January 15, 1998
Kenneth A. Logan
Homocker Wildlife Institute
P.O. Box 3246 University Station
Moscow, ID 83843
208-885-6871
e-mail: loga9044@uidaho.edu

RH: CAPTURING PUMAS – Logan et al.

CAPTURING PUMAS WITH FOOT-HOLD SNARES

Kenneth A. Logan, Hornocker Wildlife Institute, P. O. Box 3246 University Station, Moscow, ID 83843-0246

Linda L. Sweanor, Hornocker Wildlife Institute, P. O. Box 3246 University Station, Moscow, ID 83843-0246

J. Frank Smith, Hornocker Wildlife Institute, P. O. Box 3246 University Station, Moscow, ID 83843-0246

Maurice G. Hornocker, Hornocker Wildlife Institute, P. O. Box 3246 University Station, Moscow, ID 83843-0246

Abstract: We evaluated the use of foot-hold snares to capture desert-dwelling pumas for research. During 1985-1995, 107 individual pumas were snared 209 times. Males and females were equally susceptible to capture. But pumas, particularly females, became snare-shy as they gained experience with snares. In descending order, snares were most

1 Present address: P. O. Box 15177, Zapata, TX 78076
efficient when they were set at puma kills, scavenged carcasses, puma scrapes, lures, and on puma travel ways. In general, foot-hold snares were a safe method for capturing pumas. Life-threatening injuries occurred in 4.7% of individuals captured and 2.4% of total puma captures. Capture by snares affected the movements of male pumas up to 2 days post-capture, and had relatively little effect on the movements of females. Eighty-nine non-target animals were also caught in snares; 16.9% died. Modifications of snares and snare-setting protocols reduced injuries to pumas and reduced the capture of non-target animals. Our use of foot-hold snares produced fewer deaths to pumas than most other intensive studies that used trained dogs. In addition, foot-hold snares produced less serious injuries than steel leg-hold traps used to capture wolves.

Key words: capture injuries, capture success, foot-hold snare, puma, *Puma concolor*

Safe and effective techniques for capturing wild pumas (*Puma concolor*) (Wozencraft 1993, Nowell and Jackson 1996) are essential in ecological research. Because pumas are extremely cryptic and live at low population densities, capturing and tagging individuals is the only reliable way to study demographics and social organization (Logan et al. 1996). Furthermore, wildlife managers need to employ safe capture methods when the goal is live translocation for conservation (Belden and Hagedorn 1993) or for managing nuisance pumas (Ruth et al. 1996).

Wild pumas captured alive for research and management purposes usually are caught with the aid of trained dogs which trail pumas by scent, then typically bay them in trees. Once bayed, pumas are chemically immobilized, then lowered to the ground for examination. (Hornocker 1970, Logan et al. 1986). The success and safety of this method
depend largely upon the presence of trees in the environment which pumas can climb to escape pursuing dogs. Even in treed areas, however, pumas are sometimes bayed on the ground and mauled by dogs, resulting in severe injuries or death to the pumas or dogs (Shaw 1977, Barnhurst 1986, Anderson 1992). Treed pumas also run the risk of injury or death from falls during chemical immobilization (Hornocker 1965, Shaw 1977, Barnhurst 1986, Anderson 1992). Sometimes exertion from fleeing the dogs can result in life-threatening physiological problems for pumas, such as respiratory system failure (Barnhurst 1986) and hyperthermia (McBride 1976). Moreover, using dogs to capture problem pumas in urbanized areas is often not feasible.

