the context of traditional and emerging methods for monitoring mammals, what can and cannot be inferred from results when using infrared-triggered photography, and some aspects of study design. We stress the importance of using photographs obtained through the use of infrared-triggered photography for interpretative purposes to increase knowledge and appreciation of park wildlife for visitors and park staff.

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Saguaro National Park volunteers also helped make this project a success. In particular, Albi von Dach and Michael Chehoski hiked many miles, trouble-shot many cameras, and were instrumental in setting and retrieving units in remote and rugged areas of the Rincons. Dave Dalton logged many, many hours working to improve the camera units and our methods for employing them. His work greatly improved our camera success rate – thank you!

Thanks also to Chris Hass for advice on cameras and skunk identifications, and to the University of Arizona, Organ Pipe Cactus National Monument, Chiricahua National Monument, and Grand Canyon National Park for loaning camera units.

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INTRODUCTION

The Rincon Mountain District of Saguaro National Park contains a great diversity of mammals due to its extensive wilderness area (23,440 ha [57,930 acres]), large elevational range (850-2600 m [2800-8600 ft]) and proximity to several important biogeographic provinces. However, many medium to large sized mammals are vulnerable to local extinction because of their large home range sizes and low population densities (Noss and Cooperrider 1994). Although an explicit purpose of the National Park Service is to preserve native species, loss of mammalian species diversity over time has been documented in a number of western national parks (Newmark 1995). Since Saguaro National Park was established in 1933, jaguar (*Panthera onca*), bighorn sheep (*Ovis canadensis*), and Mexican gray wolf (*Canis lupus mexicana*) have been extirpated. Habitat fragmentation from expanding residential development along the boundaries of the park, loss of nearby riparian areas, and introduction of exotic species are current threats to the species diversity and abundance of mammals at Saguaro. Although several game species (Sumner 1951, Bellantoni and Krausman 1991) and coyote (*Canis latrans*; Bounds 1993) have been the subject of focused research in the Rincon Mountain District of Saguaro, no formal comprehensive mammal inventory has ever been conducted, and knowledge of most species is very limited. Therefore, in order to monitor long-term changes in the park in species diversity over time, obtaining knowledge of the presence and distribution of mammals in the district is currently one of the park's highest resource management priorities.

Available techniques for monitoring mammalian species diversity include recording observations, live-trapping, surveys for tracks and sign, DNA analysis, and infrared-triggered photography. Each technique has advantages and disadvantages. Sight records based on visitor and staff observations produce a great deal of data, but species identifications are not verifiable and results are heavily biased toward high visitor use areas and certain species. Live-trapping produces few data for the effort involved and is difficult and even dangerous with larger species. Data from track and sign surveys are often of poor quality and it is often very difficult to verify tracks and sign to species. Hair for DNA analysis is difficult to obtain; DNA in scat degrades in time and results in a high failure rate for DNA extraction. In spite of these problems, DNA analysis technology is rapidly improving and holds great promise as a method for species identification; the park is currently using it in a study on mountain lions (*Puma concolor*).

Infrared-triggered photography has traditionally been used to obtain interesting pictures or for specific studies of animal activity, such as nesting ecology (Cutler and Swann 1999). However, as a method for monitoring species diversity, this technique offers important advantages. Infrared-triggered photography is not invasive, is relatively inexpensive, and produces verifiable data that can be obtained in a repeatable study design or opportunistically. Its main limitation is that not all species are detected equally.

The results presented in this report are from the second year of a three-year study to determine the presence and distribution of medium and large mammals throughout the Rincon Mountain District using infrared-triggered cameras. Specific objectives were to:

1. Document species presence through photographs obtained by infrared-triggered photography at random locations at elevations below 1650 m (5400 ft) in the western portion of the Rincon Mountain District of Saguaro National Park.
2. Plot the locations of detections for each species using Geographic Information Systems (GIS) technology.
3. Use the photographs obtained for interpretation and environmental education activities at the park.

STUDY AREA

The Rincon Mountain District of Saguaro National Park is located east of Tucson and contains 26,917 ha (103.5 mi²), of which 23,440 ha (90.5 mi²) are designated wilderness. Six life zones are present in the district; camera locations for the current study fell in the 3 zones that occur below 1650 m (5400 ft). The Arizona Upland (Paloverde-mixed cacti) Subdivision of the Sonoran Desert occurs from outside of the park to approximately 1100 m (3600 ft) in elevation and is dominated by saguaro (*Carnegiea gigantea*), mesquite (*Prosopis* spp.), and foothills paloverde (*Cercidium microphyllum*). In a mosaic from approximately 1100-1500 m (3600-4920 ft), vegetation is in the Semi-desert Grassland Formation. Grasses include native species such as tobosa (*Hilaria mutica*) and black grama (*Bouteloua eriopoda*). Other plants include shindagger (*Agave schottii*) and shrubs such as mesquite and mimosa (*Mimosa biuncifera*). Beginning about 1500 m (4920 ft) oak-pine woodland predominates. Characteristic trees and shrubs in this community include alligator juniper (*Juniperus deppeana*), Arizona white oak (*Quercus arizonica*), Emory oak (*Q. emoryi*), and manzanita (*Arctostaphylos* spp.). Above oak-pine woodland are the pine-oak woodland, pine forest, and mixed conifer forest communities.

In relatively dry stream channels at lower elevations, two associations in the Mesquite series of the Sonoran Riparian and Oasis Forest biomes occur, with velvet mesquite (*Prosopis velutina*) being the dominant plant (Guertin 1998). In stream sections where water is more perennial, larger trees in the Mixed Broadleaf Series of the Interior Southwestern Riparian Deciduous forest and Woodland biome are present, including Arizona sycamore (*Platanus wrightii*), Arizona ash (*Fraxinus velutina*) and Arizona walnut (*Juglans major*).

The study area for this report included all of the Rincon Mountain District below 1650 m (5400 feet) in elevation except for the eastern slope, which will be surveyed during the third year of the mammal inventory beginning in September 2002. Areas above 1650 m (5400 feet) in elevation were surveyed during the first year of the study (Aslan 2000).

METHODS

To determine species presence and the distribution of medium and large mammals, we obtained infrared-triggered photographs using the Trailmaster camera system (model 1500, Goodson and Associates, Inc., Lenexa, KS; Kucera and Barrett 1993). The system consists of a transmitter, which emits an infrared beam, a receiver, which detects the beam, and the camera, which is connected to the receiver with a cable (Figure 1). The receiver triggers the camera to take a picture when an animal breaks the beam. We also experimented with passive infrared systems, the DeerCam (model DC-100, Non Typical, Inc., Park Falls, WI), and the Trailmaster 500.

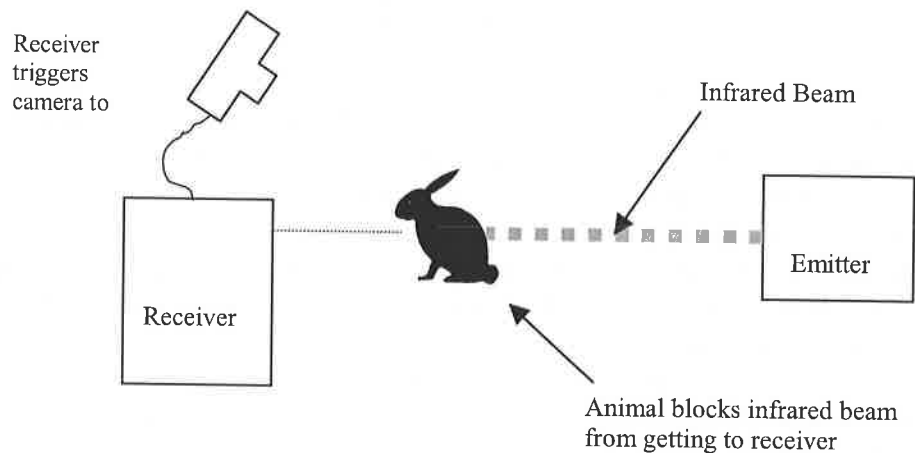


Figure 1. Typical configuration for an active infrared-triggered camera system.

Within the designated study area we set cameras at 15 locations, using randomly selected inventory points generated by the NPS Sonoran Desert Network Inventory and Monitoring Project (Figure 2; Powell and Docherty 2002). Nine locations were <1200 m (3940 ft) in elevation, 3 were 1200-1375 m (3940-4500 ft), and 2 were 1375-1650 m (4500-5400 ft). Cameras were set up for a minimum of 2 weeks per location at a time between July, 2001 and March, 2002. We placed 3 cameras at each location (Figure 3) using a stratified random design with random points, drainages, and subjectively selected points that

appeared attractive to mammals as the strata. The first point was within 50 meters (165 ft) of the randomly selected point, placed at a spot that was subjectively chosen for its attractiveness to mammals. Because mammals use drainages as corridors, the second point was in or by a drainage. We located the mapped drainage (using ArcView GIS system) closest to the random point, and placed the camera within 50 meters (165 ft) of the point in the drainage that was nearest to the random point. The third point was at least 80 meters (260 ft) from the other points at a place subjectively selected because it seemed attractive to mammals (e.g. water source, mesquite bosque) or where there was evidence of mammal activity such as a trail or scat. For visitor safety reasons, we avoided locating baited stations within 200 meters (650 ft) of a park trail. To maximize detections, we always baited the first point, and baited the third point if there was no water source. We used a 3-oz can of Fancy Feast cat food (fish variety) the first week, and a commercial cat lure with catnip poured over a flat rock the second week. We returned to each camera approximately one week after it was set up to check that it was functioning properly, to make repairs and change film if necessary, and to change bait at baited stations.

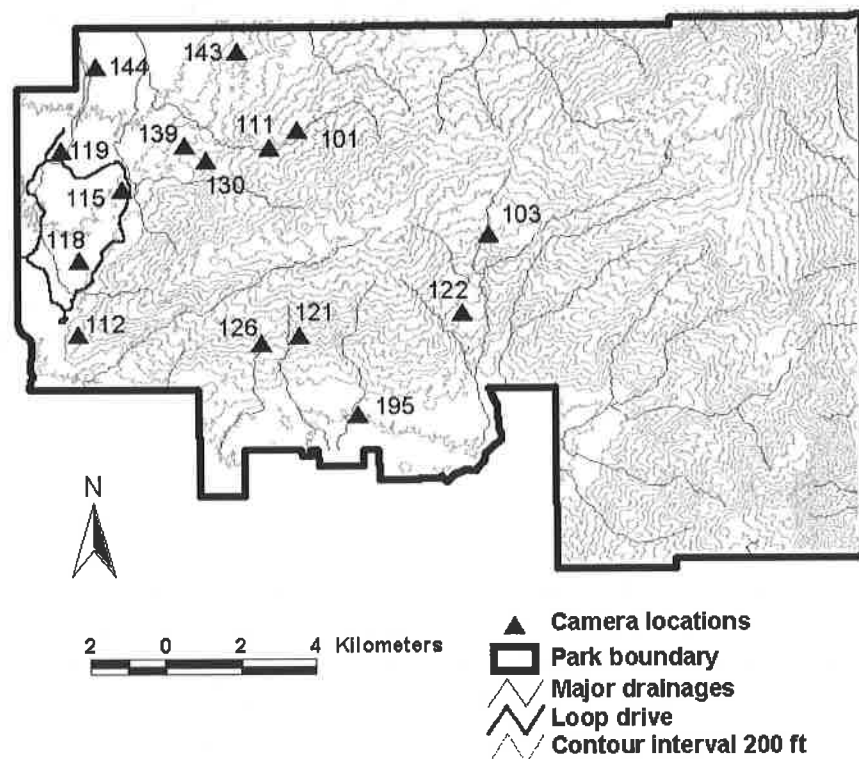


Figure 2. Randomly selected infrared-triggered camera locations, below 1650 m (5400 ft), in Rincon Mountain District, Saguaro National Park, 2001-2002.

