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Detection and Relative Distribution of Ringtails (*Bassariscus astutus*) in Zion National Park, Utah

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Ringtail in Zion National Park
Photo Credit: Shaun Mason

The ringtail (*Bassariscus astutus*) is a small mammal in the raccoon family (known as Procyonidae), commonly found throughout the southwestern regions of North America. In southwestern Utah, the ringtail is most well-known for its presence in Zion National Park (hereafter “Zion"). The ringtail is an elusive, nocturnal omnivore (i.e., it eats plants and other animals) that is capable of using a wide range of habitat types. They are “habitat generalists,” making use of caves, crevices, cliffs, boulder piles, fallen logs, living trees, and buildings for their shelter and to raise their young. In Zion, ringtails are most commonly seen along habitats close to rivers and streams (riparian areas), because this is where the most food can be found in the otherwise dry climate. Throughout the year, they will move to where the food is the most available. As seasons change, and food becomes less available in the fall and winter, and ringtails can be tempted by the available food resources found in nearby human buildings. While biologists and park staff know that ringtails use Zion canyon (Trapp 1978), they aren’t sure where ringtails are throughout the rest of the park. We studied where ringtails are located in Zion by combining a trail cameras and track-plates to survey the park.

STUDY AREA

We conducted research in three main sections of Zion National Park, Washington County, Utah U.S.A (hereafter ‘Zion’): Zion Canyon, Kolob

Terrace, and the Kolob Canyons (Figure 2). The majority of the land in Zion National Park is designated wilderness and only accessible via technical hiking or canyoneering. Elevation varies significantly throughout the park from approximately 1,100 m (3,600 ft) in the SW corner to as high as 2,600 m (8,500 ft) in the NW corner.

The Kolob Terrace region has small tributaries to the Virgin River, but these are all ephemeral (seasonally wet). The elevation here is some of the highest in the park, and firs and ponderosa pine are most common, with a few piñon-juniper communities included. Year-round water is isolated to a few narrow slot canyons. The Kolob Canyons portion of Zion has one major body of water, Taylor Creek, which feeds into LaVerkin Creek just outside of the park boundary.

METHODS

Survey Methods

We used a combination of detection methods to survey for ringtail in Zion. First, we used a camera-trap (i.e., trail camera) survey to detect ringtails because this would give us temperature and time of activity information. To increase the likelihood of detecting ringtails, we placed a track-plate tunnel at every camera location.

Each sampling location consisted of two digital trail cameras (Bushnell® Trophy Cam™ 8 megapixel, Bushnell Corp., Overland Park, KS) focused on a corrugated plastic tunnel (Coroplast ®, Dallas, TX) enclosing a 0.32 cm thick aluminum plate (Clinton Aluminum, Clinton, OH) coated in charcoal (Gompper et al. 2006) and a raccoon scent attractant (F&T Fur Harvester's Trading Post). For details on the camera and track plate configuration see Roadman (2014).

The first of the two cameras used at each site was attached to the end of the tunnel using polypropylene webbing and metal snaps secured to the plastic walls (Figure 1). This camera detected animals that ventured inside the track plate tunnel. The camera within the tunnel was inactive for 15 seconds between taking photos of moving objects (e.g., wildlife going inside the tunnel). The second camera was placed in a tree or on a camera stand facing the track-plate tunnel. This camera was used to detect animals that may have looked at the tunnel but didn't go into it. Exterior cameras were programmed to record three photos at every motion trigger on the "normal" sensitivity setting, and then remain inactive for 30 seconds before resetting. The cameras were set to record the temperature, date and time of each photo.