In areas where trees are uncommon, the risk of injury or death from using dogs to capture pumas may be excessive. We faced this logistical problem as we began puma research in the Chihuahua Desert in southern New Mexico where there was sparse tree cover, high summer temperatures (often >38°C), and scarce surface water. To meet those environmental and logistical conditions, we developed an alternative method using foot-hold snares to capture pumas. Since the development of this technique, we have consulted other large felid studies to successfully snare pumas in Arizona (Cunningham et al. 1995), California (Beier and Barrett 1993) and Texas (L. Harveson, Caesar Kleberg Wildlife Research Institute, pers. commun.), jaguars in Mexico (B. Miller, principal investigator, Cuixmala Reserve, pers. commun.), and tigers in Siberia (D. Miquelle, Hornocker Wildlife Institute, pers. commun.). This paper is the only description and evaluation of the method.
STUDY AREA

The 2,059 km² study area was located in south-central New Mexico, U.S.A. and encompassed the entire San Andres Mountains (SAM). The SAM has a semi-arid climate. Annual precipitation averaged 43.61 cm and annual temperature averaged 14.5°C during our research. July was the hottest month with temperatures averaging 25.5°C. January was the coldest month; temperatures averaged 3.4°C (Logan et al. 1996).

Vegetation was typical of the Chihuahua Desert. Shrubs on drier sites included creosotebush (Larrea divaricata), mesquite (Prosopis glandulosa), mimosa (Mimosa biuncifera), condalia (Condalia lycioides), ocotillo (Fourquiera splendens), and sotol (Dasylirion wheeleri). Protected slopes at higher elevations had mountain mahogany (Cercocarpus montanus), skunkbush sumac (Rhus trilobata), Wright’s silktassel (Garryea wrightii), and oak (Quercus spp.). Tree cover was patchy in distribution, and usually occurred on north-facing slopes. Species which seldom reached heights of 6 m included one-seed juniper (Juniperus monosperma), alligator-bark juniper (J. depeana), and pinion pine (Pinus edulis). Cottonwood (Populus deltoides weslizeni) and velvet ash (Fraxinus velutina) trees ≤10 m in height were associated with sparse perennial water sources.

Three native ungulates occurred on the study area. Mule deer (Odocoileus hemionus) were the most abundant ungulate and occurred throughout the study area. About 40 desert bighorn sheep (Ovis canadensis mexicana) lived primarily along the steep southeastern escarpment of the SAM. Pronghorns (Antilocapra americana) infrequently ranged up into the foothills in the northern portion of the SAM in small bands of <20 animals.

Three introduced ungulates ranged on the SAM. Oryx (Oryx gazella) preferred the desert basins, but a small number (<100) ranged onto our puma study area. Javelina
Logan et al.

(Tayassu tajacu) were rare (<100). Feral, trespassing cattle on the study area numbered <100 at any time.

A variety of other carnivores inhabited the SAM, including the coyote (Canis latrans), gray fox (Urocyon cinereoargenteus), bobcat (Lynx rufus), badger (Taxidea taxus), ringtail (Bassariscus astutus), striped skunk (Mephitis mephitis), and hog-nosed skunk (Conepatus mesoleucus). Black bears (Ursus americanus) were not present during the study.

MATERIAL AND METHODS

We modified foot-hold snares (Schimetz/Aldrich Spring Activated Animal Snare, Sekiu, WA 98381) to capture pumas (Figure 1). Hardware provided by the manufacturer included: a 107 cm circumference foot-loop consisting of a 5 mm diameter steel cable, angle-iron lock, and cable clamp; 122 cm of 5 mm diameter steel cable attached to a swivel or chain link with cable clamps; and a spring mechanism. We shortened the cable loop to 94-102 cm to maximize its effectiveness on pumas. When one was not provided, we inserted a 1.3 cm diameter cast-iron swivel between the snare loop and anchor cable. The swivel allowed for rotational movement and helped prevent severe leg injury. The anchor cable was then clamped to a 122 cm length of 8 mm proof coil chain. To hold the animal at the site, a double offset hook drag (44 cm long; each hook 15 cm deep) made of 16 mm re-bar steel was attached to the end of the chain with a 9.5 mm repair link. Moreover, if the puma pulled the snare free, the drag would grapple other vegetation and again hold the animal.

