

The amount of time female pumas *Puma concolor* spend with their kittens

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In the sport hunting of pumas *Puma concolor*, most states and provinces of the United States and Canada do not allow the killing of females with kittens. However, female pumas can be away from their kittens and, if detected by hunters at these times, can be mistakenly killed. To assess the extent to which females with kittens might mistakenly be killed we need to have estimates of the percent of time female pumas are with their kittens on a daily basis. Previous estimates range within 52-83%, but are based on simultaneous locations taken during the day when pumas are least active. To provide a more accurate assessment of the amount of time females spend with their young, we analyzed telemetry data collected over 24, 24-hour blocks for 15 females and their kittens. We collected data from June to September during 1989-1999 in southeastern Idaho and northwestern Utah. We found that females with 7-12 month-old kittens were within 200 m of their kittens an average $16.2 \pm 3.8\%$ (N=12) of the time. These females were >1.0 km from their kittens $30.9 \pm 6.7\%$ of the time. Three females with kittens in dens were near their dens 10.3, 12.2 and 2.3% of the time. Females were within 200 m of their kittens the least amount of time ($5.1 \pm 2.1\%$; N=8) during 11:00-14:30 and the most amount of time during 23:00-01:30 (29.4 ± 3.0 ; N=6) and 07:00-10:30 ($23.2 \pm 3.1\%$). We conclude that the probability that a hunter would encounter a female without her kittens was $>80\%$.

Key words: dependent kittens, females, Idaho, pumas, time together, USA, Utah

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In most western states and provinces of the United States and Canada, sport hunting for pumas *Puma concolor* occurs. The hunting seasons usually last from fall to early spring and vary in length from state to state. To hunt pumas, hunters use trained dogs to

chase and eventually corner them, usually up a tree. In most states, hunters rely on snow to find fresh tracks of pumas that their dogs can follow. To find these tracks, hunters travel the roads and trails into the mountains early in the morning looking for

tracks made by pumas during the previous night. In all states, hunters are allowed to kill female pumas without dependent kittens (approximately ≤ 13 -15 months old; Logan & Sweanor 2001). Female pumas can reproduce at any time of the year and kittens can stay with their mothers for up to 17-18 months. Thus during the hunting season, there will be females with kittens ranging in age from birth to almost independence. It is the responsibility of the sport hunter to discern if a female has kittens. Most times, hunters should be able to distinguish between male and female pumas based on track size or, when the puma is in the tree, on the presence of testes. However, a hunter can only determine if a female is with kittens if they travel with her and leave tracks or if, on occasion, their dogs chase a kitten up a tree near or with its mother (J.W. Laundré, pers. obs.). The problem arises in that kittens are not always with their mothers. When a hunter finds a single female track crossing the road, he does not know for sure that she does not have kittens. If he sees no evidence of kittens during the chase, he can mistakenly kill a female who has kittens but was not with them at the time of the chase. If orphaned kittens are <6 months old, they will probably die of starvation (Cougar Management Guidelines Working Group 2005).

Because the loss of such orphaned individuals can possibly affect recruitment into the population, it is desirable to determine how likely it is to encounter a female without her kittens. We can then estimate the probability that a hunter will kill a female puma with undetected kittens. Others have estimated the percent time females spend with their young based on simultaneous radiotelemetry locations (Barnhurst & Lindzey 1989, Maehr et al. 1989, Logan & Sweanor 2001); their estimates range within 53-82%. However, all of these studies relied on locations taken once or twice a day or on point locations (Laundré & Keller 1984), usually obtained during daytime hours and mostly from airplane. Females are more likely to be with their young at these times (Barnhurst & Lindzey 1989), and relocation data may overestimate the time females spend with their kittens, especially at times when the females are active and more likely to cross roads, leaving tracks for the hunters to find. The fact that Barnhurst & Lindzey (1989) found kittens with their mothers only 19-43% of the time based on snow-tracking data seems to support this observation. Snow-tracking data, however, may tend to underestimate the time females spend with their kittens,

especially kittens in dens, because we cannot estimate the time females and kittens are together based on tracks. Thus, we are still uncertain about the percent time a female spends with and without her kittens over the course of 24 hours. Such information would be helpful in evaluating the possible risk of a hunter mistakenly killing a female puma with kittens.