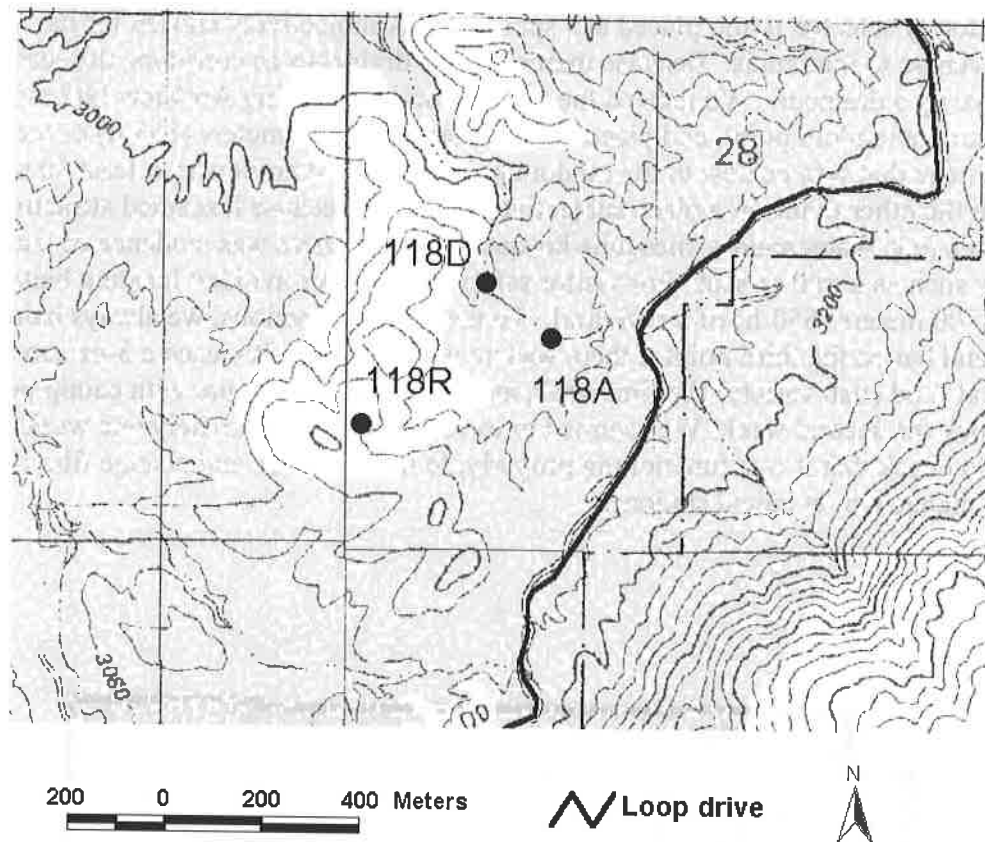


Figure 3. Example of camera placement of 3 cameras at one of the 15 locations in Rincon Mt. District of Saguaro National Park, 2001-2002. Location 118R is the random point, 118D is at the nearest mapped drainage to the random point, and 118A is a point chosen, in this case, at a natural water hole.

To make species distribution maps, we imported UTM coordinates, using NAD 27 Conus, for camera locations into ArcView (Appendix A). Species richness (the number of species present at the site) was estimated using the mark-recapture methods of Program CAPTURE for closed populations (Otis et al. 1978). This program can estimate species richness based on patterns of observations in the field, that is, whether each species is either observed ("captured") or not observed ("not captured") during successive field-days (Nichols and Conroy 1996, Swann 1999). In our analysis, species richness was estimated based on nine periods of approximately 28 sequential camera-nights.

RESULTS

Infrared-triggered cameras were set out in the field for a total of 891 camera-nights. Cameras were not always operational, usually because of equipment failure, but sometimes because the roll of film was completely exposed, and therefore could not document additional visits. We documented the presence of 16 medium to large mammal species (Table 1). Twenty-one species of medium to large mammals are believed to be present at the sampled elevations based on published reports (Doll et al. 1989) and previous photos (D. Swann, unpub. data). In this study, we did not obtain photographs of American badger (*Taxidea taxus*), spotted skunk (*Spilogale gracilis*), common raccoon (*Procyon lotor*), white-nosed coati (*Nasua narica*), or Mexican subspecies of the Virginia opossum (*Didelphis virginianus californicus*), nor did we document any species that was not already previously documented.

Table 1. Species of medium and large mammals documented in the Rincon Mt. District of Saguaro National Park by infrared-triggered photography at locations up to 1650 meters (5400 ft) in elevation, 2001-2002.

Order	Common Name	Scientific name	# Photos
Lagomorpha	Desert cottontail*	<i>Sylvilagus audubonii</i>	15
	Black-tailed jackrabbit	<i>Lepus californicus</i>	3
	Antelope jackrabbit	<i>Lepus alleni</i>	4
Rodentia	Rock squirrel	<i>Spermophilus variegatus</i>	6
Carnivora	Coyote	<i>Canis latrans</i>	24
	Common gray fox	<i>Urocyon cinereoargenteus</i>	252
	Black bear	<i>Ursus americanus</i>	13
	Ringtail	<i>Bassariscus astutus</i>	48
	Striped skunk	<i>Mephitis mephitis</i>	22
	Hooded skunk	<i>Mephitis macroura</i>	28
	Common hog-nosed skunk	<i>Conepatus mesoleucus</i>	11
	Mountain lion	<i>Puma concolor</i>	9
	Bobcat	<i>Lynx rufus</i>	5
	Collared peccary	<i>Pecari tajacu</i>	107
Artiodactyla	Mule deer	<i>Odocoileus hemionus</i>	4
	White-tailed deer	<i>Odocoileus virginianus</i>	8

* some cottontails may be eastern cottontails (*Sylvilagus floridanus*)

We obtained 559 photographs of mammals that could be identified to species (Figure 4, Appendix A), an additional 6 photographs of skunks identified to genus, and one of an unidentified canid. Two cottontail species that are very similar in external appearance, desert cottontail (*Sylvilagus audubonii*) and eastern cottontail (*S. floridanus*), probably occur in the park (Sumner 1951). We assumed that cottontails photographed at low elevations were *S. audubonii*, and that cottontails photographed above 1200 m (3900 ft) could have been either species. In addition to documenting the presence of medium to large mammals, we also obtained photographs of non-target animals such as Harris' antelope squirrel (*Ammospermophilus harrisi*), greater roadrunners (*Geococcyx californianus*), Gambel's quail (*Callipepla gambelii*), and mourning doves (*Zenaida macroura*).

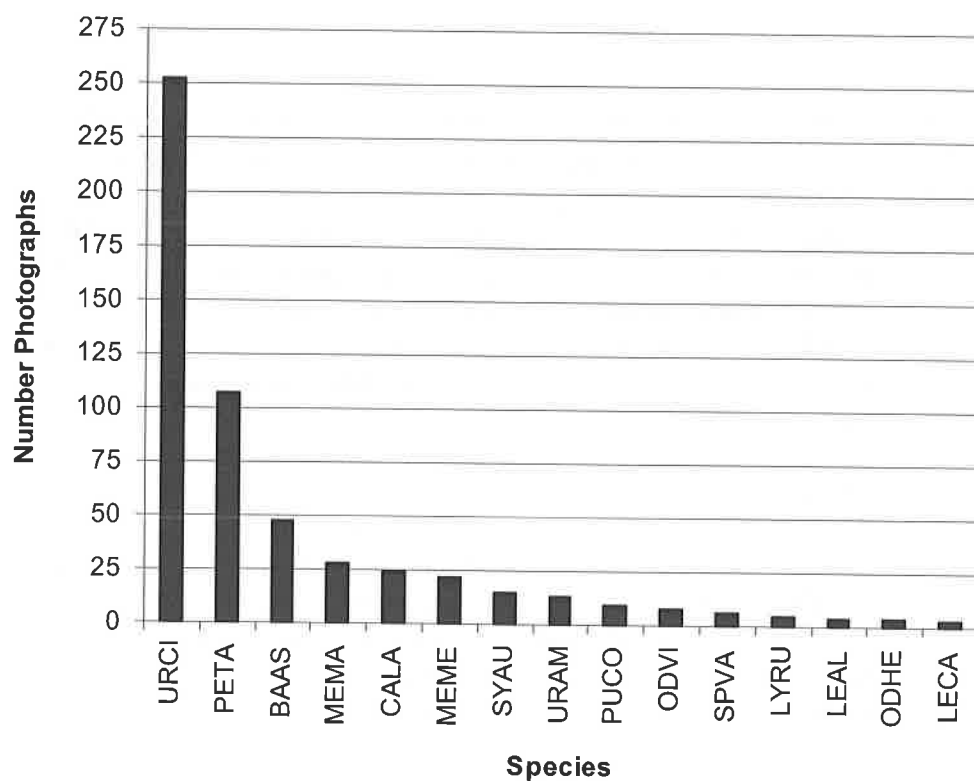


Figure 4. Number of individual photographs of 16 mammal species taken by infrared-triggered photography at Saguaro National Park, Rincon Mt. District, below 1650 meters (5400 ft) elevation, 2001-2002. Acronyms are based on scientific names: first two letters of genus name followed by first two letters of species name. See Table 1 for guide to scientific names.

We photographed at least one black bear (*Ursus americanus*) with an orange ear tag. Although we were unable to read the number and therefore identify the individual, it is likely the bear is one that was relocated by the Arizona Game and Fish Department to the east of the Rincons (Jim Heffelfinger, pers. comm.).

Of the omnivores and carnivores detected at ≥ 6 cameras, all but coyotes were detected at a greater number of baited stations than unbaited ones, after accounting for differences in availability (Table 2). Ungulates and lagomorphs were not detected more often at baited stations. For species detected more often at baited stations, we found no discernible pattern in detections for catfood vs. catlure bait after accounting for availability (Table 2).

