

Estimating detection and density of the Andean cat in the high Andes

JUAN REPPUCCI, BETH GARDNER,* AND MAURO LUCHERINI

Grupo de Ecología Comportamental de Mamíferos, Departamento de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur, and Consejo Nacional de Investigaciones Científicas y Técnicas, San Juan 670, 8000 Bahía Blanca, Argentina (JR, ML)

United States Geological Survey, Patuxent Wildlife Research Center, Laurel, MD 20708, USA (BG)

* Correspondent: beth_gardner@ncsu.edu

The Andean cat (*Leopardus jacobita*) is one of the most endangered, yet least known, felids. Although the Andean cat is considered at risk of extinction, rigorous quantitative population studies are lacking. Because physical observations of the Andean cat are difficult to make in the wild, we used a camera-trapping array to photo-capture individuals. The survey was conducted in northwestern Argentina at an elevation of approximately 4,200 m during October–December 2006 and April–June 2007. In each year we deployed 22 pairs of camera traps, which were strategically placed. To estimate detection probability and density we applied models for spatial capture–recapture using a Bayesian framework. Estimated densities were 0.07 and 0.12 individual/km² for 2006 and 2007, respectively. Mean baseline detection probability was estimated at 0.07. By comparison, densities of the Pampas cat (*Leopardus colocolo*), another poorly known felid that shares its habitat with the Andean cat, were estimated at 0.74–0.79 individual/km² in the same study area for 2006 and 2007, and its detection probability was estimated at 0.02. Despite having greater detectability, the Andean cat is rarer in the study region than the Pampas cat. Properly accounting for the detection probability is important in making reliable estimates of density, a key parameter in conservation and management decisions for any species.

Key words: Argentina, camera trapping, felids, spatial capture–recapture

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Management and conservation of species relies heavily on understanding the variation in population abundance or density for a target species. Thus, accurate estimation of population abundance is essential in making good decisions for conservation (Sadler et al. 2004; Thompson 2004). However, many carnivore species, which are frequently of special concern for conservation and management, tend to be difficult to study because of their elusive behavior and crepuscular or nocturnal activity patterns (Gese 2001; Smallwood and Schonewald 1998; Wilson and Delahay 2001). Solitary felids (e.g., tigers [*Panthera tigris*], snow leopards [*Uncia uncia*], and Andean cats [*Leopardus jacobita*]) tend to be even more difficult to monitor because of their large home ranges, low densities, and cryptic nature.

Despite an increasing number of studies on small cats in the high Andes (Cossíos et al. 2009; Napolitano et al. 2008), basic knowledge on the biology and ecology of these cats is still scarce (Marino et al. 2010; Napolitano et al. 2008). The Andean cat, classified as Endangered by the International Union for the Conservation of Nature (Acosta et al. 2008), is one of the most endangered and least known felids (Nowell

and Jackson 1996) likely because of the extreme difficulty in physically observing this cat and the inaccessibility of its habitat. Given the importance of understanding population abundance in establishing the conservation status of a species (Primack et al. 2001), this lack of basic biological information on the Andean cat renders the design of conservation actions near impossible.

The Andean cat has a limited range and is restricted to mostly high, arid regions of the Andes (Yensen and Seymour 2000). A number of threats to the Andean cat have been identified, including habitat degradation and fragmentation caused mainly by mining and ranching, prey reduction, traditional hunting (Acosta et al. 2008; Villalba et al. 2004), and potentially interspecific competition with other felids in the region (Acosta et al. 2008; Lucherini and Luengos Vidal 2003). In particular, the Andean cat shares its habitat with the more widely distributed, but poorly understood sympatric



Pampas cat (*Leopardus colocolo*), which is classified as Near Threatened by the International Union for the Conservation of Nature (Pereira et al. 2008). The role of interspecific competition between the species remains unknown; however, some evidence suggests that Andean cat populations might be affected negatively by competition with the Pampas cat (Lucherini and Luengos Vidal 2003; Lucherini et al. 2009; Walker et al. 2007). Although the Andean cat generally is considered less abundant than the Pampas cat (Marino et al. 2010; Perovic et al. 2003), no previous studies have provided density estimates that explicitly account for the probability of detection being <1 .