During 1989-1999, we intensely monitored radio-collared pumas over 24-hour time blocks. During this time, we had the opportunity to monitor 15 females simultaneously with their kittens for altogether 24, 24-hour sessions. In this paper, we present the analysis of these data relative to the percent time these females were near their kittens over the 24 hours. This analysis should provide us with new information regarding the spatial and temporal affinity between female pumas and their kittens.

Methods

Study area

Our study area was in south-central Idaho and northwestern Utah, USA (Fig. 1). We chose the study area because it was representative of the type of mountain physiognomy and habitat structure characteristic of this region. The total area of 2,400 km² contained approximately 1,700 km² of puma habitat within five small, semi-isolated mountain ranges (of 65-760 km²) with elevations of 1,830-3,151 m a.s.l. (see Fig. 1). A variety of roads and trails made most parts of the mountains accessible via motorized vehicles, which facilitated our telemetry efforts. Mule deer *Odocoileus hemionus* were the principal prey species of pumas, with only a remnant (<50) elk *Cervus elaphus* population. Other species pumas occasionally preyed on during the study period included coyotes *Canis latrans*, bobcats *Lynx rufus*, and porcupines *Erethizon dorsatum*.

Mountain ranges were internally fragmented into open and forested habitat patches that varied in size. Forested patches consisted of various mixes of Douglas fir *Pseudotsuga menziesii*, subalpine fir *Abies lasiocarpa*, juniper *Juniperus osteosperma* and *J. scopulorum*, pinyon pine *Pinus edulis*, quaking aspen *Populus tremuloides*, and curl-leaf mountain mahogany *Cercocarpus ledifolius*. Dominant shrubs in open areas included big sagebrush *Artemisia tridentata*, gray rabbitbrush *Chrysothamnus nauseosus*, bitterbrush *Purshia tridentata*, and buffalo-berry *Shepherdia rotundifolia*. The climate is hot and

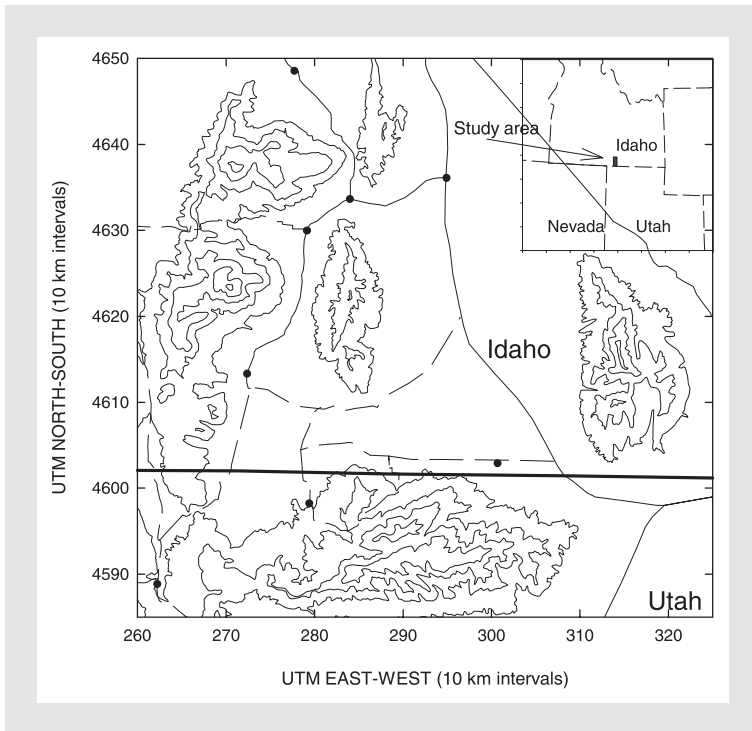


Figure 1. Location of our study area in southern Idaho and northwestern Utah. The study area consisted of five small mountains (of 64.7-760 km²; >2,000 m a.s.l.) separated by flat valley terrain. Roads allowing access to the mountains are indicated by the dashed and solid lines. Small towns (with 5-200 inhabitants) in the area are indicated by the black dots. The topographic lines begin at 2,000 m a.s.l. and are indicated for approximately every 300 m.