Survey Locations

The survey was conducted throughout all three major regions of the park: Zion Canyon, Kolob Terrace, and Kolob Canyons (Figure 2). We used ArcGIS (version 10.0, Environmental Systems Research Institute, Redlands, CA) to determine random survey locations throughout each of the three regions. We overlaid a map of the entire park with road and water layers. Next, we created a 1-km (0.62 mile) buffer around both the road and water

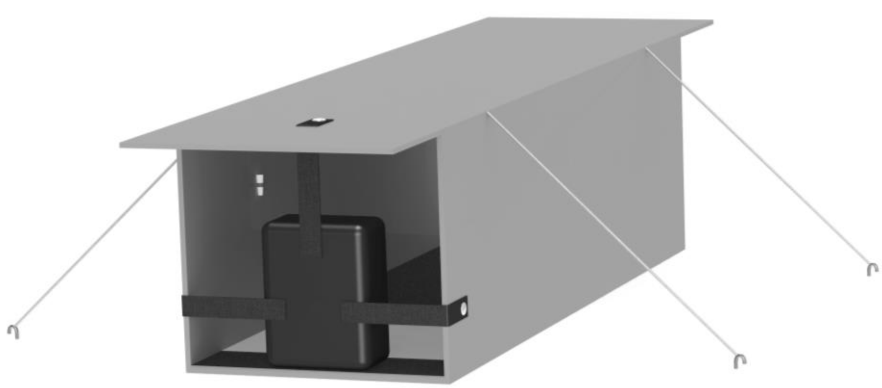


Figure 1. Schematic of the combination trail camera and track-plate tunnel used to detect ringtails (*Bassariscus astutus*), May 2012 - August 2013, in Zion National Park, Utah.