Detection bias for imperfect detection of individuals is an important consideration in estimating abundance of animal populations because individuals cannot be observed perfectly using practical sampling strategies. The probability of encountering or detecting an animal is <1 in most survey situations (MacKenzie et al. 2005). Thus, understanding detectability is an essential element in making accurate estimates of abundance and density. Although a number of techniques exist for estimating relative abundance for carnivores, such as standardized sign surveys (Gese 2001), camera-trapping arrays provide spatial and temporal data that can be used to estimate density in the presence of imperfect detection of individuals.

Camera trapping is used commonly to estimate the population size for large (Karanth et al. 2006; Maffei et al. 2004; Soisalo and Cavalcanti 2006) and medium-sized (e.g., Di Bitetti et al. 2006; Haines et al. 2006; Maffei and Noss 2007) felids, although, studies on small felids have been more limited (Cuéllar et al. 2006). Individual cats can be identified by their unique and distinctive coat patterns (stripes, spots, etc.), which allows for individual recognition, and thus, traditionally, capture–recapture models for closed populations are applied to these data.

Unfortunately, 2 major issues plague the analysis of camera-trapping data on carnivores (and felids in particular). The 1st is the violation of geographic closure resulting from animals with large home ranges moving into and out of the study area. This movement of individuals in the vicinity of the trapping array can influence the estimates of detection probability and abundance (Efford 2004; Gardner et al. 2009; Royle and Young 2008). The 2nd issue is the sparse data sets that arise when species are found in low densities or because their cryptic nature makes them difficult to detect (Gese 2001; Smallwood and Schonewald 1998; Wilson and Delahay 2001). The most commonly used capture–recapture models in analyzing these data are likelihood-based approaches that rely on asymptotic inference procedures. When dealing with small sample sizes, these approaches typically are not valid (Le Cam 1990).

The objective of this study was to provide the 1st estimates of density for the Andean cat based on camera trapping and to draw comparisons with the sympatric Pampas cat by examining differences in detectability, density, and the estimated activity centers. To address the main concerns in

analysis of camera-trapping data mentioned above we used a spatially explicit capture–recapture model that incorporates the auxiliary spatial information collected during camera-trapping studies (Gardner et al. 2009, 2010b; Royle et al. 2009; Royle and Young 2008). The model is implemented in a Bayesian framework, which provides valid inferences for small sample sizes.

MATERIALS AND METHODS

Study site.—The study was conducted in the western central Jujuy Province, Argentina ($22^{\circ}30'S$, $66^{\circ}30'W$), near the border of Chile and Bolivia. This area was part of the ecoregion of Puna that encompasses a mosaic of high-altitude, snow-capped peaks, volcanoes, salt flats, lagoons, and high-altitude plateaus (Cajal 1998). The altitude of the region ranged from 3,500 to 6,000 m above sea level, and the study site had an average altitude of 4,200 m. The ruggedness of the terrain varied markedly, alternating between broken areas with many canyons to large smooth areas with isolated cliffs. The vegetation was composed of scarce shrubland steppe and grassy steppe, with some wet areas containing cushion bogs or bofedales. The annual rainfall varied between 100 and 200 mm and was concentrated in summer (January and February—Cajal 1998). In the study area human density was rather low. The main human activity that impacts the region was ranching, including cattle, llamas, goats, sheep, and donkeys (Cajal 1998); however, the impact was considered moderate. Comparatively, some mining projects in the region might heavily impact the environment.