dry in the summers (20-35°C) and cold and windy in the winters (-25-4°C). Humidity rarely exceeds 40% and precipitation is sporadic with an annual average of 300 mm.

Field procedures

We captured pumas primarily in the winter with the aid of trained dogs. As did other hunters, we checked roads and trails early in the morning to look for fresh puma tracks made the night before. Once we found fresh tracks, we released the dogs and when they cornered a puma in a tree, we tranquilized it with a mixture of Ketamine hydrochloride (9 mg/kg) and Xylazine hydrochloride (1.5 mg/kg) administered intramuscularly via a dart gun. We lowered each tranquilized animal from the tree with a rope attached to a leg. We attached a radio-collar (Wildlife Materials, Inc., Murphysboro, Illinois, USA) to each animal and then administered an antidote of Yohimbine in equal quantity to the Xylazine hydrochloride. Researchers stayed with the animals until they recovered sufficiently. For kittens, we radio-collared only individuals ≥ 6 months old. We

recaptured and changed the collars as needed. Our capture procedures were approved by the Animal Welfare Committee of Idaho State University.

During June-September, we used triangulation to monitor 24-hour movements of collared pumas. Once we located the collared animals we were to follow, we strategically placed two monitoring stations so as to optimize the difference between compass bearings. We determined the locations of the stations from USGS topographic maps and handheld GPS units. At each station we used a 4-element double yagi null antenna system. We determined the direction of the antenna elements with a compass rose mounted on the antenna pole. We adjusted the rose to magnetic north with a handheld compass and periodically checked this adjustment during the 24 hours. Trained Earthwatch Institute volunteers took simultaneous readings each half hour from each station. To insure data accuracy, at

least one member of the research staff was present at all times and periodically checked the work of the volunteers. In addition to the telemetry stations, approximately 4-5 times over the 24 hours a research staff member collected a third compass bearing with a rooftop-mounted double yagi null antenna system. For these third bearings, the staff member would position the vehicle at a location determined from the USGS maps or a handheld GPS unit. We combined these third bearings with the two taken simultaneously at the stations and with the LOCATE II (ver. 1.82) program (V. Nams: vnams@nsac.ns.ca) estimated the animal's most likely position by the maximum likelihood estimator method (Lenth 1981). To estimate the triangulation error of our stations, we measured the distance from the LOCATE estimated location to the one based only on the two monitoring stations. We used the average of these measurements as an estimate of our telemetry error for locations based only on the two bearings from the telemetry stations. Pumas were normally in the mountains (Blum 2003), and our stations were usually > 1 km from the animals we were locating. Thus we assumed

a minimal impact of our presence on their behaviour. Conversely, because of the size of the mountains and the accessibility to the valleys within the mountain ranges, we were rarely > 5 km from the animals we monitored and were able to monitor most pumas over the 24 hours without moving stations. Also, we assumed minimal signal error because reception of the signal was predominately line of sight with little problems with signal bounce.