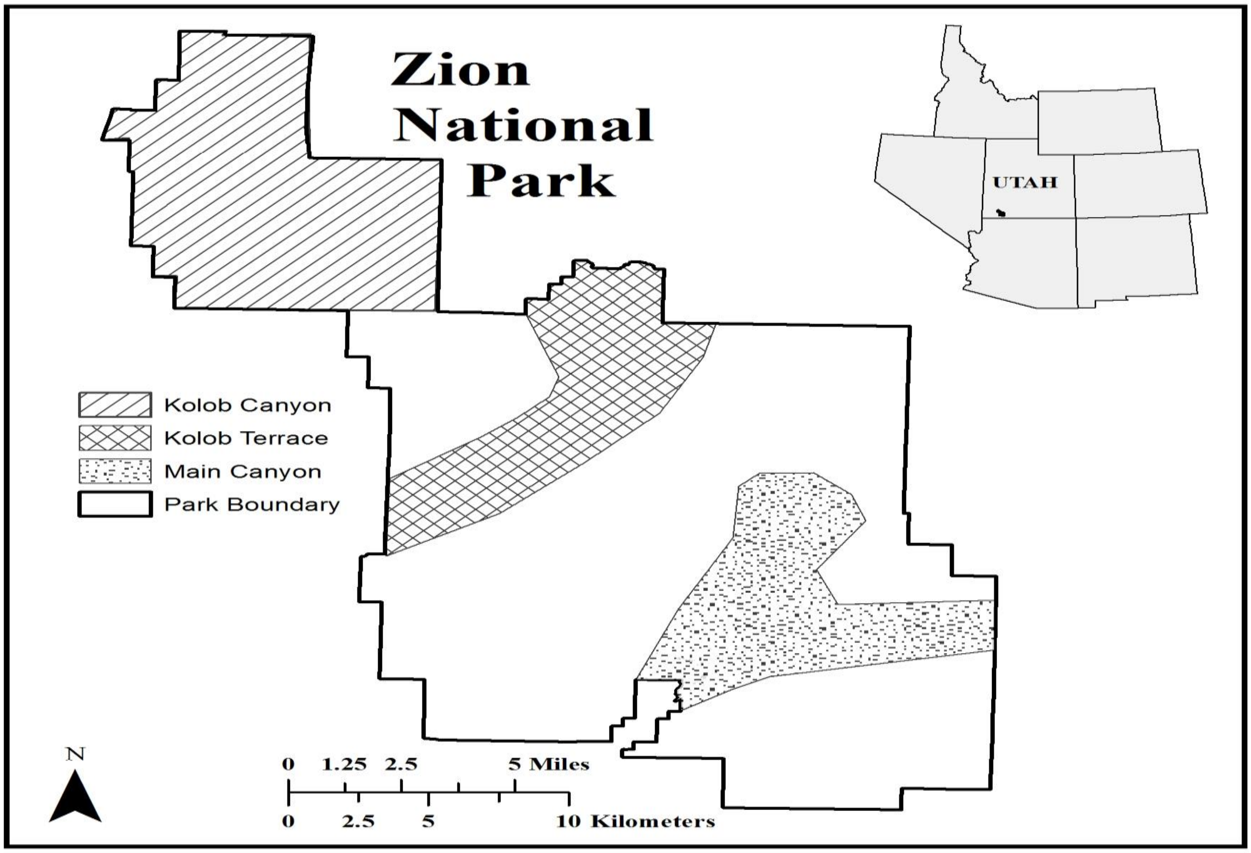


Figure 2: Location of study areas within Zion National Park, Utah, 2012-2013.

layers, and extracted the area that was both 1-km from a road and 1-km from water.

The road buffer ensured that it would be possible to reach sampling locations efficiently, safely, and consistently. Finally, we created a grid of locations 50 m (164 feet) apart, and fit it to the delineated area. With this final layer of points within 1-km of a road and water, 50 locations were randomly selected for sampling. If the random point produced was in an inaccessible area (e.g., cliff top), the point was rejected and another selected. Due to the high concentration of humans, known ringtail activity in human structures, and known potential ringtail habitat in the Zion Canyon regions, 25 locations were selected within this area; 13 locations were in Kolob Terrace, and 12 locations were in Kolob Canyon.

Survey Sampling Design

We divided the year into three seasons based on ringtail natural history: spring 2013 (January-April), summer 2012, 2013 (May-August), and fall/winter

Ringtail in Zion National Park, Utah

2012 (September-December). The spring period represented the time just before breeding (late March/early April) and summer encompassed the main kit-rearing season. Because activity declined and denning increased when temperatures dropped (Roadman, 2014), and the timing of this was unpredictable, we combined fall and winter months into one season. For each of these three seasons, we sampled five locations for seven consecutive nights. Then, we returned to the cameras and track-plates, uploaded any photos from the cameras, recorded any tracks in the track tubes, and moved the cameras and track-plates to the next five locations. We repeated this until all 50 locations had been visited.

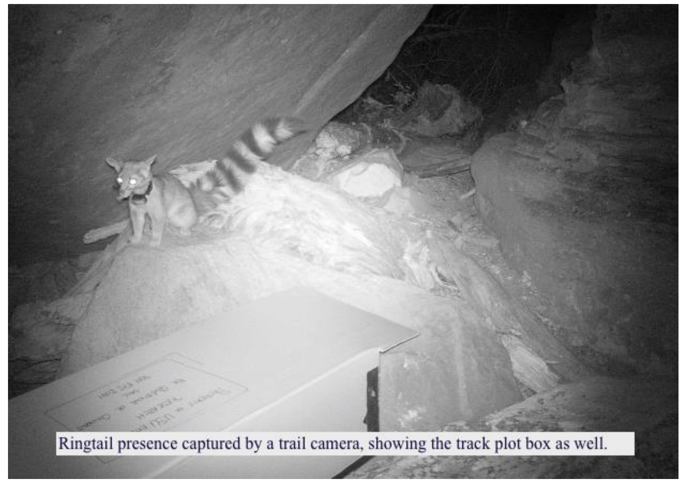

Ringtail in Zion National Park, Utah

Data Analysis

We analyzed our data by calculating the number of times we captured a photo or a ringtail track per night that the cameras and track-plates were used at a location ('capture rate'). When calculating the camera-trap detection rate, we considered multiple photos of an animal at a camera during a night as one detection. For track-plates, we couldn't determine what date the animal visited the track-plate tunnel, so the total number of tracks detected was divided by the number of nights the track plates were at the survey location. We used a general linearized mixed model (GLMM; Royle et al. 2009), using the statistical software SAS (version 9.4, SAS Institute Inc., Cary, NC) to determine any patterns of detection among the different seasons or locations; for details regarding this specific analysis, please view Roadman (2014).