Survey design.—Two separate camera-trapping surveys were carried out from October to December 2006 and from April to June in 2007. In each survey we constructed an array of sampling stations consisting of 2 cameras, 1 on each side of the expected trajectory of the animal. We deployed at least 1 Camtraker camera (Camtraker, Watkinsville, Georgia) at each site to reduce difference in detection between camera types, but a few other brands were used in the study ($<16\%$ of all cameras were Trail Master; Goodson and Associates, Inc., Lenexa, Kansas), Stealth Cam (Stealth Cam LLC, Grand Prairie, Texas), and Trapa-camera (Trapa-camera, Cidade Universitária, São Paulo, Brazil). Each sampling station was placed strategically to maximize capture probability (Jackson et al. 2006; Karanth and Nichols 1998, 2002). We selected sites where indirect evidence, such as cat tracks or scats, was detected. Stations were deployed over the area ensuring that no “holes” occurred in the sampling array; that is, such that no individual could have an entire home range located between sampling stations (Di Bitetti et al. 2006; Karanth and Nichols 2002). Because no published information about the home-range size of the Andean cat or the Pampas cat exists, we used data from cats of similar size; for example, estimated mean home-range radius for the female Geoffroy’s cat (*Leopardus geoffroyi*) is 0.77 km (Manfredi et al. 2006) and for the female European wildcat (*Felis silvestris*), 0.85 km (Monterroso et al. 2009). The maximum distance between the

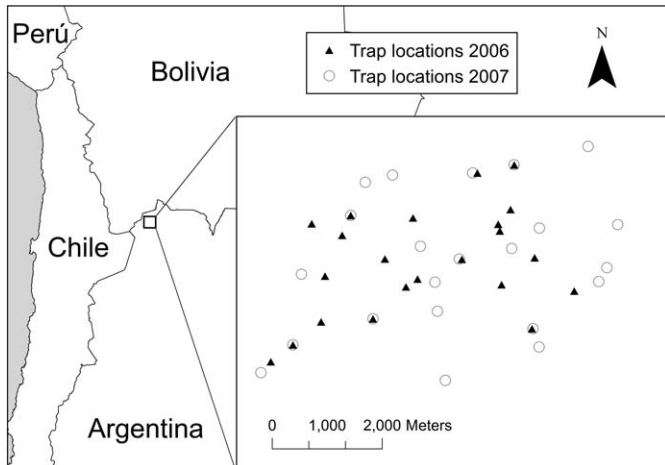


FIG. 1.—Study area location in the Argentinean high Andes. Trap locations for both surveys are shown as solid triangles for 2006 and open circles for 2007.

closest neighbor and any sampling station was 973 m in 2006 and 1,388 m in 2007. Cameras were checked almost weekly to replace batteries and film and to ensure that they were functioning properly.

Each year 22 sampling stations were deployed; however, the locations of most of the cameras were changed in the 2nd survey (Fig. 1). In the 2006 survey, 7 of the sampling stations were moved once, and in 2007, 4 of the sampling stations were moved during the course of the study. Cameras were moved to maximize capture probabilities (Jackson et al. 2006; Karanth and Nichols 2002). Cameras are expected to capture continuous data, but some problems with cameras malfunctioning or batteries running out resulted in a loss of approximately 9% of the trap days. This near-continuous set of data was divided into approximately equal-effort sampling occasions ($\bar{X} = 184$ trap days in each occasion) for analysis. For individual identification all photos were examined independently by authors and collaborators. An encounter (or capture) history for each individual then was constructed based on the time and location of the photo captures.

Spatially explicit model.—To estimate the density of cats based on our camera-trapping data we applied a spatially explicit capture–recapture model (Borchers and Efford 2008; Gardner et al. 2009, 2010a; Royle et al. 2009). Movement of individuals has been a pervasive problem in capture–recapture models. Spatially explicit capture–recapture approaches attempt to address this issue explicitly in the model description. To incorporate movement, the model assumes that each individual has an activity center (home-range center) and that the probability of capture is a monotonically decreasing function of the distance from the activity center to a trap.