For each 24-hour session, we entered the data into a program we developed to estimate the location of the animal at half-hour intervals. We then matched up the simultaneous locations of female pumas with their kittens in an Excel worksheet and determined the female-kitten distance for each half-hour location. When there was > 1 radio-collared kitten, we calculated the distance the female was from each kitten and then averaged these distances. Once we calculated the female-kitten distances for each half hour, we then counted the number of locations where the female was near her kittens. Because of telemetry error, it is possible to misclassify a female as being away from or near her kittens when indeed she was the opposite. To reduce these errors, we incorporated our telemetry error (180 ± 18.7 m; $N = 129$) and assumed that if a female's estimated position was within 200 m of the estimated locations of her kittens, they were probably together. We also counted the number of locations where the female was > 1.0 km from her kittens to facilitate comparisons with other studies. We then expressed these values as percents of the total number of locations for the 24-hour session. Our sample unit was the individual animal so for all our calculations, we averaged the sessions of females for which we had more than one 24-hour session to avoid pseudo-replication.

We used Sigmapstat© software (Systat Software, Inc., Point Richmond, CA, USA) for all statistical analyses and reported all means as \pm standard error.

Results

Over the study period, our research team monitored 15 adult pumas with kittens for 24 complete 24-hour sessions. For 12 of the females we were able to simultaneously monitor their radio-collared kittens during 21 monitoring sessions. We had single sessions for nine females and three, four and six sessions for the other three. The kittens ranged in age within 7-12 months. We were also able to monitor

one time each three other females who we knew had recently born kittens (< 1 month old) at known den sites.

The distance females were from their kittens ranged within 0.0-3.8 km over the 24 hours (Fig. 2A). The percent time females were ≤ 200 m from their kittens over the 24 hours averaged $16.2 \pm 3.8\%$ ($N = 12$). Conversely, females were > 1.0 km from their kittens $30.9 \pm 6.7\%$ of the time. The three females with kittens in dens were near their dens 10.3, 12.2 and 2.3% of the time.

Relative to time of day, females were usually ≥ 1.0 km from their kittens during 11:00-16:00. They were within 0.6-0.8 km during most of the rest of the time (see Fig. 2A). There were three periods over the 24 hours when females were ≤ 200 m from their kittens an average 23-29% of the time: 15:00-17:30 ($25.7 \pm 5.7\%$; $N = 5$), 23:00-01:30 ($29.4 \pm 3.0\%$; $N = 6$) and 07:00-10:30 ($23.2 \pm 3.1\%$; $N = 8$;

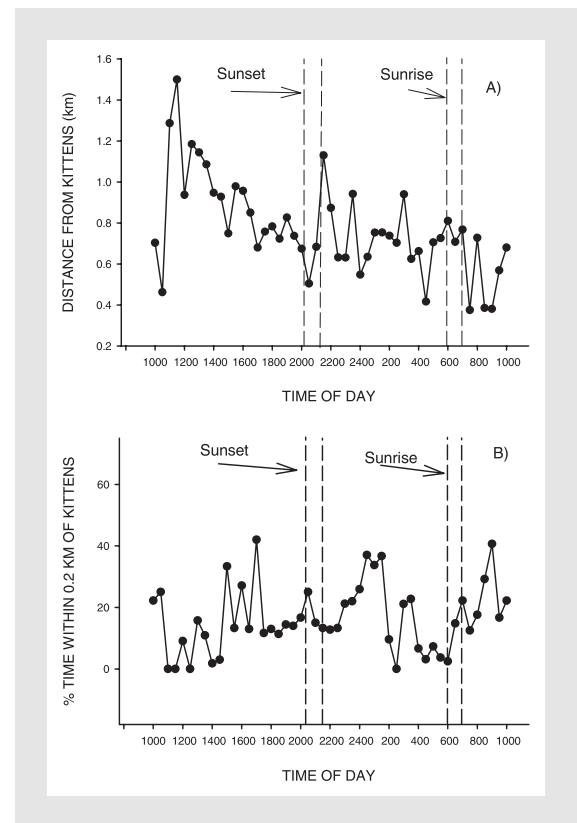


Figure 2. Average distance (in km) 12 female pumas were from their 7-12 month-old kittens over the course of 24 hours (A), and average percent time these 12 females were ≤ 200 m of their kittens (B). Average sample size for each half-hour sample was 9.8 female-kitten pairs. The average standard error for the half-hourly distances between females and kittens was 0.2 ± 0.01 . The range of sunset and sunrise times over the study period is indicated.

see Fig. 2B). During 11:00-14:30, females were near their kittens the least amount of time ($5.1 \pm 2.1\%$; $N=8$; see Fig. 2B).

