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Title

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Journal

Proceedings of the Vertebrate Pest Conference, 23(23)

ISSN

0507-6773

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Publication Date

2008

DOI

10.5070/V423110482

Live Trapping and Monitoring Mountain Lion Movements within a Feral Horse Population in Storey County, Nevada, 2005 - 2007

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ABSTRACT: The depredation of feral horses by mountain lions is usually a rare phenomenon and only a few cases have been documented in scientific literature. While such reports indicate that mountain lions are easily capable of killing feral horses, these studies have focused solely on the feral horses and have neglected to consider the mountain lion's perspective (i.e., movement patterns, prey choice). Today, feral horses have created an artificial prey base for mountain lions, and even if natural ungulate species were not present, mountain lions appear to survive and flourish while consuming feral horses. During a feral horse behavior study conducted in 2005, a resident mountain lion in the Virginia Mountain Range was deemed responsible for several feral horse deaths, with most of the carcasses found being young foals or juvenile horses. A large live trap was developed and was strategically placed in a mountain lion travel corridor where the depredated horse carcasses were found. Bait in the live trap was changed on a weekly basis to prevent spoilage. The trap was set from October through December 2006 and monitored each morning. A 7-year-old, 60-kg female lion was caught in the trap after 3 months of trapping efforts. It was tranquilized, weighed and measured, and fitted with a satellite GPS collar. The satellite collar gave 4 locations per night. Based on the those GPS locations, we determined the lion had depredated on many feral horses, and it continued to range in the same area, even though other native wildlife species, such as mule deer, were in low densities. We monitored her progress until October 2007 to determine overall movement patterns and prey choice.

KEY WORDS: depredation, *Equus caballus*, feral horses, live trap, non-native, mountain lion, Nevada, *Puma concolor*, radiotelemetry, satellite collar

Proc. 23rd Vertebr. Pest Conf. (R. M. Timm and M. B. Madon, Eds.)
Published at Univ. of Calif., Davis. 2008. Pp. 140-144.

INTRODUCTION

The overpopulation of feral horses (*Equus caballus*) is recognized as a major ecological problem. Feral horses have been successful at populating areas for several reasons including their protected status, high reproduction rates, and lack of natural predation. Feral horses pose a management dilemma, in which managers must keep them on the range while balancing their impacts on the local environment. Due to the lack of natural predation, managers must adopt other strategies in order to manage numbers (i.e., removals and contraception), all of which have issues related to their use.

Mountain lions (*Puma concolor*) consume a variety of prey items and are known to depredate on several ungulate species (e.g., mule deer, *Odocoileus hemionus*, Hornocker 1970; moose, *Alces alces*, Ross and Jalkotzy 1996; bighorn sheep, *Ovis canadensis*, Wehausen 1996, Ross et al. 1997, McKinney et al. 2006), and their prey choice varies considerably both within and between habitats and sexes (see Anderson and Lindzey 2003). Mountain lion predation on feral horses is not widely documented in the literature. Mountain lions are known to be capable of depredating feral horses, are considered a potential predator of feral horses (Greger and Romney 1999), and in some cases are able to impact population numbers by reducing foal survivorship (Turner and Morrison 2001). Mountain lion predation on deer and bighorn sheep is an important management issue,

especially where the prey population is recovering or in very low numbers (Rominger et al. 2004, Robinson et al. 2002). Mountain lion predation on horses is important for both the conservation of other ungulate species and population management of wild horses. However, most feral horse populations are not controlled by mountain lion predation, most likely due to lack of overlap of ranges between the two species. In Nevada, mountain lions are a large predatory game species and are sport hunted year-round, with populations remaining steady over the last several years (Cox et al. 2007). The state of Nevada also has high numbers of feral horses, and due to high numbers of both species, it is possible for predator-prey interactions to occur.

A field study that looked at contraception efficacy and behavioral side effects in feral horses was initiated in spring 2005. During behavioral observations, several foal carcasses were found within 800 m of a major water source. Most of the carcasses were deemed, from several identifying signs (i.e., scratch marks, teeth punctures, covered by dirt, buried under trees), to be mountain lion kills. To look at lion predation and to determine prey choice, we captured and collared a large female mountain lion that ranged in the area. Here, we present methods of live-trapping a mountain lion with the use of frozen beaver (*Castor canadensis*) carcasses as bait and the use of satellite GPS technology to find predation sites.