As the study progressed, we made additional modifications to snare assemblies to minimize injuries to captured pumas and to avoid capturing non-target animals (e.g. mule
deer, coyotes, gray foxes). Beginning in June 1992, we attached 2-4 rubber bungee cords (23 cm long, stretch length of 36 cm) to the 50-cm-long segment of chain closest to the anchor cable, so that the chain could not straighten out completely even when the bungees were stretched to full length. The bungee cords absorbed shock as the animal struggled. Later (February 1993), we attached a slide stop to the foot loop by wrapping duct tape along 13-14 cm of the end of the foot loop adjacent to the angle-iron lock to a thickness that the lock could not slip over. The slide stop minimized the closure of the foot loop to 18-19 cm circumference and consequently maximized circulation to the puma’s foot. In addition, this allowed smaller-footed non-target animals to pull free from the loop.

The spring mechanism was modified by bolting an aluminum or tin disk (15 cm diameter) or rectangle (15 cm x 13 cm) to the trigger to enhance the effectiveness of the trigger. We avoided the unintentional triggering of snares by small mammals that walked on the trigger by placing open cell foam pads (5 mm thick) under the trigger pans. Each foam pad was cut slightly larger than the trigger pan to allow free downward movement when the pad was compressed by the weight of a puma. The foam pad also prevented loose soil from falling below the trigger pan, thus insuring proper function of the trigger.

The total cost of each modified snare was $32.77. This included: Schimetz/Aldrich snare assembly and spring mechanism = $16.00; double offset hook drag = $7.00; 122 cm of 8 mm proof coil chain = $6.20; 9.5 mm repair link = $0.97; trigger disk or rectangle = $1.00; 6 mm bolt, washer and nut = $0.10; 3 rubber bungee cords = $1.50. The cable snare, drag assembly and spring mechanism together weighed 4.5 kg.

Snare sites were comprised of 1-6 snares set on paths used by pumas, at puma scrape sites, at puma kill caches, or at carcasses of deer or oryx not killed by pumas. In areas
where puma use was uncertain, we set snares along likely travel routes. We avoided setting snares on trails heavily utilized by deer or oryx, and when we suspected they might use those routes, we positioned stick hurdles about 60-70 cm horizontally above the snare. Deer and oryx generally went around or jumped over the sticks, whereas naïve pumas would walk under. When a travel way was too wide to effectively funnel a puma through a snare set, we augmented the set by using a sight lure. Lures were shiny pieces of tin, and occasionally molted feathers, which dangled from string or wire over the snare set.

We targeted unknown pumas in the population and pumas with non-functional or limited battery-life radio-collars. Pumas with well-functioning radio-collars were reliably identified in the field by radio-telemetry; therefore, we constantly avoided recapturing those individuals. We did not attempt to snare cubs unless their mother was not wearing a functional radio-collar.

As we gained experience with potential risks of using snares, we became more selective in our choice of snare site location. Preferred sites had limber bushes with multiple basal stems for securely anchoring the drag, and a safety area of ≥5 m circumference around the anchor point. We anchored the drag in vegetation with sturdy but flexible branches, so that captured pumas could not pull away from the safety area. The drag was often secured in place with a bungee. We wrapped the chain around a different springy branch in the shrub, making sure the 2-4 bungees we placed on the chain still functioned properly. Strength and flexibility of the hold were tested by pulling hard on the foot-loop. The safety area was clear of trees, fences, potentially injurious vegetation (e.g. cacti [Opuntia spp.], yuccas [Yucca spp.], agaves [Agave spp.]), and other snares, and thus helped to minimize the probability that a struggling puma might be injured. It also
minimized the chance that the snare cable would wrap around a stem or tree, isolate the swivel and bungees, and render them ineffective. Snare sites were also away from cliffs and water.

All snares were checked each day by 1000 hours during spring and summer and by 1200 hours during fall and winter to prevent excessive stress to captured pumas. In the hottest part of summer we sometimes checked snares twice per day (again at 1600 hours). During particularly hot, cold, or snowy weather, we deactivated all snares.

Pumas captured in foot-hold snares were immobilized with ketamine hydrochloride (100 mg/ml, Vetalar®, Parke-Davis, Div. of Warner-Lambert Co., Morris Plains, NJ 07959) dosed at about 12 mg/kg body weight. The drug was injected remotely usually into the caudal thigh muscles by pole syringe (length = 3.05 m) or by 3-5 ml aluminum syringes fired from a CO₂-powered pistol. After induction, pumas were quickly removed from snares, their heads were covered, and their legs were tethered. If it was necessary to calm a puma further, we injected xylazine hydrochloride (20 mg/ml, Rompun®, Haver-Lockhart, Bay Vet Div. Cutter Laboratories, Inc., Shawnee, Kansas 66201) intramuscularly with a hand syringe; the dose was about 0.5 mg/kg body weight.

