THE SOUTHWESTERN NATURALIST 50(4):466–471 DECEMBER 2005

SCAVENGING BEHAVIOR IN PUMA

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ABSTRACT—We examined scavenging on mule deer (*Odocoileus hemionus*) carcasses by puma (*Puma concolor*) in the Peninsular Ranges of San Diego County, California. Between January 2001 and October 2003, we placed 44 deer carcasses at 23 sites and used them to examine scavenging events. We also documented 2 additional deer carcasses, not placed as bait, that were scavenged by puma. Eight to 12 puma (6 males, 2 to 5 females, and 1 of unknown sex) scavenged 20 of 46 deer carcasses (43.5%) at 12 of the 25 sites. Six puma (4 males, 2 females) were captured 7 times at scavenging sites. We identified 7 scavenging puma (5 males, 2 females) through captures and telemetry, and 1 unmarked, scavenging male from a camera trap. The 7 telemetered puma that scavenged ranged in age from 11 months to 9 years, and each individual scavenged on 1 to 6 deer (mean = 2.3). Deer carcasses were found and scavenged by puma from 1 to 14 days (mean = 5 days) after deposition, when carcass conditions ranged from frozen and fresh to rotting and maggot-infested. Puma treated scavenged carcasses as they would their own kills, dragging carcasses to preferred sites, caching, depositing scats, and making scrapes in the area. However, puma did not always attempt to cache tethered carcasses. During fieldwork, we also discovered that 1 telemetered puma repeatedly visited a domestic livestock graveyard and scavenged on surface-discarded horse and cattle carcasses. Puma are known to be opportunistic predators, but our results indicate that they are opportunistic scavengers as well. Due to the propensity of puma to scavenge, it is likely that some perceived kills might be scavenging events. Frequent monitoring and timely field investigation of mortality signals detected from telemetered prey species will help investigators identify those events. Scavenging behavior should be considered when evaluating or predicting the effects of puma predation on prey species.

RESUMEN—Examinamos el uso de carroña de venado bura (*Odocoileus hemionus*) por el puma (*Puma concolor*) en las Sierras Peninsulares del condado de San Diego de California. Entre enero del 2001 y octubre del 2003, colocamos 44 cadáveres de venado en 23 sitios y se usaron para describir eventos de utilización de carroña. Adicionalmente se documentó el uso de 2 cadáveres de venado, no colocados como carnada, que fueron usados como carnada por pumas. Ocho a 12 pumas (6 machos, 2–5 hembras, 1 de sexo desconocido) comieron 20 de los 46 cadáveres de venado (43.5%) localizados en 12 de los 25 sitios. Seis pumas (4 machos, 2 hembras) se capturaron 7 veces en los sitios de carroña. Identificamos 7 pumas como carroñeros (5 machos, 2 hembras) por medio de capturas y telemetría, y un macho sin marcar por medio de una trampa de cámara. Los 7 pumas con radiotransmisores que se alimentaron de carroña variaron de edad entre 11 meses y 9 años, y cada uno se alimento de 1 a 6 venados (promedio = 2.3). Los cadáveres de venado fueron encontrados por los pumas de 1 a 14 días (promedio = 5 días) después de ser colocados, cuando las condiciones de los cadáveres partían de congelados y frescos a podridos e infestados de larvas de mosca. Los pumas trataron a los cadáveres de venados como si fueran sus propias capturas arrastrando cadáveres a sitios preferidos para almacenar, depositando excretas, y haciendo rascaderas en el área. Sin embargo, los pumas no siempre trataron de esconder los cadáveres atados. Durante el trabajo de campo descubrimos que un puma con radio visitaba en repetidas ocasiones un cementerio de animales domésticos alimentándose de cadáveres de caballos y ganado dejados en la superficie. Se sabe que el puma es un depredador oportunista, pero nuestros resultados indican que también son carroñeros oportunistas. Debido a la preferencia del puma a utilizar carroña, es probable que algunas especies presa atribuidas a cacería sean de hecho

carroña. El monitoreo frecuente y a tiempo de señales de muerte de especies presa con radiotransmisores ayudará a los investigadores a determinar esos eventos. El comportamiento carroñero debe considerarse cuando se quiera evaluar o predecir los efectos de la depredación de especies presa por el puma.