Discussion

Based on simultaneous telemetry locations collected at varying time intervals over the year, four females and their 7-12 month-old kittens in southern Utah were together 69% of the time (Barnhurst & Lindzey 1989). Three Florida panther *Puma concolor coryi* females with dependent kittens (no ages were specified) were within 0.5 km of each other 45% of the time and were > 1.0 km apart 47% of the time (Maehr et al. 1991). In contrast, in New Mexico, kittens > 6 months old were with their mothers 82% of the time (Logan & Sweanor 2001). These telemetry-based estimates are substantially higher than the 16.2% we found for the 12 females within 200 m of their kittens. Barnhurst & Lindzey (1989) and Logan & Sweanor (2001) observed that taking daytime telemetry locations when pumas are inactive (Beier et al. 1995) probably overestimated the percent time females and kittens were together. We did find that the percent time females were with their kittens changed through the daytime, with one of the highest average percentages being early morning (07:00-10:30). If telemetry flights in these studies were in the early morning, (when the air is most stable), then the estimates of Barnhurst & Lindzey (1989) and Logan & Sweanor (2001) were probably overestimates of the total time females and kittens are together. However, given the variability we found in the amount of time they were close to their kittens (0-42.0%), some of the differences could be due to the small sample sizes (3-4 females) of these previous studies.

In contrast to their telemetry based estimates, Barnhurst & Lindzey (1989) found females and their 7-12 month-old kittens together 43% of the time based on snow tracks. Because Barnhurst & Lindzey (1989) recorded only tracks crossing roads, they contended that this estimate should be the most realistic to the percent of time hunters, using the same technique, should encounter females with their kittens. Their estimate, however, was still higher than the 16.8% we found via telemetry. Again, because of the variability we found among days and animals, the higher percent of Barnhurst & Lindzey (1989) could be related to their limited sample size of two animals. Another possibility is that the percent

time females associate with their kittens differs between summer, when we collected our data, and winter. However, we currently lack the data to test this supposition.

Barnhurst & Lindzey (1989) found that two females were together with their 0-6 month-old kittens for 63% of the telemetry locations. In contrast, their snow data indicated that females traveled with young kittens 19% of the time, which was only slightly higher than our telemetry estimate of 2.3-12.2% for three females with < 1 month-old kittens. Females rarely move their kittens away from their birth sites before they are two months old (Logan & Sweanor 2001), so females will be alone when they travel for at least two of six months after the kittens are born. Therefore the estimate of Barnhurst & Lindzey (1989) from snow tracking is perhaps more applicable for kittens of 3-6 months, which we would expect to be higher. In all cases, sample sizes were extremely small (2-4 animals) but considering our data and the snow-tracking data of Barnhurst & Lindzey (1989), females appear to be with their 0-6 month-old kittens $< 20\%$ of the time.

During the diel cycle, females are least likely to be near their young from late morning to mid-afternoon (see Fig. 2B). It is during this time that they are also the furthest away (see Fig. 2A). We speculate that in late morning females separate from their young, perhaps to sleep undisturbed. It appears that they rejoin their young in late afternoon, but then separate again toward evening when they begin to be active (Beier et al. 1995). Over the nighttime, the pattern of percent time females are near their kittens appears similar to the pattern of activity (i.e. distance moved per hour) Beier et al. (1995) reported and for what we found in our study (Fig. 3). Females showed a peak in activity during 16:00-22:00 (see Fig. 3), and during this period we found them to be away from their young $> 80\%$ of the time (see Fig. 2B). Shortly before midnight females seem to rejoin their kittens, which corresponded to the reduced activity we (see Fig. 3) and also Beier et al. (1995) noted. An hour or so before sunrise, we (see Fig. 3) and Beier et al. (1995) found that pumas increased their activity, and again we found that they separated from their young (see Fig. 2B). The cycle completes itself when females rejoin their young around sunrise before they separate again in late morning. Consequently, the diel requirements of caring for their young and activity, primarily hunting, appears to produce a distinct diel pattern of association between females and their young.