During hot ambient temperatures, we protected immobilized pumas from hyperthermia by placing them in shade and by cooling them with water. In cold temperatures, we protected them from hypothermia by placing them in sunlight and by wrapping them in a canvass or blanket.

Captured pumas were sexed, aged, weighed, measured, radio-collared, and thoroughly examined for research purposes. We recorded all observable capture injuries sustained by pumas. We subjectively categorized the degree of swelling of the capture feet as severe
(1.5 times normal girth estimated by measuring the girth of the captured foot and the girth of the opposite, unaffected foot with a steel metric tape), moderate (<1.5 times normal girth), slight (swelling minimally noticeable) and none (absence of swelling). We also documented the presence of skin damage, including abrasions (rubbing or scraping away of the hair and into the skin) and cuts (openings through the skin). Skin damage was subjectively categorized as minor (up to 2 cuts or abrasions ≤2.5 cm long in aggregate), or moderate (cuts 2.5–7 cm long in aggregate; abrasions ≤2.5 cm in length might or might not be present). More severe injuries, including apparent sprains, breaks and self-mutilations were also documented.

To gauge the effects of capture on a puma’s subsequent movements, we tested the research hypothesis that a puma’s movements post capture would be adversely affected by capture (i.e. each animal would move shorter distances on a day-to-day basis immediately after capture than during periods when the animal was not influenced by capture). In the female sample, only the movements of adults without cubs or with cubs >9 months old were examined. We measured distances traveled from captures to day-bed locations 1-5 days later, then compared them to movements made by the same pumas during randomly chosen 1-5 day periods when they were not influenced by captures. Because of data non-normality, Wilcoxon signed-rank tests were used to test for differences of movements (Ott 1993).

Chi-square tests were used to test the hypothesis that male and female pumas were captured by snares in relation to their numbers in the population (Ott 1993). Experimental errors for all statistical tests were set at the 0.05 level of significance.
RESULTS

Pumas were captured with snares from 6 August 1985 through 23 February 1995. We captured 107 individual pumas (48 males, 59 females) a total of 209 times. Although captured pumas ranged in age from 6 months to 12 years, only 14 captures (9 males, 5 females; 6.7% of all captures) were of pumas ≤12 months old. Weights of captured pumas ranged from 10.0 kg (22 lb) to 71.7 kg (158 lb). Pumas were either captured by a single front foot (91.4%), a single hind foot (5.3%) or by 2 feet (3.3%). All pumas caught by 2 feet were captured at kill caches where ≥2 snares were set.

We accumulated 40,419 snare-days (1 snare set for 1 day) at 1,211 different snare sites for an overall capture success of 1 puma per 193 snare days. Although we tried to avoid unnecessary recaptures, we still made 31 recaptures of non-target individuals (radio-collared pumas that did not need collar replacement). Each male and female was captured an average of 2.4 times (range = 1-6) and 1.6 times (range = 1-5), respectively.

During a 6-year period (Mar 1989 to Feb 1995) for which both detailed trapping information and accurate information on the adult puma sex ratio was available (see Logan et al. 1996:85), annual capture success averaged 215.5 snare-days per capture (SD=60.1). The ratio of male to female captures was not significantly different than the adult sex ratio during the first 4 of the 6 years, \( (X^2 = 0.2.10; 1 \text{ df}; P > 0.1) \); however, captures during the last 2 years of the study significantly favored males when compared with the adult sex ratio of the population \( (X^2 = 8.76; 1 \text{ df}; P = 0.004 \text{ for } 1993-94; \text{ and } X^2 = 7.21; 1 \text{ df}; P = 0.006 \text{ for } 1994-95) \). We also documented the lowest capture success during the last 2 years of the study (294 and 263 snare-days per capture), primarily because of our reduced success at capturing females. Female capture success averaged 344 snare-days per capture.
(SD = 66.7) over the 4-year period from 1989-93, but 968 snare-days (SD = 119.5) over the last 2 years. Male capture success averaged 1 per 419 snare-days (SD = 165.2) from 1989-93, which was similar to the 397 snare-days per capture (SD = 66.5) during the last 2 years.