Table 2. The proportion of cameras with detections at different bait sources, after accounting for availability. Results are given only for species detected by ≥ 6 cameras.

Species	No bait	Bait	Water	Catfood/Catlure
Desert cottontail	0.38	0.11	0	
Coyote	0.13	0.11	0.25	
Common gray fox	0.5	0.82	0.75	0.5/0.5
Ringtail	0	0.21	0.25	0.43/0.57
Striped skunk	0.06	0.29	0	0.56/0.44
Hooded skunk	0.18	0.32	0	0.5/0.5
Common hog-nosed skunk	0.06	0.18	0	0.67/0.33
Collared peccary	0.38	0.14	0.5	

Due to low sample sizes, the ability to estimate mammalian species richness in the study area was poor. Program CAPTURE recommended use of the null model, which indicated insufficient data, and estimated the number of species to be 16 (SE=0.2901, 95% C.I. 16-16).

Photographs obtained in this study were copied for interpretive use by Saguaro National Park interpretive staff and have been used for a number of environmental education activities in the park. As part of the wildlife program for the Rincon Mountain District Junior Ranger Program for two weeks in June, we used the photographs to introduce park mammals and allowed the Junior Rangers to "capture" themselves on film using the infrared-

triggered units. We also presented the results of this study to park staff at an All-Employee's meeting as well as at the 4th Conference on Research and Resource Management in the Southwestern Deserts. We have two presentations to park volunteers scheduled for October, and are planning an exhibit for the Visitor's Center.

DISCUSSION

Very few U.S. national parks have voucher specimens or photographs for medium and large mammals, and analyses of species diversity and extinctions of mammals (e.g. Newmark 1995) are almost always based on sight records. The resulting poor quality of mammalian records has been a source of concern for many years and has hampered accurate assessments of the status of mammals in most parks. To our knowledge, this is the first inventory of mammals in any large U.S. national park that is based strictly on verifiable records (e.g. photographs) as well as on a repeatable, stratified random study design. Photographs obtained in this phase of the inventory have provided documentation and a permanent record of the presence of 16 species of medium to large mammals at locations throughout the Rincon Mountain District. These data, coupled with data from the other two study years (2000 and 2002-2003), should give a fairly complete knowledge base that can be used in long-term monitoring.

Although species distribution maps (Appendix B) are preliminary and are based only on photographs from this study, they are the first distribution maps produced for Saguaro National Park mammals. They are useful in that they provide documentation for where each species has been confirmed in the park. The common gray fox (*Urocyon cinereoargenteus*) for example, is clearly widespread, occurring at nearly every site where cameras were located. In apparent contrast, the antelope jackrabbit (*Lepus alleni*) was documented at only one site. It is important to emphasize that we cannot infer that a species does not occur at a location because we obtained no photographs. Like all inventory methods, infrared-triggered photography documents presence, but not absence. Mountain lion were documented at only 2 sites, but lions and lion sign have been observed at many places throughout the park, including near camera locations. Given more time, the probability of detecting a mountain lion at other locations increases. Therefore, as sampling effort increases, our confidence that our results reflect a species' true distribution also increases. More extensive sampling over time and space is especially important for those species whose distribution varies among seasons and years.

We presented data comparing the number of photographs taken of each species (Figure 4); however, it is important to recognize that these data do not reflect absolute or relative abundance of a species for several reasons. First, it is rarely possible to determine whether multiple photographs of a species at a station reflect multiple individuals or the same individual triggering the camera multiple times. For species with larger home ranges, the same individual may even be photographed at different stations. Second, randomly selected camera locations are more likely to detect species that are habitat generalists and have a

widespread distribution than habitat specific species, regardless of abundance. Third, species that travel in groups, such as the collared peccary (*Pecari tayassu*), often triggered the camera multiple times as members of the herd walked through the infrared beam. Solitary animals such as the cottontail may be more numerous, but it is less likely that several cottontails would pass through the small area covered by the beam. Fourth, herbivores are less likely to be attracted to the baited stations than omnivores or carnivores. This factor may account for the large number of photographs of fox and ringtails (*Bassariscus astutus*). In addition, one individual may stay at a baited station long enough to trigger multiple photographs. Fifth, although many animals were photographed as they apparently investigated the transmitter or receiver, some species are more “trap shy” than others, and therefore may avoid areas with human scent. Some of the coyotes photographed were running or leaping; it is likely that the relatively small number of coyote photographs reflect this species’ aversion to the cameras rather than their abundance. Finally, abundance of a species at a particular location can change seasonally or annually; a camera at a particular spot may detect different species depending on when it is operational.

Although we cannot compare the abundance of a species detected during this study with the results from past studies, we can use species distribution maps from this study in addition to our field observations to make inferences about long-term population changes in some species. For example, Sumner (1951) found no evidence that mountain lions or black bear were present in the Rincon Mountain District in 1951, despite an extensive effort to look for tracks and sign. We documented both species through photographs during this study, and found tracks and sign at locations where we did not obtain photographs. In contrast, Sumner (1951) found coyotes to be the major predator in the Rincons, occurring throughout the park, especially at elevations below 1800 meters (5900 ft). We documented coyotes at only 3 locations on the desert floor, and field observations seem to confirm that coyotes are not as widespread at higher elevations as they were in Sumner’s time. As another example, Sumner (1951) found white-tailed deer (*Odocoileus virginianus*) restricted to areas above 2100 meters (6890 ft); we photographed this species as low as 1100 meters (3600 ft) and have frequently observed them in the lower elevations.

Based on results from this study, data from infrared-triggered cameras placed opportunistically (usually at water sites) in the park, and wildlife observation reports by park staff and visitors, we believe that there are 21 species of medium and large sized mammals inhabiting the Rincon Mountains below 1650 meters (5400 ft) in elevation. Although the number of species detected in the present study increased over time (Figure 5), we detected only 16 species over 9 months. Species previously photographed in the park, but not detected in this study, are the American badger, spotted skunk, common raccoon, white-nosed coati, and Virginia opossum. These species were not detected at the randomly selected camera locations probably because they are habitat specific, rare, or both. Sampling at many additional locations would be necessary, and cost-prohibitive, to increase the probability of a camera falling in a particular habitat for a habitat specific species, or to “capture” a rare species. It is possible that some species may never be detected by randomly placed cameras. A more successful and cost effective method may be a stratified random design, using

knowledge of habitats for species to identify the strata. Including water sources as a stratum is important; the coati, raccoon, and opossum were all photographed in a previous effort using infrared-triggered photography at opportunistically selected locations near water.

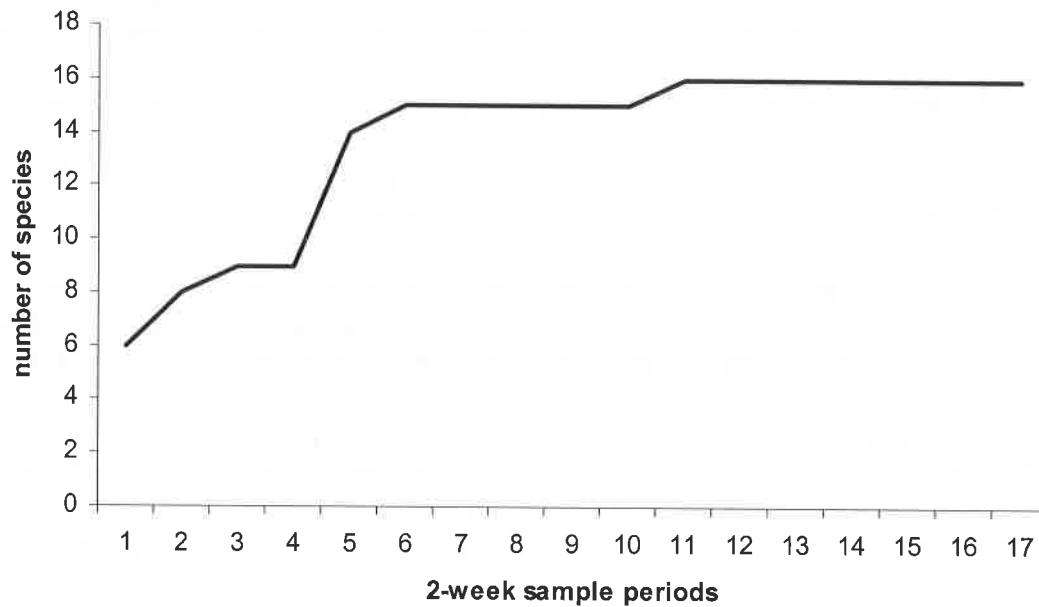


Figure 5. Species diversity curve for medium and large mammals photographed in the Rincon Mountain District of Saguaro National Park, 2001-2002.

Although our study was not designed to quantitatively determine differences in detections at baited vs. unbaited stations, several species were documented more often at baited stations. Not unexpectedly, the common gray fox, ringtail, and all 3 species of skunks appear to be attracted to bait. Inferences from results for mountain lion, black bear, bobcat (*Lynx rufus*), and rock squirrels (*Spermophilus variegatus*) could not be made because of small sample size and inherent biases in the study design. We have no evidence that any species avoided baited stations; therefore, researchers attempting to document a wide variety of species would probably maximize success by using baited stations. Our results show no discernible patterns that the type of bait used affected the species photographed at baited

stations. Because capture probably lasts longer at the site, it may be the only bait necessary; however, further research may reveal preferences by a particular species.

The present study, covering elevations up to 1650 meters (5400 ft), is part of a larger inventory of mammals in the Rincon Mountain District of Saguaro National Park that is scheduled to be completed in 2003. An inventory using infrared-triggered photography at elevations above 1980 meters (6500 ft) was conducted in 2000; areas from 1650-1980 meters (5400-6500 ft) will be sampled next year. During 2003-2005, we hope to conduct a similar inventory of the Tucson Mountain District. In spite of its disadvantages, infrared-triggered photography has proven to be a valuable tool in collecting data on species diversity in the park. Information obtained from these inventories will add to the park's knowledge of the distribution of each species throughout the park. Resource managers will use inventory results as a baseline to track changes in species diversity of medium to large mammals in the future. Photographs of the animals will continue to be used to foster appreciation and knowledge for the park's wildlife in visitors and staff.

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APPENDIX A

RESULTS OF INFRARED-TRIGGERED PHOTOGRAPHY
FOR EACH CAMERA STATION, AND CAMERA LOCATIONS,
IN SAGUARO NATIONAL PARK,
RINCON MOUNTAIN DISTRICT, 2001-2002

Table A1. Species documented at each camera location in the Rincon Mountain District, Saguaro National Park, 2001-2002.