RESULTS

Between May 2012 and August 2013, we placed cameras and track-plate tubes at 47 locations, during four seasonal sampling times. The data from Summer 2012 and Summer 2013 were considered separately, rather than combined as one interval. The first 4 weeks sampled of Summer 2012 had problems with study setup and location and may not have recorded effectively. These weeks were excluded from the analysis, but the two summer sessions were not analyzed together as a result. In total, the cameras were set for 1260 camera-trap nights. Over this time, 1,013 total captures were recorded, representing 26 different species. Some animals could not be accurately identified to species level, and were therefore recorded at the genus level (e.g. chipmunk; Table 1). The track-plates were active for 1220 trap nights, resulting in 116 captures of 8 species (Table 1).


Ringtail presence captured by a trail camera, showing the track plot box as well.

Motion-triggered cameras captured ringtails 16 times during the 1260 trap nights (capture rate /TN = 1.3%). During 1220 available trap nights for the track-plates, ringtails were detected 6 times (capture rate /TN = 0.5%). To compare these two capture rates, for each location, we also considered if the cameras captured a photo of a ringtail throughout a 7-day trap interval, and created a presence/absence score for that station during that interval; we did the same for the track plate data. We compared the camera and track-plate presence/absence data for 164 7-day intervals; camera-traps detected ringtails nine times (capture rate/interval = 5.5%) and track-plates detected ringtails six times (capture rate = 3.66%; $F_{1,275}$=35.33, $P < 0.0001$). Cameras were more successful detecting ringtails than track-plates ($F_{1,275} = 35.34$, $P < 0.0001$), and ringtails were detected at a lower rate in Fall/Winter 2012 than any other season ($F_{3,275} = 26.17$, $P < 0.0001$), with no recorded track-plate detections during this time period (Figure 3).

Most detections (13 of 15) were in Zion Canyon, while one track-plate detection and one photo detection were in the Kolob Terrace region in Summer 2012 (Figure 4). All ringtail detections within Zion Canyon were within 1 km (0.6 miles) to a permanent water source. The average distance to the nearest water source was 92 m (range: 2 m – 230 m; 5.6 – 755 feet).

Table 1. Photograph and footprint detection rates for all animals detected between May 2012 and August 2013 in Zion National Park, Utah. Represented as number of captures per 100 trap nights (TN)*.