The model can be formulated as a generalized linear model with random effects, i.e., a generalized linear mixed model. First, we assumed that each individual in the population has an activity center, $\mathbf{s}_i = (s_{1i}, s_{2i})$ and that these activity centers are uniformly distributed across some region S . We denoted the trap locations as $\mathbf{x}_j = (x_{1j}, x_{2j})$. The model was formulated to

accommodate the movement of traps both within each primary sample period and between the primary periods (Gardner et al. 2010a). Next, we defined the encounter process—that is, the number of times an individual i is captured in trap j during a sampling occasion, y_{ij} —as a Poisson random variable with mean, λ_{ij} , such that:

$$y_{ij} \sim \text{Poisson}(\lambda_{ij}).$$

Thus, for individual i and trap j , the half-normal detection function yields a log-linear model of the form (Royle et al. 2009):

$$\log(\lambda_{ij}) = \log(\lambda_0) - (1/\sigma^2)d_{ij}^2,$$

where $d_{ij} = \|\mathbf{s}_i - \mathbf{x}_j\|$ is the distance from individual i 's activity center to trap j and λ_0 is the baseline encounter rate, defined as the expected number of captures in a trap during a sampling occasion given that an individual's activity center is located precisely at that trap location. The detection function is specified as a half-normal with scaling parameter σ . By assuming a bivariate normal model for detection, we can convert the estimated σ into a 95% home-range radius estimate.

In this formulation of the model d_{ij}^2 is considered a latent random effect because the activity centers (\mathbf{s}_i) are not observed. To carry out inference on N we supposed that the \mathbf{s}_i s are distributed uniformly over some region S , which we prescribed to be an arbitrarily large polygon containing the trap locations. Based on this formulation of the model, density is a derived parameter that we calculated as $N_t/\|S\|$, where N_t is the number of estimated activity centers (\mathbf{s}_i) in the region S during year t , and $\|S\|$ is the area of S . For this analysis we specified S as a rectangle centered around the trapping array with an area of 168 km². Thus, data from both years were combined to estimate λ_0 , σ , N_1 , and N_2 in the model (i.e., the model provided separate density estimates for each year but using a combined data set to make the most efficient use of the limited data). We used a Bayesian framework for analysis of the model using data augmentation (Royle et al. 2007), where we added $M = 50$ all-zero encounter histories. This creates a zero-inflated version of the model but does not bias the parameter estimates (see Gardner et al. [2009] and Royle et al. [2009] for a description of data augmentation specifically in spatially explicit capture–recapture models). The model was implemented in the freely available software package WinBUGS (Gilks et al. 1994).

When a Poisson encounter model is used, the probability of detecting an individual in a trap is given by:

$$\Pr(y_{ij} > 0) = 1 - \exp(-\lambda_{ij}),$$

which is the probability that $y > 0$ under the Poisson model. Thus, we used this formula to convert the baseline encounter frequency (λ_0) into the baseline detection probability. When λ_0 is small (e.g., < 0.5), the 2 values—encounter frequency and detection probability—are very similar.

Standard approaches.—For comparison we estimated N under classical closed-population models with constant

TABLE 1.—Posterior summaries of model parameters for the Andean cat. Density was calculated as the number of Andean cats per km², shown in the table as D_1 and D_2 for 2006 and 2007, respectively. σ , the shape parameter in the detectability function, is given in kilometers. The expected number of encounters per interval for an individual with an activity center located precisely at a given trap was λ_0 . N_1 and N_2 were the number of estimated activity centers in the boundary box S for year 2006 and 2007, respectively.