Point #	Elevation (m/ft)	Vegetation	Species common name	Species scientific name	# Photos
101	1375/4500	W	Desert cottontail	<i>Sylvilagus audubonii</i> *	2
			Common gray fox	<i>Urocyon cinereoargenteus</i>	3
			Striped skunk	<i>Mephitis mephitis</i>	1
			Skunk species	<i>Mephitis sp.</i>	1
			White-tailed deer	<i>Odocoileus virginianus</i>	1
103	1615/5300	W	Common gray fox	<i>Urocyon cinereoargenteus</i>	31
			Black bear	<i>Ursus americanus</i>	13
			Hooded skunk	<i>Mephitis macroura</i>	1
			Common hog-nosed skunk	<i>Conepatus mesoleucus</i>	2
111	1250/4100	WGM	Common gray fox	<i>Urocyon cinereoargenteus</i>	3
			Ringtail	<i>Bassariscus astutus</i>	13
			Striped skunk	<i>Mephitis mephitis</i>	2
112	1000/3300	S	Common gray fox	<i>Urocyon cinereoargenteus</i>	32
			Striped skunk	<i>Mephitis mephitis</i>	13
			Hooded skunk	<i>Mephitis macroura</i>	7
			Common hog-nosed skunk	<i>Conepatus mesoleucus</i>	1
			Bobcat	<i>Lynx rufus</i>	1
115	915/3000	S	Desert cottontail	<i>Sylvilagus audubonii</i>	1
			Common gray fox	<i>Urocyon cinereoargenteus</i>	5
			Striped skunk	<i>Mephitis mephitis</i>	3
			Skunk species	<i>Mephitis sp.</i>	2
			Collared peccary	<i>Pecari tajacu</i>	7
118	945/3100	S	Coyote	<i>Canis latrans</i>	7
			Common gray fox	<i>Urocyon cinereoargenteus</i>	17
			Hooded skunk	<i>Mephitis macroura</i>	6
			Common hog-nosed skunk	<i>Conepatus mesoleucus</i>	2
			Bobcat	<i>Lynx rufus</i>	2
			Collared peccary	<i>Pecari tajacu</i>	32
			Mule deer	<i>Odocoileus hemionus</i>	3
119	850/2800	SM	Desert cottontail	<i>Sylvilagus audubonii</i>	7
			Coyote	<i>Canis latrans</i>	11
			Bobcat	<i>Lynx rufus</i>	2
			Collared peccary	<i>Pecari tajacu</i>	1
			Mule deer	<i>Odocoileus hemionus</i>	1
121	1430/4700	WG	Rock squirrel	<i>Spermophilus variegatus</i>	1
			Common gray fox	<i>Urocyon cinereoargenteus</i>	6
			Hooded skunk	<i>Mephitis macroura</i>	2
			Mountain lion	<i>Puma concolor</i>	2
			Collared peccary	<i>Pecari tajacu</i>	10
122	1250/4100	SG	Common gray fox	<i>Urocyon cinereoargenteus</i>	20
			Unknown canid species		1

Table A1, continued.

Point #	Elevation (m/ft)	Vegetation	Species common name	Species scientific name	# Photos
126	1375/4500	WG	Desert cottontail	<i>Sylvilagus audubonii</i> *	1
			Rock squirrel	<i>Spermophilus variegatus</i>	1
			Common gray fox	<i>Urocyon cinereoargenteus</i>	19
			Ringtail	<i>Bassariscus astutus</i>	1
			Striped skunk	<i>Mephitis mephitis</i>	1
			Hooded skunk	<i>Mephitis macroura</i>	6
			Skunk species	<i>Mephitis sp.</i>	1
			Mountain lion	<i>Puma concolor</i>	7
			Collared peccary	<i>Pecari tajacu</i>	16
			White-tailed deer	<i>Odocoileus virginianus</i>	1
130	1100/3600	SGM	Common gray fox	<i>Urocyon cinereoargenteus</i>	20
			Ringtail	<i>Bassariscus astutus</i>	1
			Collared peccary	<i>Pecari tajacu</i>	34
			White-tailed deer	<i>Odocoileus virginianus</i>	6
139	1000/3300	S	Rock squirrel	<i>Spermophilus variegatus</i>	1
			Common gray fox	<i>Urocyon cinereoargenteus</i>	8
			Ringtail	<i>Bassariscus astutus</i>	6
			Striped skunk	<i>Mephitis mephitis</i>	1
			Hooded skunk	<i>Mephitis macroura</i>	5
			Skunk species	<i>Mephitis sp.</i>	1
			Common hog-nosed skunk	<i>Conepatus mesoleucus</i>	5
			Collared peccary	<i>Pecari tajacu</i>	5
143	1000/3300	SM	Common gray fox	<i>Urocyon cinereoargenteus</i>	42
			Ringtail	<i>Bassariscus astutus</i>	11
			Skunk species	<i>Mephitis sp.</i>	1
			Common hog-nosed skunk	<i>Conepatus mesoleucus</i>	1
			Collared peccary	<i>Pecari tajacu</i>	1
144	825/2700	SM	Desert cottontail	<i>Sylvilagus audubonii</i>	4
			Black-tailed jackrabbit	<i>Lepus californicus</i>	2
			Antelope jackrabbit	<i>Lepus alleni</i>	4
			Coyote	<i>Canis latrans</i>	6
195	1000/3300	G	Black-tailed jackrabbit	<i>Lepus californicus</i>	1
			Rock squirrel	<i>Spermophilus variegatus</i>	3
			Common gray fox	<i>Urocyon cinereoargenteus</i>	46
			Ringtail	<i>Bassariscus astutus</i>	16
			Striped skunk	<i>Mephitis mephitis</i>	1
			Hooded skunk	<i>Mephitis macroura</i>	1
			Collared peccary	<i>Pecari tajacu</i>	1

* may include eastern cottontail (*Sylvilagus floridanus*)

Vegetation codes (from Brown 1994):

S- Sonoran desertscrub, Arizona Upland, Paloverde-Mixed Cacti series

W- Madrean evergreen woodland

G- Semi-desert grassland

M- Sonoran Riparian and Oasis Forests- Mesquite series

Table A2. Location of camera stations in the Rincon Mountain District, Saguaro National Park, 2001-2002. Datum for UTM coordinates is NAD 27 conus. R= random point, D= drainage point, A= subjectively selected point, P= experimental passive system point.

Point #	Easting	Northing
101R	532229	3563631
101D	532230	3563542
101A	532399	3563663
103R	537302	3560857
103D	537240	3560999
103A	537222	3560928
103P	537277	3560920
111R	531466	3563182
111D	531434	3563208
111A	531467	3563018
112R	526369	3558183
112D	526508	3558365
112A	526452	3558335
115R	527549	3562061
115D	527295	3562049
115A	527313	3561953
118R	526397	3560173
118D	526643	3560459
118A	526793	3560342
118P	526780	3560357
119R	525913	3563118
119D	526039	3563230
119A	526059	3563162
121R	532255	3558134
121D	531870	3558097
121A	532181	3558112
122R	536565	3558751
122D	536674	3558584
122A	536692	3558455
126R	531233	3557932
126D	531233	3557932
126A	531265	3558079
130R	529788	3562847
130D	529758	3562615
130A	529620	3562589
139R	529200	3563248
139D	529036	3563237
139A	528949	3563271
143R	530630	3565727
143D	530468	3565885
143A	530623	3565683
144R	526882	3565343
144D	526597	3565383
144A	526599	3565234
195R	533822	3556011
195D	533645	3556071
195A	533593	3556032

APPENDIX B

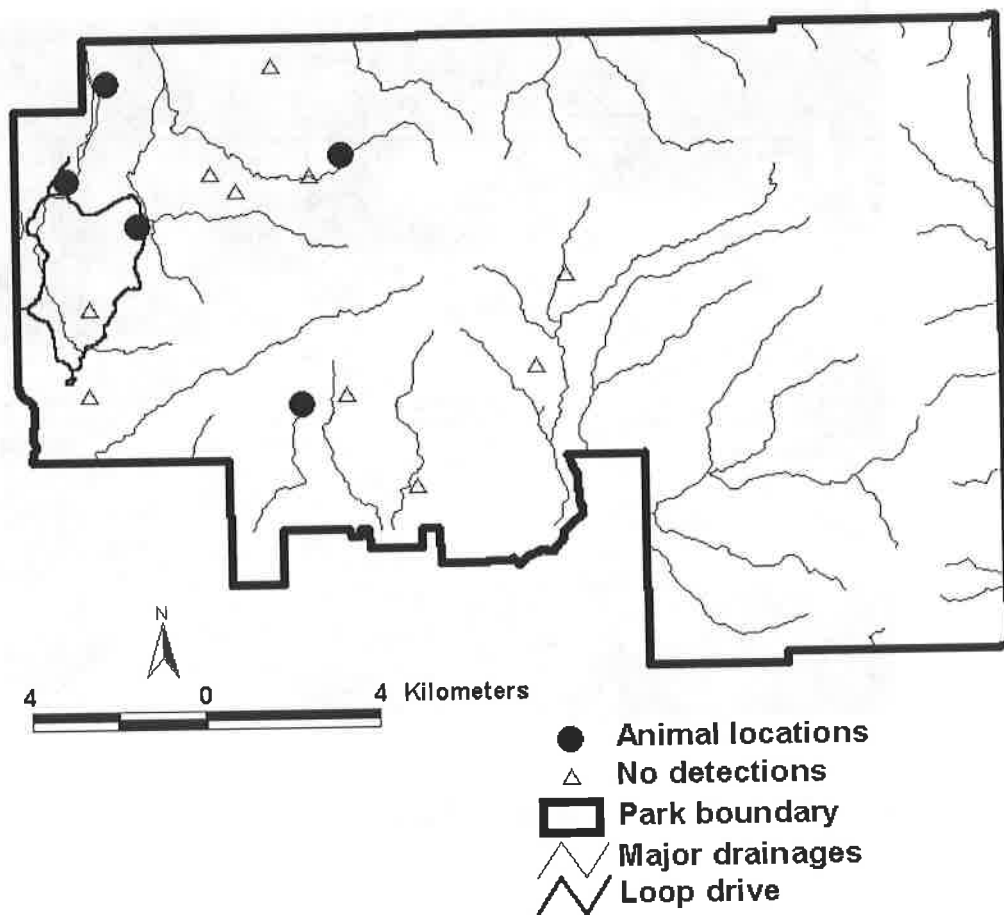
**SPECIES DISTRIBUTION MAPS AND SAMPLE PHOTOGRAPHS
OF MEDIUM TO LARGE MAMMALS
DETECTED BY INFRARED-TRIGGERED PHOTOGRAPHY IN SAGUARO
NATIONAL PARK, RINCON MOUNTAIN DISTRICT, 2001-2002**