Our examination of scavenging behavior by puma resulted from efforts to capture and radiocollar puma in the Peninsular Ranges of southern California (Sweanor et al., 2004). Few researchers studying puma diet or puma-prey relationships have reported incidences of scavenging. The most logical explanation for this is that puma rarely scavenge. However, there is also the possibility that scavenging events are misidentified as predation, especially when carcasses have decayed or been consumed to the point that exact cause of death can no longer be determined. The potential for scavenging by puma is important because it might be a potential source of error in studies of the effects of predation on prey populations, as well as in identifying cause-specific mortality. Our objectives were to determine the propensity with which puma scavenge. If we observed scavenging, we also wanted to document the characteristics of scavenging behavior and carcass condition when scavenging events occurred.

METHODS—*Study Area*—We examined scavenging behavior of puma in the Peninsular Ranges of San Diego County, California, from January 2001 through October 2003. The study area included Cuyamaca Rancho State Park (SP) and 2 properties administered by San Diego County Parks 11 km north of Cuyamaca Rancho SP: Volcan Mountain Wilderness and Santa Ysabel Open Space Preserves. The state park and preserves were surrounded by a mix of public and private lands, with Cuyamaca Rancho SP and the 2 preserves comprising 100 km^2 and 26.1 km^2, respectively. Plant communities included chaparral, grassland, southern oak (*Quercus*) woodland, and yellow pine (*Pinus*) forest (Munz and Keck, 1959), and elevations ranged from 1,067 to 1,985 m. Mule deer (*Odocoileus hemionus*) occurred throughout the area and were the primary food source for puma (Sweanor et al., 2004). Other animals that occurred in the area and were documented as puma prey included bobcat (*Lynx rufus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), wild turkey (*Meleagris gallopavo*), pets (cats, dogs), and hobby animals (alpacas, chickens, geese, goats, pigs, and sheep).

Field Methods—We obtained fresh deer carcasses by collecting deer that died from collisions with vehicles ($n = 35$), a United States Department of Agriculture, Wildlife Services deer-culling operation in Los Angeles County ($n = 5$), disease or fighting injuries ($n = 2$), unknown causes ($n = 1$), and a dog attack ($n = 1$). Estimated average weights for female and male mule deer carcasses were 41 kg and 56 kg, respectively. Carcasses were either placed at bait sites immediately or frozen in a chest freezer until needed. Only one carcass at a time was placed at a given bait site, but several bait sites were used more than once. We set baits in areas where we previously had observed puma sign (i.e., tracks, scrapes, scats) or adjacent to wildlife trails. Each carcass was tied securely to a bush or tree in an attempt to prevent it from being dragged or carried from the site by scavenging animals. Leghold snares were set around 5 of the baits. We also periodically placed cameras (CamTrakker, Watkinsville, Georgia) at some of the bait sites to record animal species that approached carcasses. Baits were examined each morning for signs of scavenging. When scavenging was detected, we estimated the amount consumed as a proportion of edible tissue (i.e., soft tissue and bone, excluding the rumen, skull, and lower portions of the legs below the elbows and knees). We also attempted to determine the species responsible. Puma scavenging was determined based on the discovery of carcass consumption and puma sign (i.e., tracks, feeding pattern, covering of carcass, scrapes, and feces), photographs, and GPS locations and radio telemetry of collared puma at the site. We examined carcasses daily until no edible soft tissues remained.

We placed a cage trap at sites where a puma that was targeted for capture or recapture had scavenged a carcass. The scavenged carcass was placed inside the cage and the cage door was rigged with a radiotransmitter. Remote monitoring of the transmitter indicated when the cage door closed. Cage traps were monitored continually after they were set. Captured puma were immobilized chemically with Telazol [tiletamine and zolazepam (100 mg/mL solution); Fort Dodge Animal Health, Fort Dodge, Iowa] at dosages in accordance with the California Department of Fish and Game Wildlife Restraint Handbook (2000) and fitted with either a VHF collar (Telonics MOD500, Telonics, Inc., Mesa, Arizona) or GPS collar (Televilt P-1D, Telemetry Solutions, Walnut Creek, California). After a successful capture, the carcass was removed from the cage, left unsecured at the site, and monitored for subsequent scavenging events.