Parameter	\bar{X}	SD	2.5%	Mode	97.5%
D_1	0.07	0.03	0.04	0.05	0.15
D_2	0.12	0.05	0.08	0.10	0.24
σ	2.05	0.42	1.40	1.82	3.00
λ_0	0.08	0.03	0.04	0.07	0.14
N_1	11.21	5.45	4.00	8.00	25.00
N_2	20.47	8.06	9.00	16.00	40.00

detection probabilities (often referred to as model M_0 —Otis et al. 1978) and with heterogeneous detection probabilities (model M_h —Burnham and Overton 1978), which are 2 estimators commonly used in camera-trapping studies. The analysis was carried out using program CAPTURE (White et al. 1978). We estimated density as $D = N/A(W)$, where N is the estimated abundance produced by CAPTURE and $A(W)$ is effective trapping area. We calculated a buffer strip (W) equivalent to the mean maximum distance moved (MMDM) by all animals photographed at ≥ 2 locations during both surveys, which was added to the convex hull of the camera-trap locations (Karanth and Nichols 1998, 2002). Researchers generally choose some value between one-half and the full MMDM for the buffer; we used both MMDM and $\frac{1}{2}$ MMDM for comparison. These techniques are essentially a 2-stage approach to the estimation of density, where 1st N is estimated and then associated with an effective trapping area. This approach does not have a formal model-based justification, and, as such, the variance estimation is not straightforward and can be biased.

RESULTS

Sampling was conducted over 2 time periods (2006 and 2007), which were subdivided into 6 sampling occasions within each period. The sampling effort of 1,113 and 1,078 camera-trap days in 2006 and 2007, respectively, resulted in photo-captures of Andean cats, Pampas cats, mountain vizcachas (*Lagidium viscacia*), culpeo foxes (*Lycalopex culpaeus*), and several unidentified small mammals and birds. This data set contained a total of 25 Andean cat photo-captures, from which we obtained encounter histories for 3 individuals in 2006 and 6 in 2007, of which 1 cat was captured in both years. Andean cats were detected at 23% of camera stations each year, and the interval between photo-captures was approximately 7 days in 2006 and 3.5 days in 2007. Based on the spatially explicit capture–recapture model, the posterior mean for the baseline encounter rate, λ_0 (i.e., the expected number of captures in a trap given that the activity center is located precisely at the trap), was 0.08 (95% posterior interval

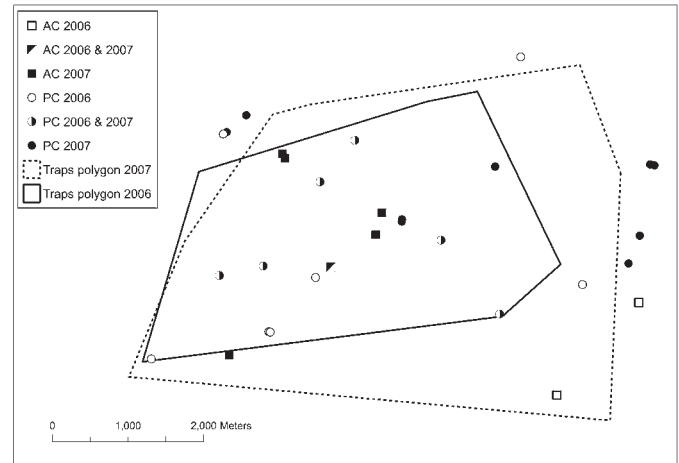


FIG. 2.—Estimated activity center locations for captured individuals of Andean cats (AC) shown in squares (this study) and Pampas cats (PC—Gardner et al. 2010a) in circles. Open symbols show those individuals captured only in 2006, half-filled symbols those captured in both years, and filled symbols those captured only in 2007. The convex polygon encompassing all trap locations is shown for 2006 and 2007.

[PI] = 0.04–0.14), and hence the estimated mean detection probability was 0.07. The estimated mean Andean cat population size (i.e., number of activity centers, N , in S , a 168-km² area) was 11.21 cats (95% PI = 4.00–25.00) in 2006 and 20.47 cats (95% PI = 9.00–40.00) in 2007. Density was derived by standardizing N by the area of the state space, S , resulting in mean posterior density estimates of 0.07 (95% PI = 0.04–0.15) and 0.12 (95% PI = 0.08–0.23) individual/km² for 2006 and 2007 (Table 1).