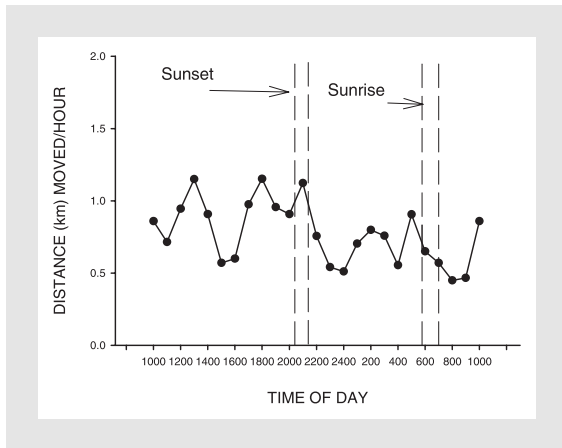


Figure 3. Average distance (in km) the females in our study moved per hour over the 24-hour cycle. The average number of animals we used per hour is the same as in Fig. 2. The range of sunset and sunrise times over the study period is indicated.

Given that females spend considerable amounts of time away from their young, what are the management implications? As proposed by Barnhurst & Lindzey (1989), the probability that a hunter will detect a female with kittens is low and even less for females with extremely young vulnerable kittens. Females are most likely to cross roads and trails, leaving tracks for hunters to find, when they are active at night. Based on our data in Fig. 2B, it is during these periods of activity that females are less likely accompanied by their young. This further decreases the probability that a hunter will find a female's track accompanied by those of her kittens. When a hunter releases his dogs on a single female track, the dogs usually run faster than the humans. Thus, hunters rarely travel closely with their dogs during the chase (J.W. Laundré, pers. obs.). Many times, when the dogs reach the puma and she has kittens, the female goes in one direction and the kittens in another (J.W. Laundré, pers. obs.). Because the dogs have been tracking the scent of the female, they most often continue on her trail, leaving the kittens behind (J.W. Laundré, pers. obs.). Thus, even if a female had rejoined her kittens after crossing a road, by the time the dogs chase her up into a tree, she is alone again. Hunters normally know when the dogs have a puma in a tree by the change of the frequency and tone of their bark. They then travel directly to the tree, missing much of the chase trail, where they might have noted kitten tracks. Consequently, the hunter would mistakenly assume the female was without kittens and may decide to kill her. If we add to this the fact that

females are either pregnant or with dependent kittens approximately 80% of their adult lives (Logan & Sweaner 2001) and that females can give birth to kittens at anytime of the year, then the probability that a hunter will unknowingly kill either a pregnant female or one with undetected dependent kittens is extremely high.

One way of reducing possible orphaning of <6 month-old kittens is to adjust the hunting seasons to times when the minimal possible number of such young kittens occurs in the population (Cougar Management Guidelines Working Group 2005). However, given the frequency distribution of births (Cougar Management Guidelines Working Group 2005, Laundré & Hernández 2007), 60% of the kittens are ≤ 6 months old (born in July-December), and thus dependent on their mothers, during the traditional December-March hunting season. This leaves little room for adjustment of the seasons. An obvious solution would be to prohibit the killing of all females. However, given the current concern about the impacts of puma predation on ungulate populations (Ballard et al. 2001), it is unlikely that game agencies would enact such a restriction. On the other hand, under the current hunting regulations, the laws prohibiting the killing of female pumas with kittens would seem relatively ineffective. If we continue the harvest of female pumas, we must accept that the undetected loss of kittens for future recruitment will occur. What remains to be studied is the impact of this loss on the population dynamics of hunted puma populations.

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