Desert cottontail
Sylvilagus audubonii



Point #119A July 21, 2001 1:25 am

Desert cottontail
Sylvilagus audubonii

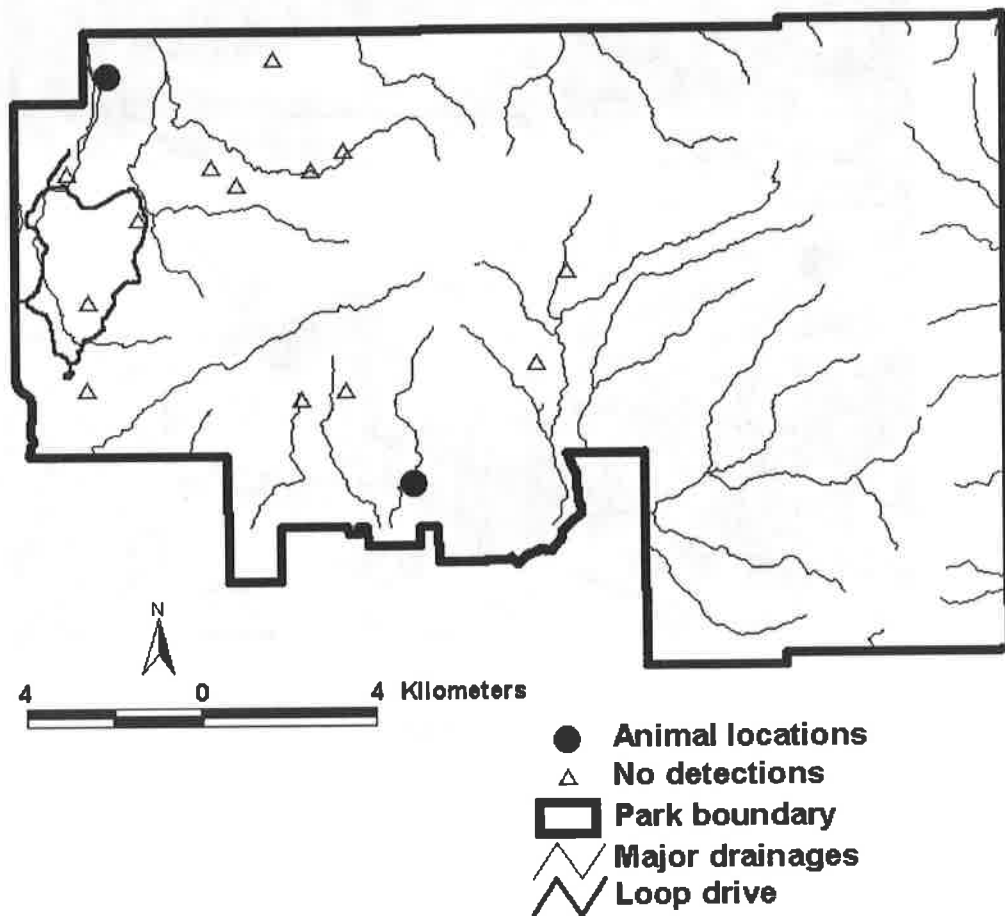


Black-tailed jackrabbit
Lepus californicus



Point #144 August 15, 2001 7:27 am

Black-tailed jackrabbit *Lepus californicus*

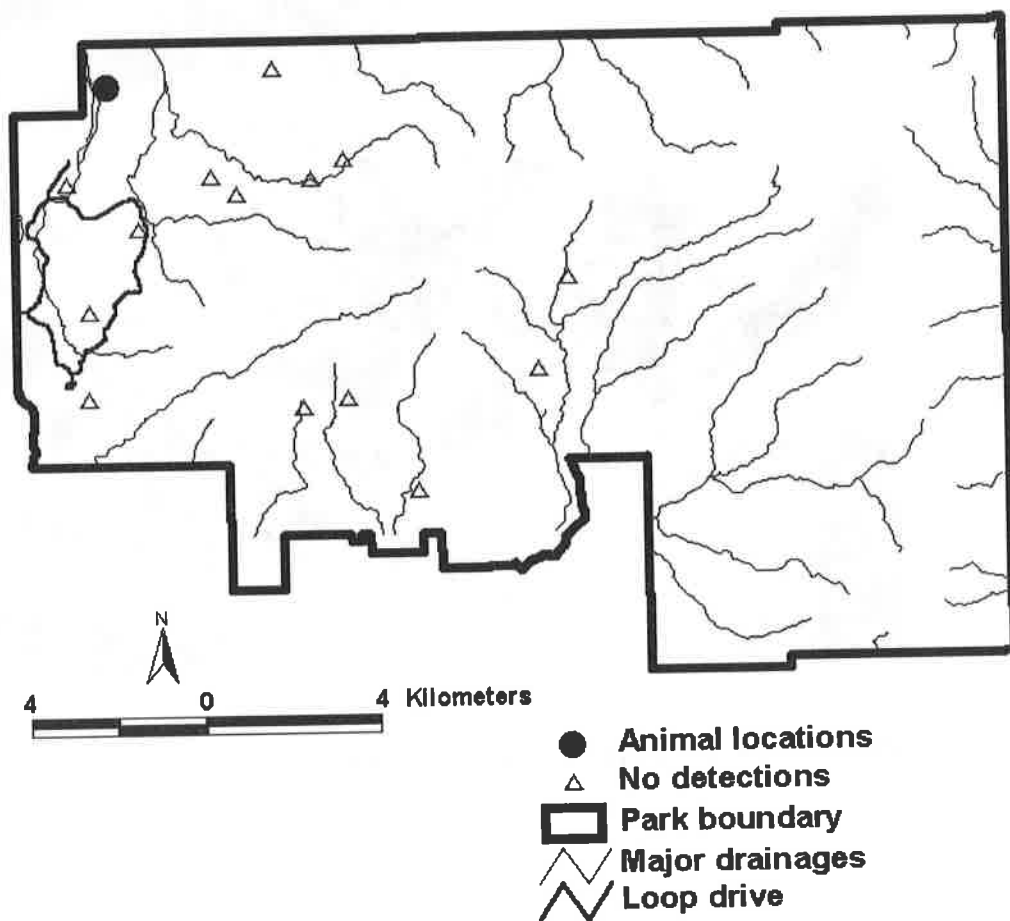


Antelope jackrabbit
Lepus alleni



Point #144D August 21, 2001 5:22 am

Antelope jackrabbit
Lepus alleni

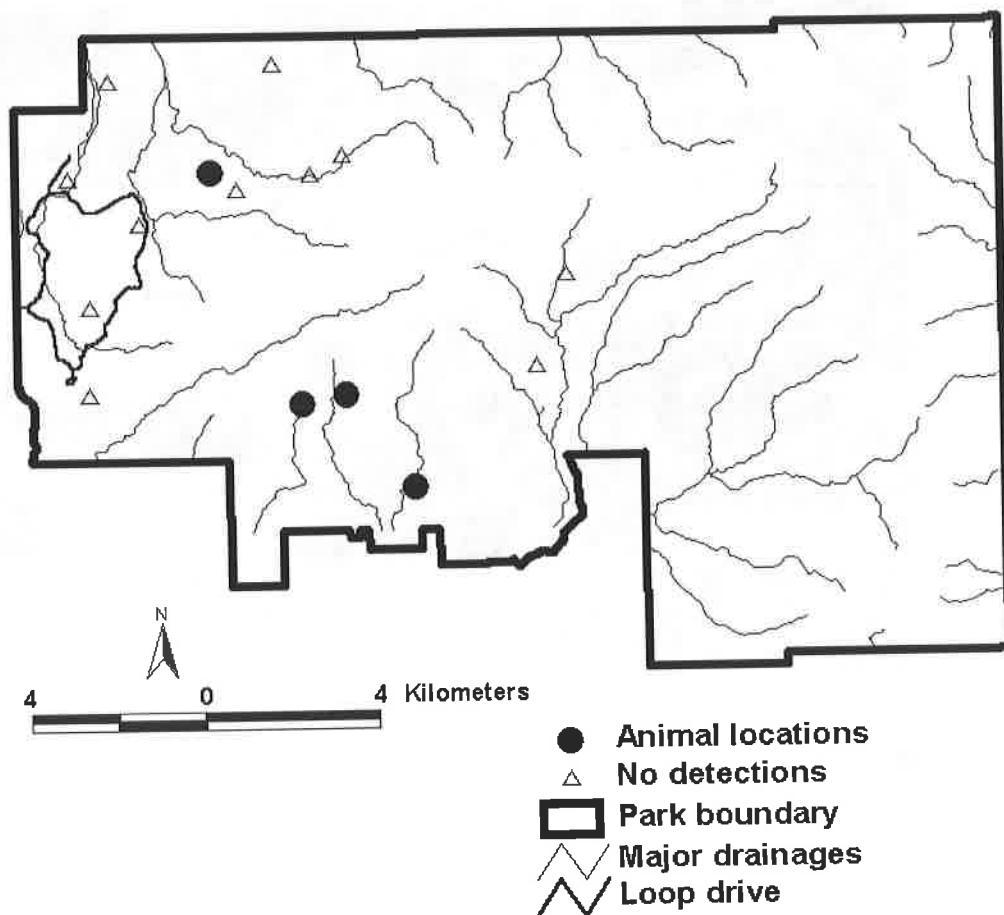


Rock squirrel
Spermophilus variegatus



Point #139A November 11, 2001 8:30 am

Rock squirrel