Although pumas were caught most frequently at trail sets (55% of all captures, and 54% of captures that occurred after 7 Mar 1989), trail sets also required the greatest capture effort (\(\bar{K} = 274.9\) snare-days per capture; Table 1). In contrast, snares set at puma kill caches resulted in a much smaller percentage of captures (12-14%), but required the smallest capture effort (\(\bar{K} = 24.2\) snare-days per capture). Snares set at carcasses and at scrapes sites also had much better success rates per unit effort than those set along trails; however, the benefit from using sight lures over simple trail sets was minimal.

**Injuries**

The majority of puma captures (\(n = 195; 93.3\%\)) resulted in minor or non-detectable injuries except for capture-foot swelling, which ranged from none to \(\geq 1.5\) times normal girth (Table 2). Most cuts and abrasions were inflicted by the snare loop or slide stop and were between the toes, on the toe pads, or around the wrist. The deepest cuts extended into the hypodermis. While struggling to get free, some pumas also received minor cuts from surrounding vegetation, and claw cuticles occasionally became reddened or bloody. Three pumas (1 adult male, 2 adult females) damaged their teeth (broke incisors or chipped canines) while struggling to escape.

Although we documented severe swelling during 43 captures where other injuries were minor or non-detectable, the actual seriousness of swelling was unknown. Slight swelling of a female puma’s capture foot was not evident when she was recaptured by the
opposite foot 3 days later. A male that experienced severe swelling to the capture foot showed no visible signs of swelling or injury to the foot when he was recaptured by his opposite front foot 20 days later. However, upon recapture, several pumas had rings of white hairs where the snare cables had previously encircled the animals' feet; this indicated skin cell damage had occurred.

Moderate skin damage was observed during 3.4% of captures (n = 7). The most serious cut consisted of a 7 cm long laceration into the dermis of the heel of a sub-adult male caused by the cable.

Two pumas (1.0% of captures) suffered serious, but not life-threatening, injuries during capture. One 10.5-month-old female cub injured her foreleg while trying to free herself from the snare. The tail end of the snare loop became wrapped around thin trunks of willow baccharis (Baccharis sp.) and effectively isolated the swivel. Thus, when the female twisted and turned in her struggles, the snare loop did not freely turn with her. Her foot became severely swollen, and we suspect she suffered ligament damage (sprain or tear). She remained within 450 m of the capture site for 6 days, then rejoined her mother and 2 siblings on the seventh day. Subsequently she moved with her family. The other puma, an adult male, partially severed the third toe at the second phalange of his capture foot. We amputated the toe. Although we inspected the capture site, we could not determine how he sustained the injury. The male remained within 540 m of the capture site for 3 days, but then moved 1.6 km from the capture site on the fourth day. Subsequent locations and track observations indicated the male was traveling normally. When the wound was examined 5 months later, we found that the skin had grown completely over the stump of the toe.
Five of 209 snare captures (2.4%) resulted in severe, life-threatening injuries. One adult female appeared to have suffered minor capture injuries (slight swelling, minor skin damage); however, she died 5 days post capture. She aborted 3 fetuses (approximately 56 days gestation) 3-4 days after being captured by both a left fore and right hind foot. A necropsy and subsequent consultation with M. Roelke (D.V.M., Florida Panther Recovery Project, pers. commun.) suggested that the female suffered a fatal injury to the lumbar region of the spine as she struggled against the snares. Tracks indicated paralysis of the hind legs just prior to death. The other 4 pumas (1 adult male, 2 adult females, 1 female cub) suffered fractures to the ulna and radius of the capture leg. Each puma had wrapped the distal end of the foot-loop around a single-stemmed bush or tree so that the stem was between its leg and the swivel. As the pumas twisted the cables, the lower leg bones torqued, causing them to break. Two of these pumas subsequently chewed off 1 or more toes of the injured leg and were euthanized. We attempted to have the fractures of 2 females (mother and her 14-month-old cub) repaired. Although the mother died during surgery, the daughter was rehabilitated and returned to her natal area 6 months after injury; there she established adult residency and raised cubs.