METHODS

The study site was located in the middle of the western part of the Virginia Mountain Range, located east of Reno, Nevada. The range is bounded by Highway 80 on the north, Highway 395 on the west, Highway 50 on the south, and Highway 95A on the east. It is dominated by sagebrush (*Artemisia tridentata*), rabbit brush (*Chrysothamnus nauseosus*), and a variety of grasses in the valley areas and some pinyon pine (*Pinus monophylla*) and junipers (*Juniperus utahensis*) in higher elevations. Feral horses are the dominant ungulate in the mountain range, and other species present to a lesser extent include mule deer and pronghorn (*Antilocapra americana*). Other large mammals include coyotes (*Canis latrans*), mountain lions, bobcats (*Lynx rufus*), and less frequently, black bears (*Ursus americanus*).

Trap Design and Set-Up

A large, steel-cage live trap was built to a size of $1 \times 1 \times 2.5$ m in order to accommodate a large mountain lion. The trap was constructed by USDA APHIS Wildlife Services and was transported to the trap site by helicopter. The trap site was selected based on evidence of recent mountain lion activity, proximity to recent horse kills, and isolation from humans. Once the live trap was in place, it was covered with sagebrush while dirt, leaves, and small branches were used to cover steel grid trap floor.

Artificial corridors leading to the door of the trap were constructed from large willow tree branches and sections of sagebrush. The addition of the "brushing off" vegetative material was employed to help funnel the mountain lion directly in front of the set live trap. A frozen juvenile beaver carcass, used as bait, was attached to the back of the trap. The trap had a push-lever system (trap pan) that allowed the door to shut in two separate ways: first, if the mountain lion pushed down on the pan with its paw, or second, if the mountain lion pulled down on separate lever on the trap's ceiling. A small section of pigeon wing was attached with a string to the top lever, and it hung down so as to move when the wind blew. Frozen beaver carcasses were replaced on a weekly basis or when the bait appeared rancid. A live trap was selected over other capture methods (i.e., trailing dogs, snares) due to issues with private lands, dry rocks (which would have made trailing with dogs difficult), and our desire to minimize potential stress to the lion. The live trap was set October 10, 2006 and was checked with binoculars each morning.

Lion Capture

Due to lack of lion interest in the area, an electronic call box was placed behind the trap. It was set to emit sounds of mountain lions mating and was programmed to run 20 minutes at a time for 4 separate periods during nighttime hours (see Miller and Spencer 2006). A large female mountain lion was captured December 11, 2006, approximately 2 weeks after the call box was installed. Once the mountain lion was captured, a team of researchers and veterinarians were called to respond. The mountain lion was darted with 150 mg tiletamine base and 150 mg zolazepam base (Telazol®) intramuscularly in the right hindquarters, using a dart gun at a distance of 15

m while she was still in the trap. An additional injection of 100 mg tiletamine base and 100 mg zolazepam base was given in the rump, to complete sedation. Once tranquilized, the trap was opened and immediately her back and front legs were hobbled. She was carried out of the trap by two researchers and put on a blanket. Her body was covered and her eyes were treated with ointment. She measured 193 cm from nose to tip of tail and weighed approximately 60 kg. She was aged by tooth wear to be around 7 years of age and was considered in overall good condition. She was given a general exam that included a parasite check, blood sampling, and a pregnancy check. The total time of exam was 45 minutes.

A satellite GPS collar (Model #TGW-3580, Telonics, Mesa, AZ) was fitted around her neck. The collar weighed 950 g and was programmed to take 4 GPS points per night at the 1600, 2000, 2300, and 0200 hrs in the winter and at 1700, 2100, 2400, and 0300 in the summer, in order to monitor nocturnal behavior. The collar also contained a VHS receiver and a mortality sensor, and it had an approximate battery life of 350 days. It was programmed to release on October 10, 2007. Once the collar was fitted, the mountain lion was placed back into the trap with her face toward the back of the trap. The hobbles were removed, and the door was left open. She was monitored from a distance for approximately 3 hrs, until she was walking and maintaining alertness.