The posterior mean estimate for σ , the scaling parameter of the distance function, for the Andean cat was 2.05 (95% PI = 1.40–3.00), and Gardner et al. (2010a) estimated the posterior mean estimate for the Pampas cat as 1.91 (95% PI = 1.25–2.87). This resulted in estimated mean home-range radii of 3.60 and 3.31 km for the Andean and Pampas cats, respectively. The posterior mean activity center locations for both the Andean cats and Pampas cats captured during the study showed extensive overlap (Fig. 2).

The estimated N (SD) for the Andean cat under model M_0 was 3 (0.6) cats in 2006 and 6 (0.9) cats in 2007, and the estimated N under model M_h was 6 (2.6) cats in 2006 and 6 (2.3) cats in 2007. We estimated the effective trapping area, $A(W)$, using one-half MMDM and full MMDM as 34.71 (14.85) and 64.78 (20.29) km² in 2006 and 45.65 (17.03) and 79.36 (22.46) km² in 2007. The calculated full MMDM estimate was 2.32 (0.71) km and the one-half MMDM estimate was 1.16 (0.36) km. Using the estimates of $A(W)$ based on full to one-half MMDM, we computed an Andean cat density of 0.05 (0.02) to 0.09 (0.41) individual/km² in 2006 and 0.08 (0.02) to 0.14 (0.05) individual/km² in 2007 from the model M_0 results (Table 2). Using the estimates of N from model M_h , and $A(W)$ based on full to one-half MMDM, the densities were estimated as 0.09 (0.05) to 0.17 (0.10) individual/km² and 0.08 (0.04) to 0.13 (0.07) individuals/

TABLE 2.—Summary of estimated densities (number of individuals/km²) for the Andean cat obtained applying 3 different models, the spatially explicit capture–recapture (SECR) model, the nonspatial null model (M_0), and the nonspatial heterogeneity model (M_h). One-half mean maximum distance moved (MMDM) and full MMDM were used for both nonspatial models.

Year	SECR	One-half MMDM model M_0	Full MMDM model M_0	One-half MMDM model M_h	Full MMDM model M_h
2006	0.07	0.09	0.05	0.17	0.09
2007	0.12	0.13	0.08	0.14	0.08

km² in 2006 and 2007, respectively. We reported the estimates of N and density from classical closed–population models here for comparison with the spatially explicit model (Table 2); however, these estimates are not directly comparable because of the difference in the definition of N and the estimation of the effective trapping area under traditional approaches.

DISCUSSION

In recent years the number of studies on high Andean carnivores has increased; however, the available information on the Andean cat has remained scarce because this cat occurs predominantly in harsh and remote environments (Marino et al. 2010). This predicament is a common issue in conservation because the species of highest management priority often are the most difficult to study (Thompson 2004). Camera-trapping studies in conjunction with spatially explicit capture–recapture models provide a framework for estimating density of rare and elusive species. This framework includes the estimation of detection probabilities, which is critical in achieving unbiased estimates of abundance and density (MacKenzie and Kendall 2002).

Our density estimates for the Andean cat (0.07–0.12 individual/km²) were extremely low compared with the density estimates for Pampas cats from the same study area (0.74–0.79 individual/km²—Gardner et al. 2010a) and those available for similar sized felids from the Neotropics. In a review of lowland Neotropical cats de Oliveira et al. (2010) found that the highest population densities of jaguarundi (*Puma yagouaroundi*), margay (*Leopardus wiedii*), little spotted cat (*L. tigrinus*), and Geoffroy’s cat ranged from 0.20 to 0.42 individual/km², and that of ocelots (*L. pardalis*), usually the most abundant species, reached 1 individual/km² in very productive ecosystems. Additionally, our estimates for the Andean cat, based on allometric functions of Carbone and Gittleman (2002), were considerably lower than the expected density for a 4.5-kg carnivore (the average body mass of an Andean cat) of 0.52 individual/km². Conversely, the expected population density for a 3.5-kg cat (the average body mass of a Pampas cat), would be 0.65 individual/km², which is similar to the estimated density for Pampas cats in this area (Gardner et al. 2010a).