**Effects of Capture on Subsequent Movements**

The straight-line distances traveled by males during the 1-day and 2-day periods post-capture averaged 1.4 km and 2.9 km, respectively. Those males moved an average of 3.2 km and 4.8 km during the same time intervals when they were not influenced by capture. Post-capture movements were significantly shorter for both the 1-day ($T = 164, n = 34, P = 0.01$) and 2-day ($T = 41, n = 20, P = 0.008$) periods. However, there were no significant differences in movements for 3-day ($T = 98.5, n = 20, P > 0.1$),
4-day ($T = 74, n = 17, P > 0.1$), and 5-day ($T = 44, n = 14, P > 0.1$) periods. Females did not move shorter straight-line distances during 1-day or 2-day intervals post-capture than during those same time intervals when they were not influenced by captures ($n = 15-18, P > 0.1$). Although sample sizes were small ($n = 7-9$), no differences were found for 4-day or 5-day movements, either ($P > 0.1$). However, females moved significantly further during 3-day intervals when they were not influenced by captures ($T = 25, n = 14, P = 0.05$).

**Modifications to Reduce Injuries**

Modifications to the snare, including bungees and slide stops, reduced the capture injuries suffered by female pumas. After we began using bungees, the number of females that exhibited no or slight swelling of the capture foot increased from 44% (34 of 77 captures) to 68% (13 of 19 captures). Bungees alone did not greatly reduce the percent of serious or life-threatening injuries suffered by females (5.3% of 76 captures before the use of bungees versus 5.0% of 20 captures after); however, their use in conjunction with slide stops appeared to help reduce the risk of injury substantially. In 11 captures where both modifications were used only 1 female suffered severe swelling of her capture foot, and other injuries were limited to minor skin injuries.

Unlike females, male pumas did not appear to benefit from the snare modifications. The proportions of males that exhibited no or slight swelling before and after bungees were utilized were similar (48.0% of 77 captures before versus 47.2% of 36 captures after). Additionally, the only life-threatening injury to a male occurred after both bungees and snare stops were being used.
Capture of Non-target Animals

We captured 89 non-target animals during 30,980 snare days between 7 March 1989 and 23 February 1995. Animals included 72 mule deer, 6 oryx, 7 coyotes, 2 gray foxes and 2 feral cows. One deer was caught at a lure set; the rest of the non-target animals were captured at trail (78.6%) or scrape site (20.2%) sets. Thirteen deer and 2 oryx subsequently died, most from apparent muscle myopathy. A puma killed 1 deer while it was in the snare. Prior to using the slide stop on the foot loop, we captured 81 non-target animals over 20,352 snare-days for 1 capture every 251 snare-days. After we employed the slide stop, we captured 8 non-target animals (4 deer, 4 oryx) over 10,628 snare-days resulting in 1 capture every 1,385 snare-days. The only other non-target species we captured during the research was javelina (n = 2); these were snared and released before we began to collect complete records on non-target captures.

DISCUSSION

In desert mountain habitat, wild pumas from 6 months to 12 years old were effectively captured with foot-hold snares. Snares were relatively inexpensive, and workers rapidly learned how to use them. The equipment was also compact and easily carried into remote areas.

Both sexes appeared to be equally susceptible to being caught by snares. However, as individual pumas, especially females, gained experience with snares, they usually avoided snares by circumventing or jumping over them. Although we improved snare concealment as our study progressed, our overall effort per capture still increased. This occurred principally because of 2 snare-shy females that we unsuccessfully targeted for recapture.
Five pumas, a male captured 5 times and 4 females each captured 1-3 times, learned how to remove the foot loop, apparently by using their teeth. During their second captures, we observed 2 other pumas (a male and a female) attempt to open the foot loops by inserting their upper canines between the cable and foot and pulling outward. Researchers should be aware that long-term projects utilizing snares to capture pumas might have problems with trap-wise animals.