Spermophilus variegatus

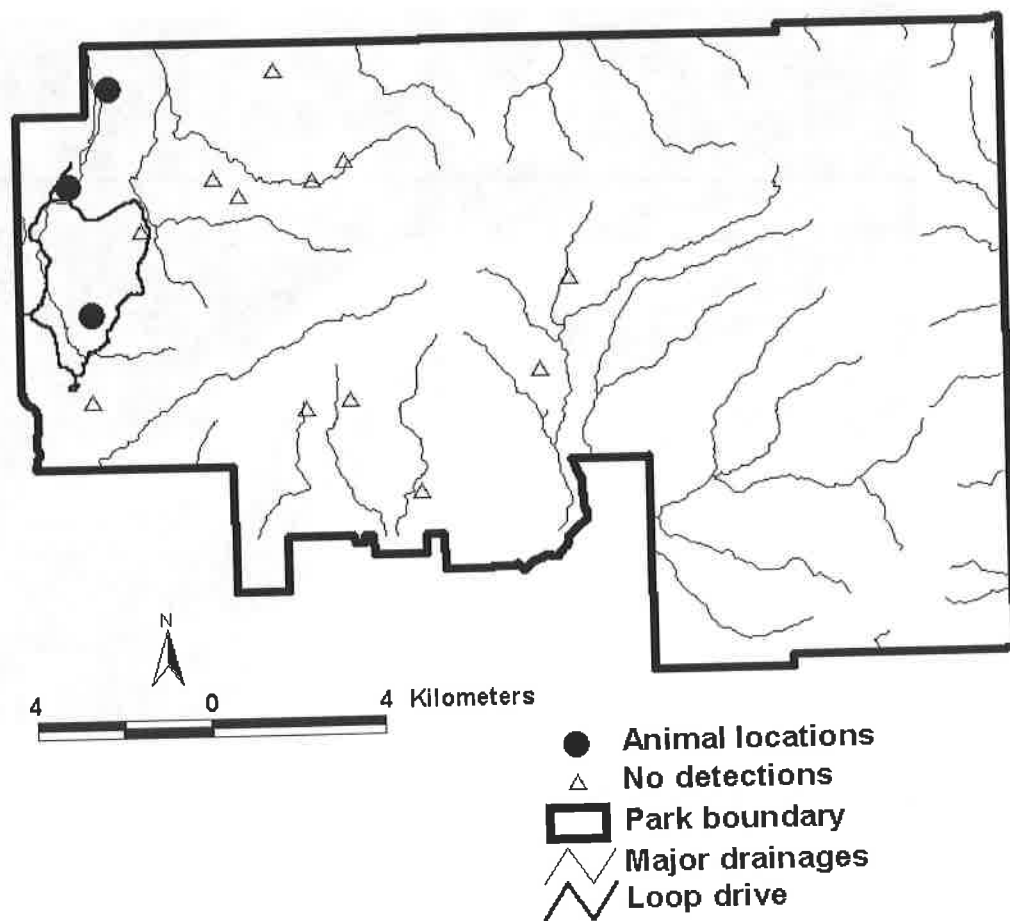


Coyote
Canis latrans



Point #118A November 1, 2001

Coyote *Canis latrans*

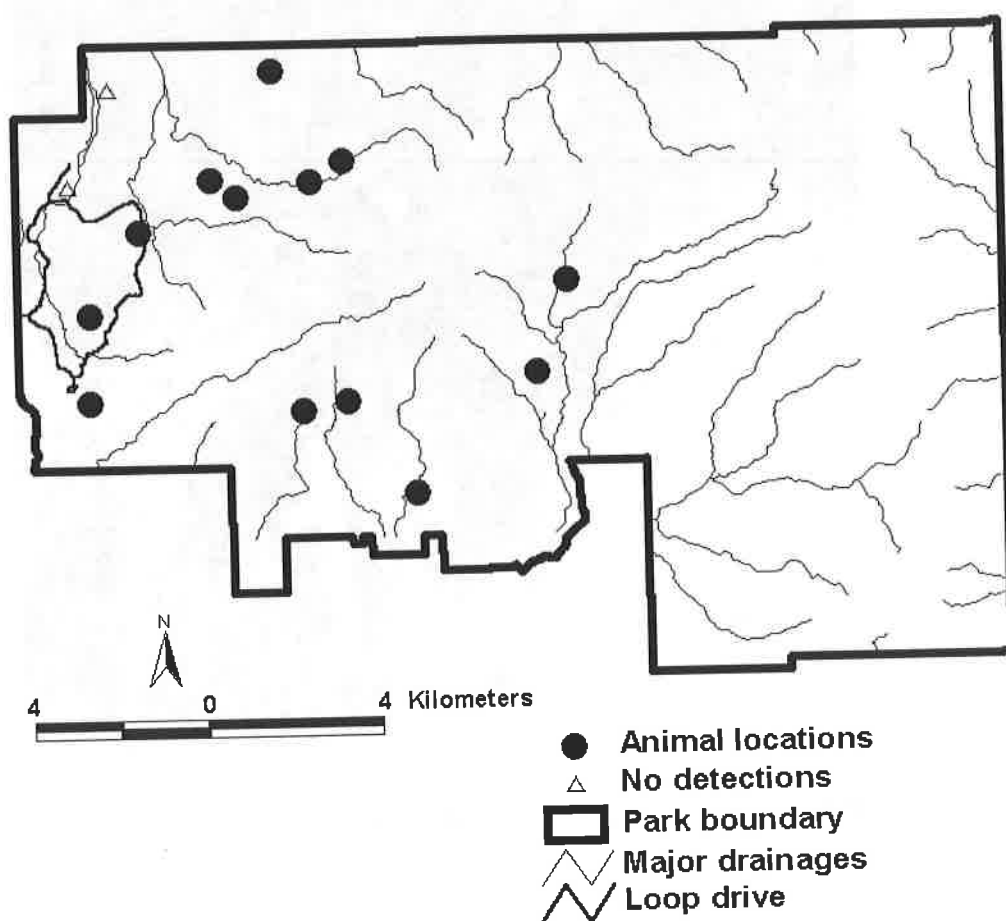


Common gray fox
Urocyon cinereoargenteus



Point #195A February, 2002

Common gray fox
Urocyon cinereoargenteus

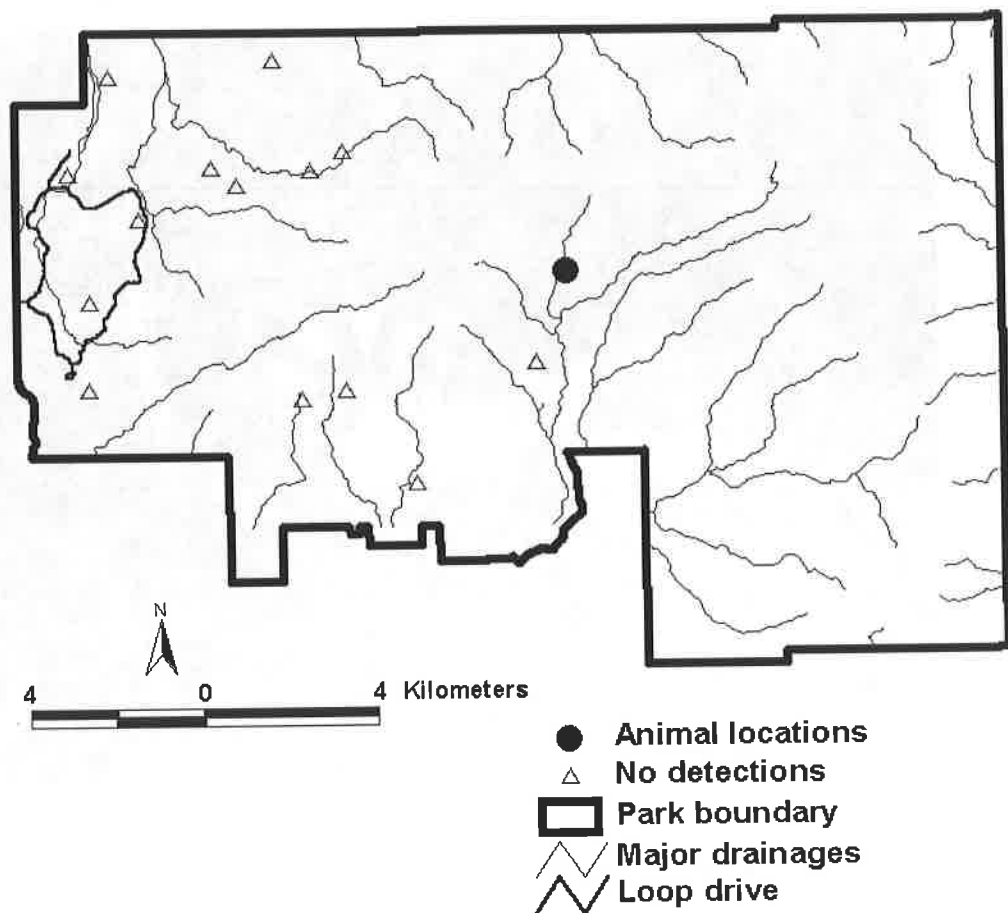


Black bear
Ursus americanus



Point #103 October 8, 2001 5:06 am

Black bear
Ursus americanus

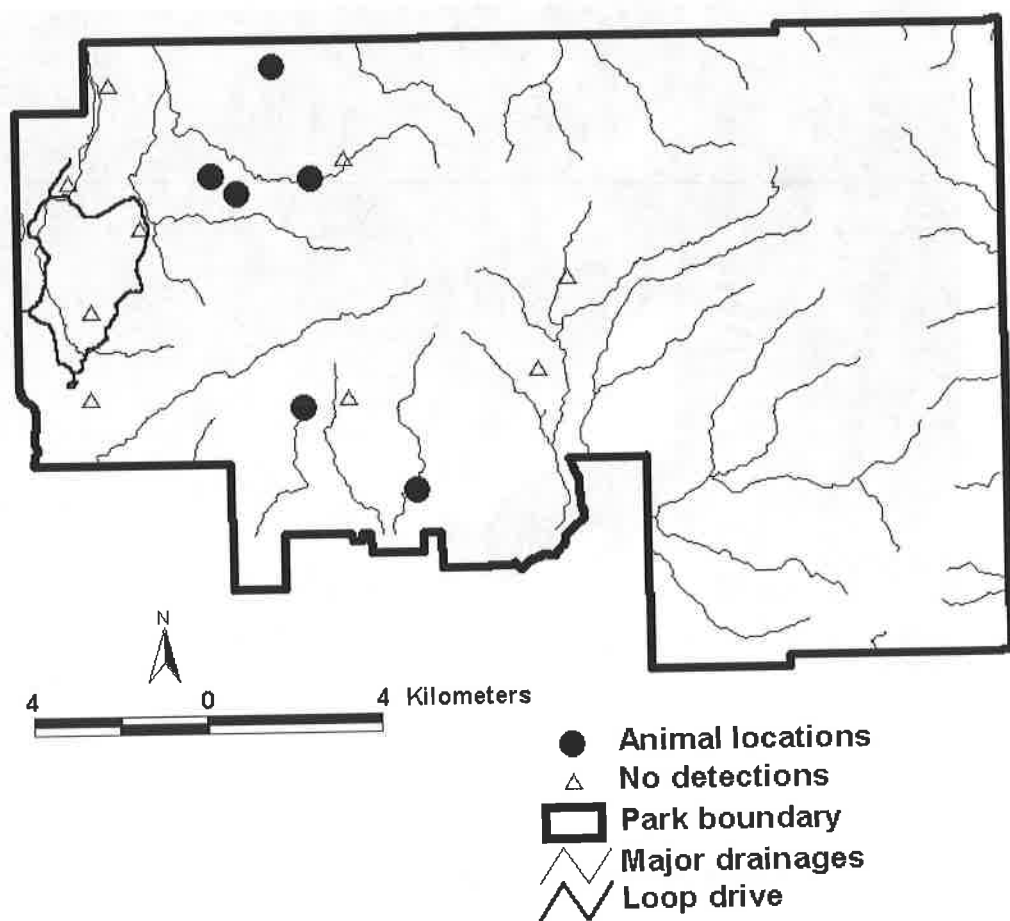


Ringtail
Bassariscus astutus



Point #195D February 4, 2002 12:54 am

Ringtail