One potential reason for this discrepancy in density for the 2 species could be that the Andean cat is thought to be a more specialized predator (Napolitano et al. 2008; Walker et al.

2007), with a preference for the mountain vizcacha, a large rodent. The Pampas cat has been described as more of a generalist (Napolitano et al. 2008; Walker et al. 2007); thus our results are consistent with the other studies showing that in carnivore assemblages the more specialized species usually occurs at lower densities (Mills and Biggs 1993) and support the finding that ecological specialization contributes to species being vulnerable to extinction (Harcourt et al. 2002; Primack et al. 2001). As noted previously, the higher density and much greater range of the Pampas cat in comparison to the Andean cat is consistent with the notion that range sizes of ecologically similar species are correlated positively with abundance (Brown 1984) and suggest that Pampas cats are competitively dominant over the more specialized Andean cats.

The map of the activity centers for both species suggests that in general both species are using the same areas. Because we found no clear separation in the spatial locations, we cannot exclude that intraguild competition was responsible for the low density estimates of the Andean cat, especially because considerable overlap has been observed in the trophic (Walker et al. 2007) and temporal (Lucherini et al. 2009) niches of these 2 cats. In addition, most carnivore species are influenced to some degree by intraguild competition (Linnell and Strand 2000; Palomares and Caro 1999), and thus one might assume that some of the variation in the density estimates that could not be explained by differences in prey densities was related to interspecific competition (Carbone and Gittleman 2002). Regardless of whether intraguild competition influenced the density of the Andean cat, the results of this study show that densities of the Andean cat are much lower than those of the Pampas cat in this region and support the perilous conservation status of the Andean cat.

Some possibility exists that we overestimated density because to maximize capture probability we concentrated the trapping effort in exceptionally good-quality areas or our trapping area was relatively small (Maffei and Noss 2007). As a result, our density estimates should not be extrapolated to large portions of the distributions of these species. That the Andean cat density estimates under our model were different between the 2 sampling occasions (also the number of photo-captured individuals doubled) is of particular interest. Although this could have been due to a different placement of cameras in 2007, which led to a greater number of photo-captured individuals, estimating detection separately for the 2 sampling occasions showed that detection probabilities were lower in 2007 but did not affect our estimates of density. With such small sample sizes—for example, 3 photo-captured individuals in 2006—1 individual can greatly influence the parameter estimates. Although the density estimates from CAPTURE for model M_h were more consistent between years, this again is a function of the small sample size and the particularly large heterogeneity in encounter histories for the 3 individuals in 2006. One advantage of the spatially explicit capture–recapture model is that we combined information across years, which potentially reduced the bias from the small sample sizes within each year. Additionally, other possible

biological hypotheses exist that could explain this change in density. It is possible that a real increase in density occurred due to a potential increase in mountain vizcacha abundance that drew more Andean cats to the area during the study. Testing this hypothesis would require better understanding of the population dynamics of the mountain vizcacha. Also, mating in Andean cats occurs between July and August (Villalba et al. 2004). Thus, in the 2nd period we could have detected juveniles that were not detected in the previous sampling period. In the 1st sampling period, which occurred in October, juveniles likely were kittens accompanying adults and thus had lower detection probabilities; for example, tiger cubs have been found to have a low detection probability (Karanth et al. 2006). These juveniles might be starting to disperse looking for new areas to establish their home ranges, thus causing an apparent increase in population numbers. More data and spatial replication of such studies are required to test these hypotheses.