		Camera Traps				**Track Plates**	
Species		**Summer 2012**	**Fall/Winter 2012**	**Spring 2013**	**Summer 2013**	**TN**	**Capture Rate/ Trap Event**
Bobcat	*Lynx rufus*	--	0.1 (1)	--	0.2 (3)	--	--
Bighorn Sheep	*Ovis canadensis nelsoni*	0.2 (3)	--	0.2 (3)	--	--	--
Bird	--	0.5 (6)	0.7 (9)	1.2 (16)	1.2 (17)	0.1 (1)	0.1 (1)
California Condor	*Gymnogyps californianus*	--	--	0.2 (3)	--	--	--
Chipmunk	*Neotamias spp.*	0.5 (6)	1.7 (22)	3.7 (47)	5.2 (66)	2.9 (35)	0.3 (35)
Cow	*Bos primigenius*	--	0.2 (2)	--	--	--	--
Coyote	*Canis latrans*	--	0.1 (1)	--	--	--	--
Desert Cottontail	*Sylvilagus audubonii*	0.2 (3)	0.4 (5)	2.3 (29)	0.6 (8)	--	--
Domestic Dog	*Canis lupus familiaris*	--	0.1 (1)	--	0.1 (1)	--	--
Gray Fox	*Urocyon cinereoargenteus*	2.9 (37)	3.3 (41)	0.9 (11)	1.1 (14)	0.1 (1)	0.0 (1)
Human	*Homo sapiens*	1.9 (24)	1.6 (20)	3.4 (43)	3.4 (43)	--	--
Horse	*Equus ferus caballus*	0.2 (2)	--	--	--	--	--
Merriam's Kangaroo Rat	*Dipodomys merriami*	--	0.7 (10)	0.4 (5)	--	0.2 (2)	0.0 (2)
Invertebrate	--	0.9 (11)	1.6 (20)	3.3 (42)	1.0 (12)	0.4 (5)	0.0 (5)
Lizard	--	1.0 (13)	0.4 (5)	1.0 (12)	3.0 (38)	--	--
Mule Deer	*Odocoileus hemionus*	2.0 (25)	6.4 (81)	1.5 (19)	1.7 (21)	--	--
Mouse	--	1.5 (19)	2.1 (27)	3.9 (49)	3.4 (43)	3.2 (39)	0.3 (39)
Marmot	*Marmota flaviventris*	--	--	0.1 (1)	--	--	--
Porcupine	*Erethizon dorsatum*	--	0.1 (1)	--	--	--	--
Raccoon	*Procyon lotor*	0.3 (4)	0.5 (6)	0.1 (1)	0.5 (6)	--	--
Red Squirrel	*Sciurus vulgaris*	--	--	0.1 (1)	--	--	--
Ringtail	*Bassariscus astutus*	0.5 (7)	0.2 (2)	0.2 (2)	0.4 (5)	0.5 (6)	0.0 (6)
Rock Squirrel	*Otospermophilus variegatus*	3.6 (46)	1.0 (13)	3.4 (43)	5.3 (67)	2.2 (27)	0.2 (27)
Snake	--	0.1 (1)	--	--	--	--	--
Striped Skunk	*Mephitis mephitis*	0.3 (4)	--	0.3 (4)	0.3 (4)	--	--
Wild Turkey	*Meleagris gallopavo*	0.1 (1)	0.2 (2)	0.1 (1)	0.1 (1)	--	--

*Total number of capture events per species is given in parentheses.

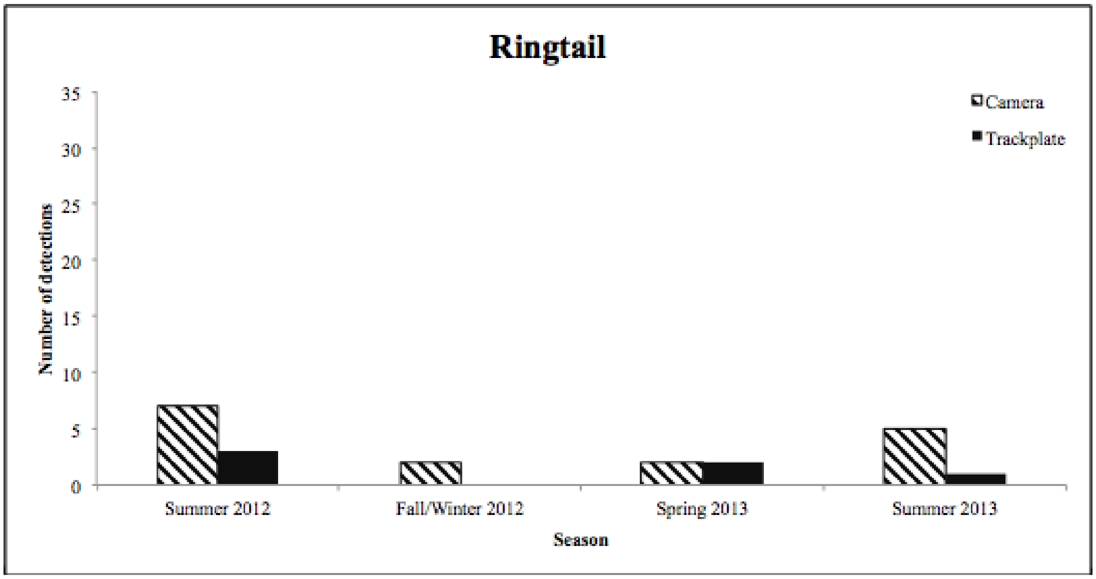


Figure 3. Number of detections of ringtails (*Bassariscus astutus*) using trail cameras and track-plates in Zion National Park, Utah, May 2012 - August 2013.