Bassariscus astutus

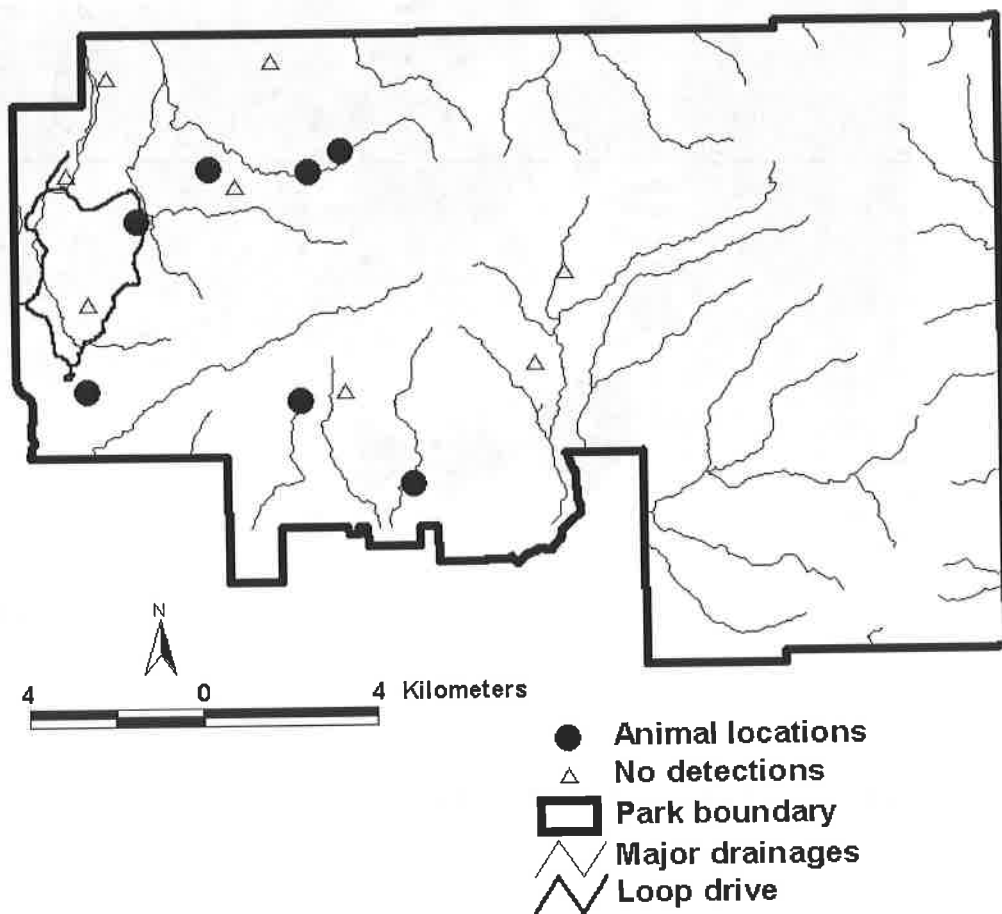


Striped skunk
Mephitis mephitis



Point #112 October 30, 2001 01:27 am

Striped skunk
Mephitis mephitis

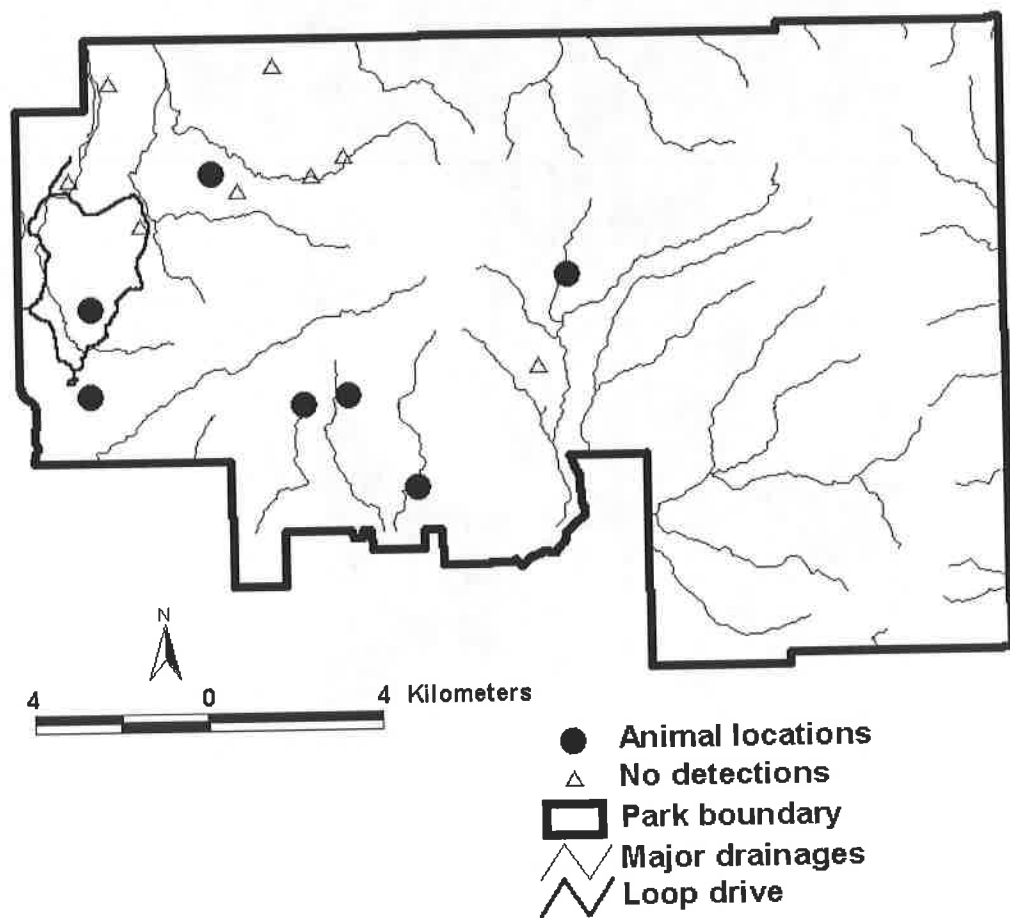


Hooded skunk
Mephitis macroura



Point #112 October 24, 2001 12:06 am

Hooded skunk
Mephitis macroura

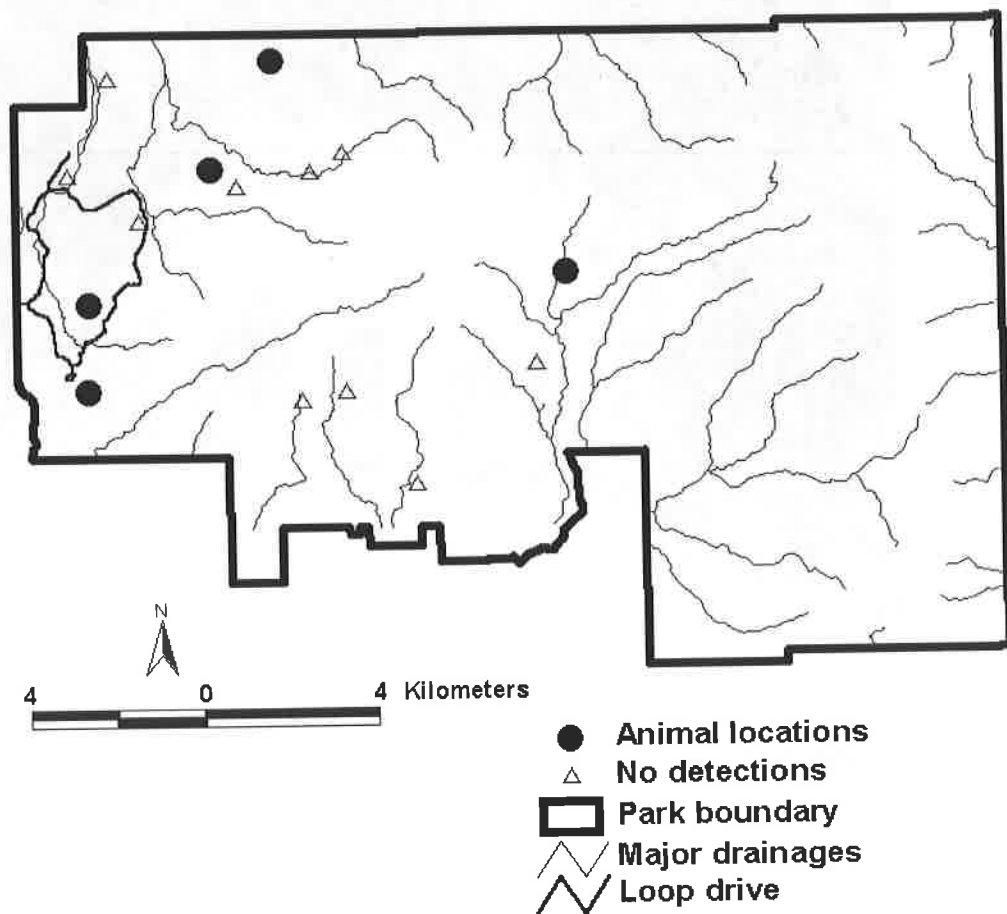


Common hog-nosed skunk
Conepatus mesoleucus



Point #139A August 13, 2001 8:03 pm

Common hog-nosed skunk
Conepatus mesoleucus

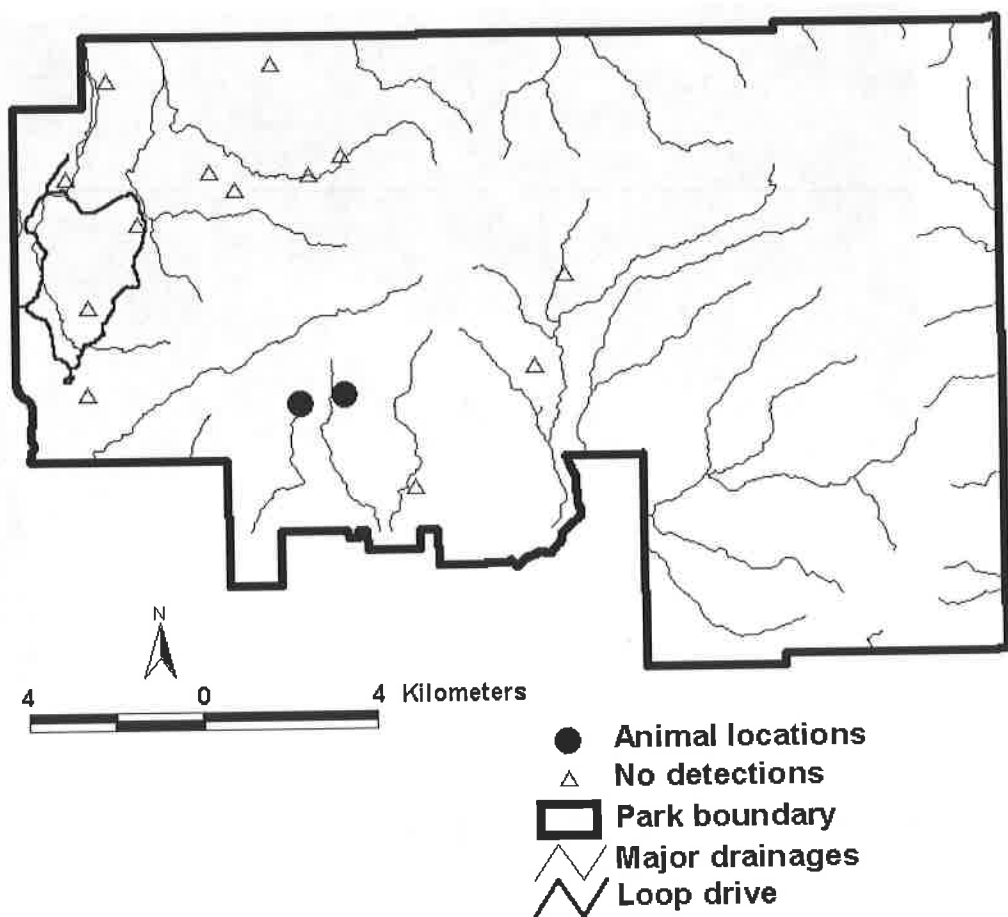


Mountain lion
Puma concolor