Predation Site Surveys

The GPS collar was deployed successfully, and it automatically emailed the previous night's available GPS points every morning. Home range size was determined using 95% kernel estimates (Worton 1989) with HOMERANGER v1.5 (Hovey 1999). Potential kill sites were determined from GPS point clusters (Anderson and Lindzey 2003). GPS clusters were investigated within a few days of receiving the downloaded data, with predation located on the ground using a hand-held GPS receiver. Most of the carcasses were found exactly at the GPS cluster, but if a kill was not found at the point cluster, an area with a radius of 800 m was searched. Once a kill was found, the species, sex, age, color, markings, and GPS location of the prey were recorded. It also was noted what body parts were consumed, the location of carcass (i.e., under tree, buried, open), and any other characteristics of the predation event (e.g., carcass dragged from kill site). When applicable, a Photohunter® camera was set up at carcasses that were intact enough for another visit by the mountain lion. The camera was placed between 3–4.5 m away from the carcass at a height of 0.3–0.6 m. These predation sites were monitored until the release of the collar. Frequency of visits was determined using ArcView™ software (ESRI, Redlands, CA).

RESULTS

The collar stayed intact for the duration of the study, and no adverse side effects on the lion's health and apparent condition were noticed in photos taken at kill sites. The collar successfully released on the programmed date and was retrieved the next morning with

the use of a VHF receiver. The mountain lion appeared to be in good physical condition for the 10 months, and she gave birth to 2 healthy kittens that were documented to be with her at the end of the study. We estimated that the kittens were born in late May 2007.

Prey Selection

Over the course of 10 months of monitoring, we found 22 carcasses attributed to the mountain lion's predation. A summary of carcass kills is found in Table 1. Three species of prey appeared to comprise her entire diet: over 77% of the carcasses found were feral horses, and all were determined to be under the age of 9 months. The only other species consumed were mule deer and coyotes. She spent an average of 4.86 days on each carcass. Cameras documented other visitors at the predation sites, including turkey vultures (*Cathartes aura*), coyotes, magpies (*Pica hudsonia*), and one black bear.

Movement Patterns

Based on GPS locations and collar data, there were no changes in average ambient temperature or altitude during study. She never ranged into the suburban areas of the mountain range. The lion's home range size was estimated to be 170.3 km². Her movements decreased in June compared to May, after her kittens were born.

DISCUSSION

To our knowledge, this was the first case in Nevada of live-trapping a mountain lion using bait, rather than a fresh mountain lion kill. This method of capture was used because the terrain was not conducive to using dogs (presence of dry rocks, and the threat of hounds near houses and highways) for treeing a lion. Further, much of the mountain range is private property with segments of suburban areas. While this method took several months, it was successful and ultimately did not appear to adversely alter the health of the mountain lion. It is possible that the lion, before we set the trap, shifted to another part of her home range because of recent rains and cooler temperatures, which could be a possible explanation for the duration of time required to trap her.

The call box was most likely responsible for her capture, since she was trapped 2 weeks after its deployment. In the future, the use of call boxes would most likely decrease capture time by enticing animals into the area. The only non-target species we trapped was a gray fox (*Urocyon cinereoargenteus*), and it was released immediately after it was found. With this trapping method, it is important to check the trap every morning and use fresh bait as often as possible, as mountain lions tend to utilize fresh meat. We changed bait every 7-10 days, as cool winter weather kept the meat fresh for long periods of time.

While the collar was successful at transmitting GPS points, there were several periods of time (up to 3 weeks on one occasion) that the GPS collar did not transmit a signal. When the collar was retrieved, both of its antennas had been completely worn down, which could influence the satellite capabilities. Also, the nature of mountain lions inhabiting rock crevices may have also

Table 1. Total prey found at predation sites from GPS clusters of a collared female mountain lion ranging in Nevada, from December 2006 through October 2007.

Prey Species	Percentage in Diet	Predation Rate*
Horse	77.27	5.41
Mule Deer	13.63	3.50
Coyote	9.09	1.50

*based on average nights visited per kill

obstructed signals. Predation frequency was difficult to determine because of problems with the collar, but when she was in constant contact, she fed once per week, even with kittens. GPS technology was the only way to find kill sites and document daily movement patterns. We acknowledge that we missed several kills because of poor satellite coverage, and it is possible that she fed on small mammals (see Rosas-Rosas et al. 2003); however, these data reflect accurate depredation on feral horses over other native ungulates, since the overwhelming majority of carcasses found were horses (77%). We found that the quicker we investigated GPS clusters, the more likely we were able to find a carcass, thus noting the importance of weekly or even daily investigations of kill sites.