RESULTS—We determined that puma scavenged 20 of 46 deer carcasses (43.5%). We

placed 44 deer carcasses at 23 bait sites. Two sites were in the Volcan Mountain Wilderness and Santa Ysabel Open Space Preserves, the rest were within Cuyamaca Rancho SP. All sites were >100 m apart. We used each bait site from 1 to 6 times (mean = 2.4). Eight to 12 puma (6 males, 2 to 5 females, 1 of unknown sex) scavenged 18 of 44 carcasses (40.9%) at 10 bait sites. We observed 2 additional cases of scavenging on carcasses that were not placed at bait sites. The first case was of a male puma scavenging a deer that had been struck by a vehicle and euthanized approximately 250 m away from the highway. The second case involved a male that removed a deer carcass from the open bed of a researcher's pickup truck at night during the time interval between collection of the carcass and intended deposition at a bait site. This incident occurred on a paved parking lot in Cuyamaca Rancho SP about 50 m from an occupied cabin and under full illumination of an all-night security light about 11 m from the truck bed. The puma pulled the deer carcass from the truck bed and dragged it past the security light and approximately 200 m uphill into dense chaparral cover where it scavenged the carcass.

We identified 7 scavenging puma (5 males, 2 females) through captures, telemetry, or both, and one unmarked, scavenging male puma from a camera trap. Six adults (4 males, 2 females) were captured 7 times at scavenging sites. Another 9 scavenging events were by 4 collared males (3 adults, 1 cub) that were not captured. There were up to 3 other females and one puma of unknown sex that scavenged on 4 deer carcasses; however, we suspect that 1 to 3 of these scavenging events were by a collared female who was captured at a subsequent deer-scavenging site. An additional case of scavenging might have been curtailed because the puma was captured in a leghold snare as he approached the carcass. Five of 6 adults captured at scavenging sites seemed to be in excellent physical condition, weighing from 58 to 65 kg for 4 males and 43 kg for 1 female. A second female weighed 35 kg at capture and was in fair condition, having suffered a severe injury to her lower mandible 1 to 2 weeks prior to capture. Four of the 6 puma were documented killing mule deer between and after scavenging events.

Each of 10 bait sites was visited by 1 to 4 scavenging puma (mean = 1.8 puma). Four puma (3 males, 1 female) scavenged 5 carcasses at a single bait site. In 3 cases, adult males returned to the same site to feed on a different deer carcass. In 2 cases, a male and a female fed on the same deer carcass. The 7 radio-collared puma (5 males, 2 females) that scavenged ranged in age from 11 months to 9 years, and each scavenged on 1 to 6 deer (mean = 2.3).

Puma scavenged deer carcasses from 10 hours to 15 days (mean = 5.2 days) after initial deposition at bait sites. The condition of carcasses at time of initial scavenging ranged from frozen to fresh to putrid and maggot-infested. Five carcasses had been sitting at least 9 days prior to being scavenged. In one of those cases (a 14-day-old putrid carcass), the female puma ate about 1 kg of tissues, covered the carcass, then regurgitated the meal and covered it. She did not return to the carcass again. On 2 occasions where puma began scavenging on decaying carcasses (9 to 15 day exposure), we replaced them with fresh carcasses to facilitate cage capture. In both cases, the puma returned to the bait site and fed on the replacement.

In 7 of 11 cases where puma were undisturbed by capture attempts, the puma consumed at least 50% of edible tissues. Five of 7 individuals captured at carcasses returned to feed after release; in 3 of those cases, the puma consumed at least 50% of the carcass. Puma dragged the 2 untethered carcasses from 75 to 200 m to dense vegetative cover prior to feeding. At least 8 carcasses were covered or partially covered between feedings; 4 carcasses (all tethered) were not covered. All carcasses were left uncovered after the last feeding. In at least 3 scavenging events, the puma scraped, deposited feces, or both near the carcass.

Only 2 of the 46 deer carcasses were not scavenged by some other animal. In addition to puma, scavengers determined from photographs, tracks, and inadvertent capture in a cage trap included bobcat, coyote, gray fox (*Urocyon cinereoargenteus*), striped skunk (*Mephitis mephitis*), turkey vulture (*Cathartes aura*), common raven (*Corvus corax*), and American crow (*Corvus brachyrhynchos*). At least 3 carcasses that were scavenged by puma also were scavenged by bobcat or gray fox. We do not know how many carcasses might have been detected

by puma but not approached and fed on. In one instance, an uncollared female walked about 200 m from a 3-day-old carcass without approaching it. Additionally, a GPS-collared female walked about 15 m from a 7-day-old carcass without approaching it.

In addition to scavenging on deer carcasses, we documented one GPS-collared male that repeatedly visited a domestic livestock graveyard and scavenged on surface-discarded horse and cattle carcasses. The carcasses were not moved or covered between feedings, but we found scrapes and puma feces within 10 m of 2 of the carcasses.