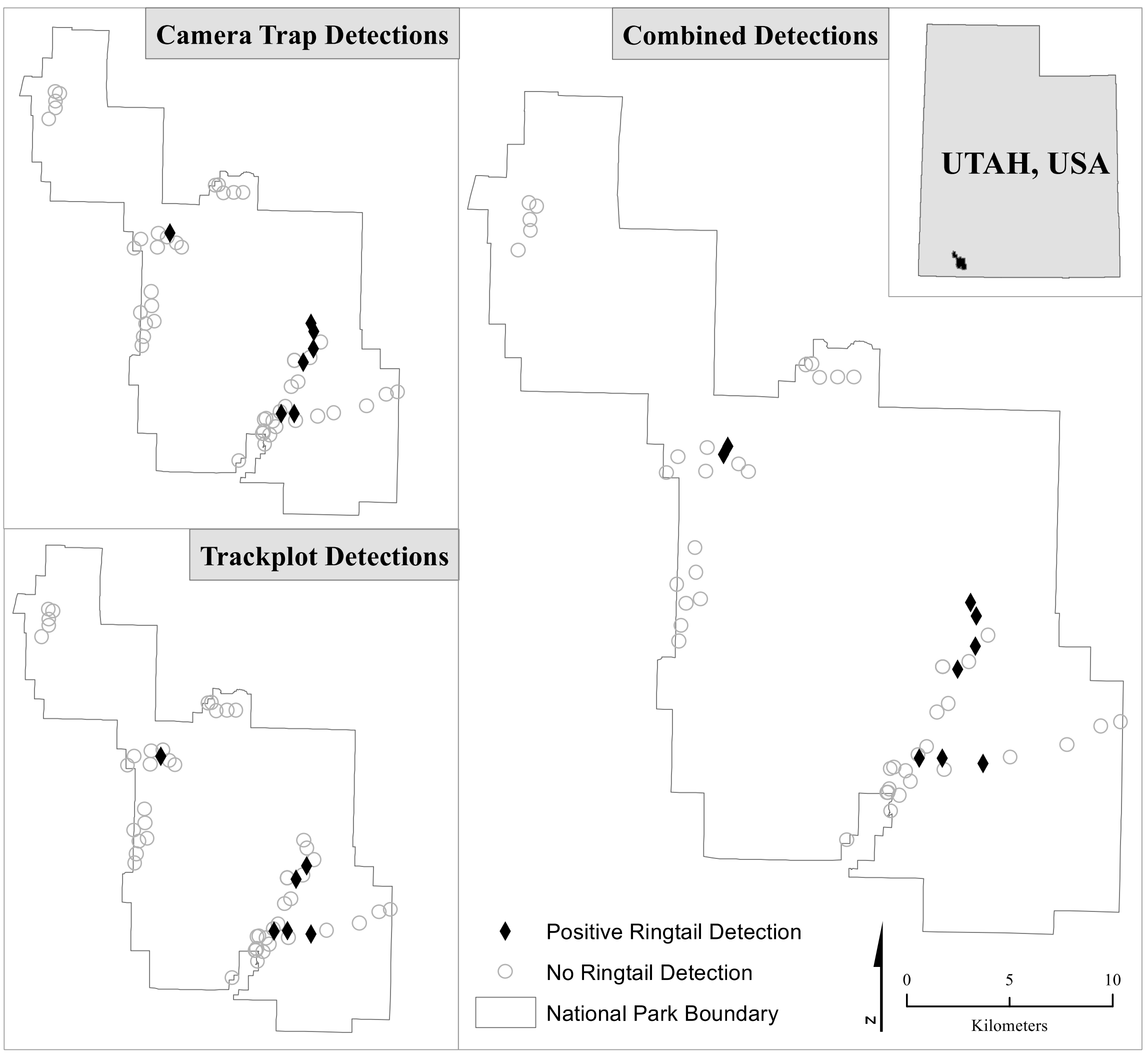


Figure 4:The locations of ringtail detections by trail cameras and trackplots in Zion National Park, Utah 2012 – 2013.