Point #126D January, 2002 11:00 pm

Mountain lion
Puma concolor

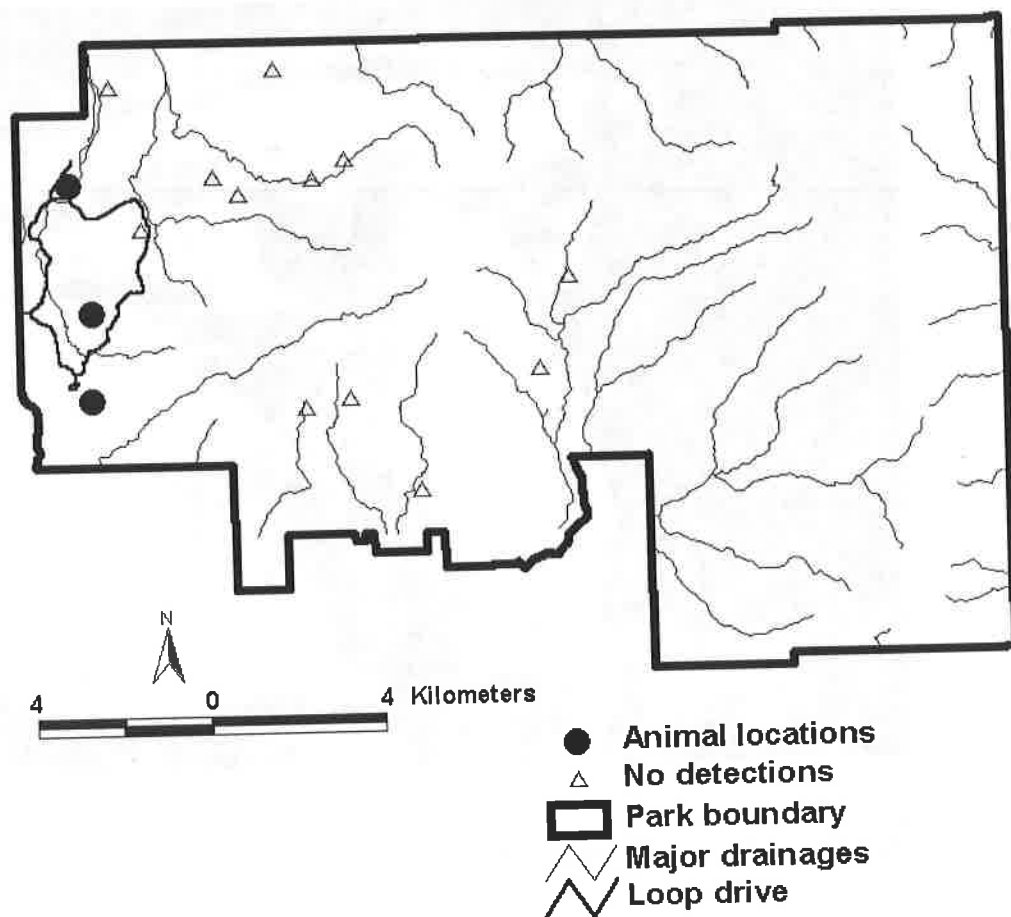


Bobcat
Lynx rufus



Point #118 November 9, 2001 5:08 am

Bobcat
Lynx rufus

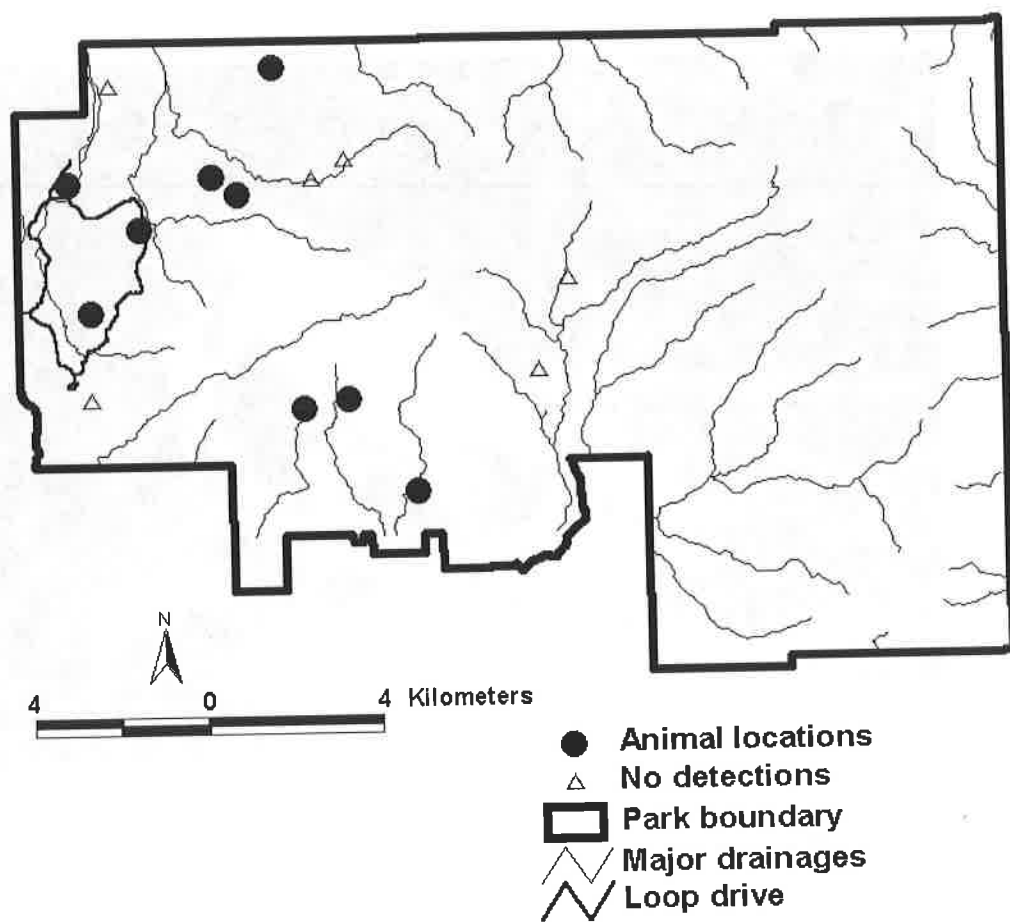


Collared peccary
Pecari tajacu



Point #118A November, 2001

Collared peccary
Pecari tajacu

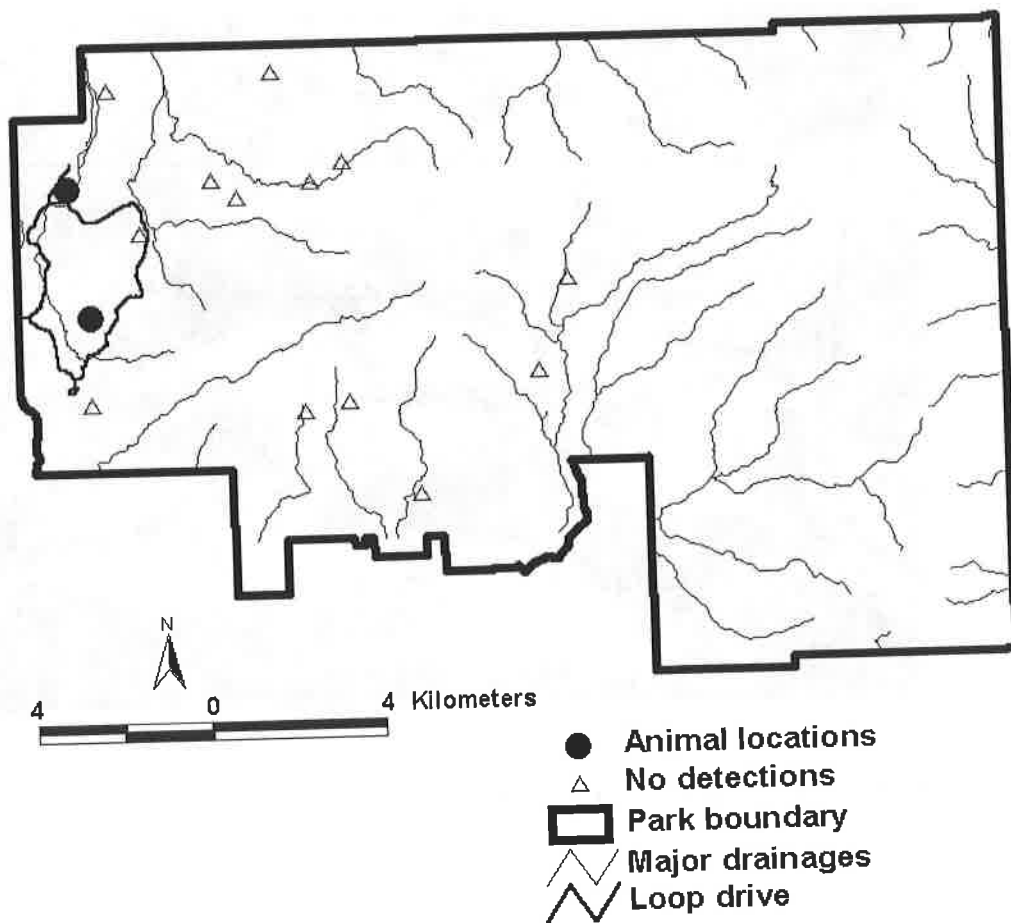


Mule deer
Odocoileus hemionus



Point #118A November 1, 2001

Mule deer
Odocoileus hemionus



White-tailed deer
Odocoileus virginianus



Point #126A September 13, 2001 9:46 am

White-tailed deer
Odocoileus virginianus