Our results showed that density estimates from the spatially explicit capture–recapture model generally were intermediate between the estimates of density using the one-half and full MMDM nonspatial closed-population approaches. The density estimates from the traditional approach were influenced greatly by the choice of buffer in this study (see Table 2). A number of concerns arise when using traditional approaches for analyzing camera-trap data, which suggests that direct comparisons between the techniques can be somewhat questionable. In part this is because no formal way to convert estimates of N to density exists under the nonspatial closed-population models. The choice of buffer strips is ad hoc and can influence density estimates and associated variances. Telemetry-calculated MMDM is usually between full and one-half MMDM estimated from camera traps (Di Bitetti et al. 2006; Soisalo and Cavalcanti 2006), but no clear objective method exists for determining what percent of the MMDM would be appropriate as a buffer. Because of this, density estimates can vary greatly despite the estimated N remaining constant. In contrast, the spatially explicit capture–recapture model we applied in this study accounts for the spatial location of individuals relative to traps and sets a constant state-space, removing the arbitrary decision related to choosing an effective trapping area.

We have shown that the density of the Andean cat was lower than that of the Pampas cat while simultaneously the estimated detection probability was much greater for the Andean cat. Gardner et al. (2010a) estimated the mean detection probability for the Pampas cat to be 0.02, and we determined the detection probability for the Andean cat to be 0.07. This has 2 clear implications. First, naïve estimates of the Andean cat that do not account for detection (e.g., indices calculated by number of individuals or photo-capture rate) might inflate its relative abundance. Second, comparisons of such naïve estimates between the 2 species would be misleading and incorrect. It is likely that the Andean cat is rarer than previously suspected, particularly when we consider that our study area is an excellent habitat for the Andean cat. Thus, the very low densities of the Andean cat, in addition to

the known patchy distribution of its main prey, have very important conservation implications. Because of the rare and elusive nature of such species, it is of particular relevance that we properly account for detection so that abundance estimates are not misleading. The application of this protocol in different locations also could help in understanding the abundance of the Andean cat and in evaluating the conservation status of the species.

RESUMEN

El gato andino (*Leopardus jacobita*) es uno de los félidos más amenazado y menos conocidos del mundo. Aunque esta especie está considerada en riesgo de extinción, no se cuenta con rigurosos estudios poblacionales cuantitativos. Las observaciones del gato andino en la naturaleza son muy difíciles, si no imposibles, por lo que utilizamos una serie de cámaras trampa para foto-capturar a los individuos. El estudio fue llevado a cabo en el Noroeste de Argentina, a aproximadamente 4,200 m de altura, durante octubre–diciembre de 2006 y abril–junio de 2007. En cada año, instalamos 22 pares de cámaras trampa, posicionándolas estratégicamente. Para estimar la probabilidad de detección y densidad, aplicamos una clase de modelos, recientemente desarrollados, de captura–recaptura espacialmente explícitos utilizando un marco Bayesiano. Las densidades estimadas fueron de 0.07 y 0.12 individuos/km² para 2006 y 2007, respectivamente. La probabilidad de detección media estimada fue de 0.07. Comparamos estos resultados con los obtenidos anteriormente para el gato del pajonal (*Leopardus colocolo*), otro felino poco conocido que comparte su hábitat en los Andes con el gato andino. Las densidades estimadas para el gato del pajonal fueron de 0.74–0.79 individuos/km² en la misma área de estudio para 2006 y 2007, respectivamente. Nuestros resultados corroboran el delicado estado de conservación del gato andino, indicando que, a pesar de tener una mayor probabilidad de detección, este félido es más raro que el gato del pajonal en la región de estudio. Por lo tanto tener en cuenta en forma apropiada la probabilidad de detección es muy importante para hacer estimaciones confiables de densidad, un parámetro clave para las decisiones de conservación y manejo de cualquier especie.

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