DISCUSSION

Ringtails were more often found by the cameras or track-plates in the main Zion Canyon than other areas of the park. However, this area was more heavily sampled than the other two areas due to our prior knowledge of ringtail conflict with humans near structures. The detections in Zion Canyon were all associated with riparian areas and running water, which is driving factor in habitat selection by ringtails (Roadman, 2014). Where we detected ringtails in Kolob Terrace were not in areas of known running water; because we only detected ringtails in this study area a few times, they may be using this area to disperse, rather than as a permanent home range. There were no detections of ringtails in Kolob Canyons, but there were a few places that did have water and suitable habitat that we were not able to safely access during our study. It is possible that ringtails live in these regions we were unable to access, and did not visit the areas where we had set our survey.

We detected ringtails with trail cameras and track-plates more often during the summer; this corresponds to the time when ringtails are more active and foraging for food. We knew from prior research in the area that ringtail activity is reduced in the winter (Roadman, 2014), therefore, we weren't surprised that we detected them fewer times during Winter/Fall than during other months.

While trail cameras are an effective method to determine the presence of wildlife in an area, they do have their limits in desert environments; the body heat of an animal may not be different enough from the ambient (outside) temperature to allow for it to be detected by the camera. For example, in Zion, the ambient temperature, as well as radiant heat from nearby sandstone features, may have been high enough throughout the evening as to cause a failure in the infrared sensors of the cameras. It is unclear exactly how wide of a temperature difference is necessary for the camera to properly function for an animal the size of a ringtail (or with similar body temperature). For the sake of example, let's suggest a 10° F difference between the ambient temperature and an animal is required to detect the animal. A ringtail has an active body temperature of 99.7° F (Chevalier 1984, Mugaas et al. 1993) ; therefore, any time the ambient temperature is between 89.7° F and 109.7° F, the camera may not detect a ringtail if it is present. During the sampling period between May 2012 and August 2013, 90 days were above 99.7° F, and 18 days averaged higher than 89.7° F; night time cooling would reduce the temperature no more than 10 degrees (NPS 2014). Thus, there were at least 90 nights were ringtail detection may have been compromised. This corresponds to the time of the greatest ringtail activity and possible movement throughout the park. In this situation, relying on camera traps to detect ringtails might not be an effective method. As was shown here, the addition of a track-plate can provide additional information to avoid those instances in which a camera may not detect an animal that is actually there.

MANAGEMENT IMPLICATIONS

These findings confirm that ringtails are concentrated in the riparian areas of Zion National Park, mainly in Zion Canyon. Because of the ringtail concentration within Zion Canyon it is important to protect this habitat as much as possible going into the future. Conservation measures such as a shuttle system and trail maintenance in the last decade manage the use of the habitat by humans, creating zones of low human use throughout the canyon.

Most of the riparian habitat within Zion Canyon that is being used year-round by ringtails is also in close proximity to the areas that humans also use, so the potential for human-wildlife interaction is high. Thus, active management may be needed to reduce any negative human-ringtail interactions. Ringtails have a history of readily associating with humans (Trapp, 1978). In recent years, ringtails commonly accessed historic structures within Zion, including the Lodge, where they visited the restaurant (while open) and the gift shop, causing monetary damage to merchandise (personal observation, 2013). Managers have been actively excluding ringtails from structures and enacting educational programs to alter human behavior that encourages ringtails' use of buildings (e.g., keeping restaurant kitchen doors closed). Monitoring for future ringtail activity is important to maintain the safety of both human residents and visitors, as well as ringtails.

Trail cameras and track-plates were both successful at detecting ringtails in an area. In areas of human residence, trail cameras may be an invasion of privacy. Additionally, the ambient heat, and heat coming off buildings may limit the effectiveness of a trail camera. Thus, the ability to use track-plates to detect ringtail presence in these areas is important for managers engaged in continued exclusion of ringtails from human-used structures.

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