DISCUSSION—Our findings suggest that puma in southern California are naturally inclined to scavenge. Scavenging by puma in other areas of North America also has been reported in the literature. In some instances, it is treated with a certain amount of ambiguity. The summary by Young (1946) of results from field and laboratory examinations of stomach contents by the United States Fish and Wildlife Service suggested that puma scavenging was occurring. Field examinations of puma stomachs collected by Fish and Wildlife Service hunters throughout the western United States from 1918 to 1922 reported ''bait'' and carrion occurring in 4 of 394 and 1 of 394 stomachs, respectively. Stomach content analyses from 113 puma collected in 9 western states indicated annual consumption of carrion was 2.2% by volume and 3% by frequency of occurrence (Young, 1946). Spalding and Lesowski (1971) reported finding carrion, defined as flesh from animals killed by means other than puma predation, in 6 of 62 stomachs examined. Robinette et al. (1959) reported that federal hunters in Utah and Nevada found several dead puma that apparently died from feeding on 1080 poison-bait stations. In another instance, the stomach from a puma killed during the winter contained approximately 3.5 kg of beaver (*Castor canadensis*) flesh. Because no beaver hide was present, the authors suspected the puma had scavenged on a skinned carcass. The authors also documented 3 cases of puma having fed on hunter-killed deer (Robinette et al., 1959). Likewise, puma have been reported to feed on hunter-killed elk (*Cervus elaphus*) (Hibben, 1937). Puma scavenged 4 cow moose (*Alces alces*) in southwestern Alberta (Ross and Jalkotzy, 1996). Ackerman et al. (1984) reported scavenging on one mule deer and 2 cows, and Linsdale and Tomich (1953) mentioned a scavenging event on a deer that died from natural causes. In Texas, McBride (1976) noted a steer that had been killed and partly eaten by a puma was scavenged by a second puma one month later. Logan and Sweanor (2001) reported the greatest number of scavenging events. They found 12 mule deer, one bighorn sheep (*Ovis canadensis*), and one oryx (*Oryx gazella*) scavenged by puma in their New Mexico study area.

Scavenging might provide advantages to individual fitness. Because scavenging does not require the energy expenditures necessary for hunting and killing prey, it meets the energy needs of the puma and reduces the risk of injury during attempts to capture large prey. In New Mexico, 3 adult female puma died after sustaining injuries from unsuccessful attempts to kill mule deer (Logan and Sweanor, 2001). Two of the females suffered massive blows that caused the lungs to bleed, and the other was gored through the eye, probably by a deer's antler. Studies in Utah, Idaho, and Alberta also have documented puma fatalities from struggles with prey (Gashwiler and Robinette, 1957; Hornocker, 1970; Lindzey et al., 1988; Ross et al., 1995).

Scavenging might be more prevalent in winter, when cold temperatures reduce spoilage. Puma did not scavenge any of the carcasses we placed out between May and August ($n = 10$). All of the scavenging we documented occurred between September and April, and 9 of 20 events occurred between November and January. However, 4 carcasses were scavenged during the months of March and October, when temperatures were moderating and the carcasses had been sitting at least 9 days. In one of these events, the puma regurgitated the spoiled meat.

It is probable that scavenging by puma is underestimated, because puma might treat scavenged prey similarly to animals they kill themselves (e.g., dragging carcass to a more secure site, covering the carcass, scraping, and defecating near the carcass). Although field sign (e.g., puma and prey tracks converging on an area of disturbance, drag-line originating from or blood stains present at the disturbance site) can be used as strong supporting evidence,

confirmation of puma predation can be made only when the carcass is fresh enough to reveal mortal injuries inflicted by the puma (e.g., canine punctures to the neck or head with resulting subcutaneous hemorrhaging, crushed trachea). Consequently, researchers must consider the potential for error and bias when analyzing agent-specific mortality. Bias (overestimating or underestimating predation and scavenging) could be reduced by: 1) developing specific criteria for classifying predation versus scavenging behavior; 2) frequent monitoring of radio-collared prey animals and timely investigation of mortality signals of those animals; and 3) timely investigation of radio-collared puma locations when the researcher suspects the puma is feeding on prey.