The most efficient snare set types were at puma kill caches and carcasses, followed in descending order of efficiency by snares at scrapes, lures, and on trails. Field workers targeting individual pumas for capture (e.g., pumas that kill livestock, particular study animals) would maximize efficiency by setting snares at kills.

Foot-hold snares were relatively safe for capturing pumas. The large majority of captures resulted in minor or non-detectable injury. Life-threatening injuries occurred in less than 3% of puma captures. Females were more prone to serious injuries than males (5.2% versus 1.8%); this may partly be a result of their smaller diameter (hence more fragile) leg bones. Self-mutilation of capture feet only occurred in animals that had broken their leg bones.

Movements of male pumas were apparently affected by the ordeal of capture for at least 2 days post-capture; however, any adverse effects of capture on the subsequent movements of females was not generally detected. Although straight-line distances between locations may not accurately represent the real distance traveled (Sweanor 1990:53), they do indicate the capability of animals to travel long distances. The influence of capture on puma movements may be easier to measure in males because they tend to travel long directional distances on a day-to-day basis (Sweanor 1990); minor foot injuries
may discourage such long-distance travel. Females have smaller home ranges and
generally travel shorter distances (Sweanor 1990); minor foot injuries may not impede this
kind of travel. Males may also have suffered greater, but undetected, injury because the
slide stops we installed to accommodate the average wrist diameter of females were
ineffective on the larger wrists of males. Hence, if male pumas are targeted for capture, we
recommend that field workers lengthen the slide stop to 18 cm.

We learned by experience that the best way to enhance safety of snares for all pumas
was through wise choice and modification of the snare location (see Material and
Methods). We probably would have experienced a greater injury rate if we had not begun
setting snares far enough apart to avoid 2-footed captures. The back injury sustained by 1
female may have resulted from the torque suffered while pulling with both her front and
hind legs. All other serious injuries occurred when pumas wrapped the foot loop around
single stemmed bushes or small trees causing the swivel on the snare mechanism to be
ineffective. Consequently, we stress that snares should not be used at those sites, or that
dangerous trees or bushes should be removed. In 2 other studies, snared pumas have
climbed trees, then accidentally hung from branches until death (J. Rutledge pers.
commun., Texas Parks and Wildlife Dep.; Pittman 1995). Additionally, we do not
recommend using snares during extended periods of freezing ambient temperatures
because of the risk that an animal’s capture foot will freeze.

Snared animals face other hazards that animals captured using dogs do not. Snared
animals are prone to thermoregulation and water stress, and they also are at risk of
discovery and death by other large predators or humans. However, the percent of
capture-related deaths we documented from using snares on pumas (1.9% of captures; 3.7% of individuals) was lower than the percentages reported in most of the intensive studies that used dogs. In Idaho, 3.7% of 109 dog captures resulted in deaths (Hornocker 1970). Of 110 captures with dogs in Colorado, 4.6% resulted in puma deaths (Anderson 1992). Eight percent of individuals caught by dogs died in Utah (Lindzey et al. 1989).

The only long-term intensive study with a mortality-free capture record was conducted by Ross and Jalkotzy (1992) in Alberta; they captured 68 pumas 129 times with dogs.

Snares cause less injuries than steel traps. Van Ballenberghe (1984) found that wolves (Canis lupus) caught in foot-hold snares experienced fewer serious injuries of feet, limbs, and oral tissues than wolves caught in steel traps. Severe leg injuries, including broken limb bones, occurred in 41% of wolves caught in traps, but never occurred in wolves caught in snares. Tooth breakage in wolves caught in steel traps has been reported at rates of 34% to 46% (Kuehn et al. 1986, Van Ballenberghe 1984, respectively); we observed such injuries only 3 times in snare-captured pumas.