By looking at the predation from the lion's perspective, we can quantify prey choice. Mountain lions are known to kill feral horses (Turner et al. 1992, Turner and Morrison 2001), and here we document another example of a mountain lion that killed and consumed feral horses even in the presence of other wildlife (deer) and human development (pets). We also found this mountain lion consumed more feral horses than native mule deer, which was not the case in the Montgomery Pass population (Turner and Morrison 2001). This may not represent a true preference, but rather reflected the abundance of horses within the range, compared to other ungulates. Conservative estimates showed feral horses to be 4-6 times more abundant than mule deer in our study area. From the kill sites, we determined this lion exclusively preyed on foals or juveniles. Young and solitary animals have been reported as most vulnerable to mountain lion predation (e.g., Turner et al. 1992), and we found every horse kill to be a foal or a juvenile (<9 months), as has been reported in other feral horse populations (Turner et al. 1992, Turner and Morrison 2001). Feral horses provide a constant food source of young, small horses because of an 11-month gestation, and the majority of foals are born in the spring (April-June) every year (Keiper and Houpt 1984, Garrott and Siniff 1992). Therefore, when yearlings become potentially too big to capture, the next year's foals are being born. Because of this, a strategy to depredate young horses would work successfully for mountain lions.

All kills were consumed to the bones and often eaten with maggots present. This is not often the case with male mountain lions, but because this female had kittens, she may have been forced to eat spoiled meat. She spent an average of 4.86 days on each carcass, and for horse carcasses she stayed on average 5.41 days. Horses may not only be easier to catch, but also may give her longer duration of time between kills because of their size.

These data are consistent with other mountain lion predation rates (Anderson and Lindzey 2003). There was also a seasonal effect, in which she stayed on carcasses less (3.11 days) during the summer months. This was attributed to warmer conditions and shorter times for meat to taint. It was difficult to sex carcass kills, and no differences were found in the kills that were sexed. No differences in color were found among the horse carcasses.

While these kill sites attracted other species, most of the kills were protected due to burial or hidden underneath trees. Roughly 64% of carcasses were found under a tree or thick brush, while the rest were buried in the dirt or under grass. The mountain lion made an attempt to cover all carcasses, but several scavengers came to investigate or eat part of the carcass. The most common visitor was the turkey vulture, followed by other bird species, then coyotes and small rodents. One carcass was visited and consumed by a black bear, which resulted in the mountain lion leaving the kill and the general area for a few weeks. The presence of a black bear visiting the mountain lion kill may have forced her to make additional kills rather than to compete with the larger predator, especially since she had two vulnerable kittens. These dynamics may shift prey choice and predation strategies, but more data would be needed to tease apart those interactions.

Our efforts to detect the mountain lion with a camera were surprisingly successful, since mountain lions are known to be difficult to capture on film (e.g., Long et al. 2003). This may be due to setting the cameras up at kill sites that mountain lions are mostly likely to revisit. We photographed the lion at several kill sites at least once, and were able to detect kittens as well. The first camera installation was set with a delay of 5 minutes, which resulted in 1-4 photos of the lion, along with other visitors. Toward the end of the study, we decreased the delay to 1 minute and were able to get several more photos. The mountain lion was present mostly during nighttime hours but on some occasions was documented at predation sites during dusk. During nighttime photos, a flash was used to get the photo. This did not seem to impact feeding behavior adversely, since the lion was seen re-visiting several carcasses over a several-night period, or she would drag the carcass to another location. The kittens were seen at kill sites in September 2007 and began to eat the meat with their mother. To our best estimates, they were born late May 2007, making them 4 months of age when they started to participate in eating meat. We photographed a deer carcass that was visited by another mountain lion while the collared lion was present, but it was not apparent if the unknown mountain lion was attracted to the carcass or was attracted to the female lion. No aggression was seen, and no changes in the health of the adult female or the kittens were seen after this encounter. This was the only occurrence of this kind that we documented.

In conclusion, we present a new approach to trapping mountain lions without causing massive shifts in movement patterns. While we emphasize we only collared one individual, it is nonetheless another documentation of the ability of mountain lions to

depredate feral animals, and to do so in the presence of native ungulate species. These data have implications for potential population control of feral horses. They will hopefully add to a future larger study that will track more mountain lions, both within this range where feral horses are present, and also in other ranges where horses are not present. While we found this one lion killing feral horses, there are very few (estimated to be less than 6) mountain lions in that mountain range; thus, they would likely not be a major source of population control.

ACKNOWLEDGEMENTS

We thank the USDA APHIS Wildlife Services for technical support and the use of the live trap. We thank Mike Teglas and Amber Long for technical support during the capture. We thank private land owners for access to trapping and predation sites.

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