Scavenging behavior can provide opportunities for safe captures. We captured 6 puma 7 times using cage traps (n = 6) or leghold snares (n = 1) baited with deer carcasses. We checked carcasses daily for evidence of puma scavenging, only placed baits inside cage traps when a targeted puma began feeding on a carcass, and continuously monitored the trap after the bait was placed inside. Consequently, we were able to avoid unnecessary captures, immobilize cage-captured puma within 30 minutes of capture, and reduce the opportunity for captured puma to become injured. The only injuries we documented to puma caught in cage traps were a single, superficial lacerations to the top of the heads of 4 individuals. This apparently was caused when puma attempted to jump up and out of the cage trap.

While puma are known to be opportunistic predators (Logan and Sweanor, 2001), our results indicated that they are opportunistic scavengers, too. Due to the propensity of a puma to scavenge, it is likely that some perceived kills of prey might, in fact, be scavenging events. To better understand the frequency at which scavenging by puma occurs in ungulate populations, further study needs to be done.

Support for the puma research was provided by California State Parks, California Department of Fish and Game, and private donations to the Wildlife Health Center at the University of California-Davis. We thank California State Parks, especially J. G. Burke, J. C. Dice, M. Fuzie, L. Y. Itogawa, M. C. Jorgensen, and P. D. Jorgensen for their administrative and logistical support of the project. California State Parks and California Department of Fish and Game, especially R. Botta, helped secure deer carcasses as bait. We thank the United States Department of Agriculture, Wildlife Services for providing deer carcasses and lending us a cage trap. We thank C. Ruiz for building us a cage trap. We thank San Diego County Parks and The Nature Conservancy for allowing access to their lands to capture puma. We also thank C. A. Lopez Gonzalez for providing the Spanish translation of the abstract.

Literature Cited

Ackerman, B. B., F. G. Lindzey, and T. P. Hemker. 1984. Cougar food habits in southern Utah. Journal of Wildlife Management 48(1):147–155.

California Department of Fish and Game. 2000. Wildlife restraint handbook. State of California Resources Agency, Wildlife Investigations Laboratory, Rancho Cordova, California.

Gashwiler, J. S., and W. L. Robinette. 1957. Accidental fatalities of the Utah cougar. Journal of Mammalogy 38:123–126.

Hibben, F. C. 1937. A preliminary study of the mountain lion (*Felis oregonensis* ssp.). University of New Mexico Bulletin, Biological Series 5(3):1–59.

Hornocker, M. G. 1970. An analysis of mountain lion predation upon mule deer and elk in the Idaho Primitive Area. Wildlife Monograph 21.

Lindzey, F. G., B. B. Ackerman, D. Barnhurst, and T. P. Hemker. 1988. Survival rates of mountain lions in southern Utah. Journal of Wildlife Management 52:664–667.

Linsdale, J. M., and P. Q. Tomich. 1953. A herd of mule deer: a record of observations made on the Hastings Natural History Reservation. University of California Press, Berkeley.

Logan, K. L., and L. L. Sweanor. 2001. Desert puma: evolutionary ecology and conservation of an enduring carnivore. Island Press, Washington, D.C.

McBride, R. T. 1976. The status and ecology of the mountain lion (*Felis concolor stanleyana*) of the Texas-Mexico border. Unpublished M.S. thesis, Sul Ross State University, Alpine, Texas.

Munz, P. A., and D. D. Keck. 1959. A California flora. University of California, Berkeley.

Robinette, W. L., J. S. Gashwiler, and O. W. Morris. 1959. Food habits of the cougar in Utah and Nevada. Journal of Wildlife Management 23:261–273.

Ross, P. I., and M. G. Jalkotzy. 1996. Cougar predation on moose in southwestern Alberta. Alces 32:108.

Ross, P. I., M. G. Jalkotzy, and P. Y. Daoust. 1995. Fatal trauma sustained by cougars, *Felis concolor,* while attacking prey in southern Alberta. Canadian Field-Naturalist 109:261–263.

Spalding, D. J., and J. Lesowski. 1971. Winter food

of the cougar in south-central British Columbia. Journal of Wildlife Management 35:378–381.

SWEANOR, L. L., K. A. LOGAN, J. W. BAUER, AND W. M. BOYCE. 2004. Final report for interagency agreement No. C0043050 (Southern California Ecosystem Health Project) between California State Parks and UC-Davis Wildlife Health Center. University of California, Davis.

YOUNG, S. P. 1946. Economic status. In: S. P. Young and E. A. Goldman, editors. The puma, mysterious American cat. American Wildlife Institute, Washington, D.C. Pages 127–131.

Submitted 24 August 2004. Accepted 17 April 2005. Associate Editor was Cheri A. Jones.