Slide stops that we installed on the foot loops greatly decreased the capture of small-footed, non-target animals. Capture of non-target animals can also be minimized simply by avoiding the use of snares in busy travel ways of those animals. We do not recommend the use of snares in areas where large-footed non-target animals are common [e.g. elk (Cervus elaphus), cattle, bears]. Field workers must also be cognizant of the dangers of capturing large animals capable of pulling the drag free from its anchor. Animals could leave the capture site and never be found or potentially attack approaching investigators. Three female pumas charged us as we delivered the immobilizing drug, but the drag restrained the pumas' movements.
Pumas captured alive for research, conservation, or translocation are dependent entirely upon their human handlers to be able to resume their lives unimpeded. Consequently, we emphasize that workers using this technique should maximize its safety by following the criteria for modification and placement of snares that we described in the Material and Methods.

Acknowledgements. This paper is a product of an ecological study of pumas funded by the New Mexico Department of Game and Fish and the Federal Aid to Wildlife Restoration Act, under Pittman-Robertson Project W-128-R. We are appreciative of the access and cooperation provided by the U.S. Army, White Sands Missile Range. We also thank personnel of the San Andres National Wildlife Refuge for their support. B. R. Spreadbury, T. K. Ruth, J. L. Cashman and J. R. Augustine were also instrumental in capturing and recording information on pumas for this study. T. K. Ruth also reviewed an earlier draft of this paper.
LITERATURE CITED


Received

Accepted
Table 1. Capture success of pumas based on the type of snare set, San Andres Mountains, New Mexico.

<table>
<thead>
<tr>
<th>Snare set type</th>
<th>Trail</th>
<th>Scrape</th>
<th>Kill</th>
<th>Carcass</th>
<th>Lure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapping period:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snare days&lt;sup&gt;c&lt;/sup&gt;</td>
<td>22,815</td>
<td>6,725</td>
<td>508</td>
<td>423</td>
<td>509</td>
<td>30,980</td>
</tr>
<tr>
<td>Capture effort&lt;sup&gt;d&lt;/sup&gt;</td>
<td>274.9</td>
<td>164.0</td>
<td>24.2</td>
<td>71.0</td>
<td>254.5</td>
<td>202.5</td>
</tr>
</tbody>
</table>

<sup>a</sup>A total of 40,419 snare days were spent to capture 209 pumas for an overall capture effort of 193.4 snare days per capture. Detailed information on capture effort per set type was not collected for the period 6 Aug 1985 through 22 Feb 1989.

<sup>b</sup>Number of captures, males:females.

<sup>c</sup>Snare day = 1 snare set for 1 day, based on the period 7 Mar 1989 to 23 Feb 1995.

<sup>d</sup>Capture effort = snare-days per puma capture, based on period 7 Mar 1989 to 23 Feb 1995. Average annual capture effort for the same period was 215.5 snare-days per capture.
Table 2. Injuries sustained by pumas from snare captures (n=209) in the San Andres Mountains, New Mexico from August 1985 through January 1995.

<table>
<thead>
<tr>
<th>Type of Injury (excluding swelling)</th>
<th>Degree of Swelling&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>None apparent</td>
<td>17:14&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Minor skin damage</td>
<td>5:5</td>
</tr>
<tr>
<td>Moderate skin damage</td>
<td>1:0</td>
</tr>
<tr>
<td>Ligament / muscular</td>
<td></td>
</tr>
<tr>
<td>Broken toe</td>
<td>1:0</td>
</tr>
<tr>
<td>Vertebral / spinal</td>
<td>0:1&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Leg bone fractures</td>
<td>0:2&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Injuries: minor skin damage = up to 2 cuts or abrasions ≤2.5 cm long in aggregate; moderate skin damage = cuts 2.5-7 cm long in aggregate; abrasions ≤2.5 cm long might or might not be present.

<sup>b</sup>Swelling of capture foot: 0 = no swelling; 1 = slight swelling; 2 = swelling ≤1.5 times normal girth; 3 = swelling ≥1.5 times normal girth.

<sup>c</sup>No. males : no. females

<sup>d</sup>Puma died or was euthanized.

<sup>e</sup>One puma rehabilitated, other died during surgery.
Fig. 1. Snare components used to capture pumas in the San Andres Mountains, New Mexico, 1985-95. Drawing is to scale; spring mechanism is 2x scale of snare.