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Band size, activity pattern and occupancy of the coati *Nasua narica* (Carnivora, Procyonidae) in the Southeastern Mexican rainforest

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Abstract: The White-nosed coati or tejon, *Nasua narica,* is relatively common within terrestrial mammal communities though little information on its population ecology has been gathered in certain regions. This study evaluates the band size, activity pattern and occupancy of *N. narica* at Los Chimalapas, in the eastern region of the state of Oaxaca, Mexico, a biodiverse region. It is expected that band size will be greater and activity time will differ from that of predators. Camera traps were used to record the species (2011–2013) in a rainforest at Southeastern Mexico. Band size and activity pattern were calculated based on photographic records. Activity pattern was compared between seasons and with that of predators. The spatial distribution of activity, as well as relationship to the proximity of water, populated areas, crops and the presence of predators, was evaluated with occupancy models. Average band size was 9.03±0.52 individuals. As expected, *N. narica* presented principally diurnal activity and its activity patterns did not differ seasonally, but differed significantly from those of its predators. The occupancy probability of *N. narica* was 0.66 and the detection probability was higher in proximity to the nearby village. The population of *N. narica* at Los Chimalapas may be considered similar to other regions, particularly the band size; predator activity patterns may be an important factor in the activity of *N. narica,* but not in its occupancy.

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Introduction

The coati *Nasua narica* (Linnaeus 1766) is considered common in terrestrial mammal communities. Its population ecology, however, is insufficiently known in various regions. In arid or semiarid habitats, the occurrence of this species is strongly associated with the availability of food and water (Valenzuela 1998, Valenzuela and Ceballos 2000). Home range size and activity of *N. narica* may differ depending on the distribution of resources in tropical dry forests (Valenzuela and Ceballos 2000, Valenzuela and Macdonald 2002). *Nasua narica* is also recognized for its ecological plasticity and is consequently present in areas with varying degrees of disturbance (Gompper 1995, Hernández-Díaz et al. 2012).

The presence of *Nasua narica* ranges from the southern US to northern Colombia (Gompper 1995, Wilson and Mittermeier 2009). It is an omnivorous species that lives in varying types of vegetation such as pine-oak forests, deserts and xeric shrubland and tropical dry forests and rainforests (Gompper 1995, Espinoza-García et al. 2014). The coati's social system is unusual: females and offspring live in family groups or bands, comprised of eight to 30 individuals, while adult males are mostly solitary (Gompper 1995, 1996, Valenzuela and Ceballos 2000). Band size varies within a population as a result of deaths and births, and new bands may form through migration of individuals between bands (Gompper 1995, 1997). Males gather around bands during the mating period in the dry season; however, usually only one male is present in the non-mating season (Booth-Binczik et al. 2004). *Nausa narica* is a diurnal species (González-Maya et al. 2009), but solitary males frequently display nocturnal activity (Caso 1994, Valenzuela and Ceballos 2000).

Nasua narica is prey to different species of predators (Gompper 1995). In the southern USA, Mexico, Guatemala, and Costa Rica, *N. narica* is an important component of the diet of jaguars (*Panthera onca* Linnaeus 1758) and puma (*Puma concolor* Linnaeus 1771) (Nuñez et al. 2000, Novack et al. 2005, Estrada 2008, Bustamante-Ho et al. 2009), and predation by felines accounts for as much as 50% of adult mortality (Valenzuela 1998, Hass and Valenzuela 2002). *N. narica* is also prey to the ocelot (*Leopardus pardalis* Linnaeus 1758), and various predatory birds (Hass and Valenzuela 2002). In Costa Rica, predation of nestling *N. narica* by white-faced capuchin (*Cebus capucinus* Linnaeus 1758) is also quite common (Rose et al. 2003), and in Arizona there is predation by the black bear (*Ursus americanus* Pallas 1780) (Hass and Valenzuela 2002).

Studies of the ecology of *Nasua narica* have been carried out with the use of direct methods, i.e. observations, telemetry (Sáenz 1995, Gompper 1997, Burger 2001, Hass and Valenzuela 2002, Booth-Binczik et al. 2004), and not so frequently with camera traps (Espinoza-García et al. 2014). Different parameters can be estimated with this technique, although it is difficult to calculate population size without spot patterns (Rowcliffe et al. 2008). One alternative is to use the portion of the area occupied by the species, known as occupancy. Occupancy is considered analogous to abundance and is a way of characterizing the state of a population (Mackenzie and Nichols 2004).

Given that *Nasua narica* is the prey of several predators, as well as an agent of seed dispersion, and has been insufficiently studied in Southeastern Mexican rainforests, this work provides important information in terms of band size, activity pattern and occupancy of *N. narica* in Los Chimalapas rainforest in the state of Oaxaca, Southeastern Mexico. This is a highly preserved region with extraordinary biodiversity, and is part of the Selva Zoque, a region prioritized for conservation (Arriaga et al. 2000). It has also been identified as a priority for the preservation of carnivores in Mexico (Valenzuela and Vázquez 2008).

Goals for this study were: 1) to estimate the band size of *Nasua narica* in this area, 2) to compare the activity pattern of *N. narica* with that of its predators, and 3) to determine how much of the total area is occupied by *N. narica* as opposed to its population size. The results are expected to show that band size is greater in comparison with tropical dry forests and that activity times vary from those of its predators in order to decrease the risk of predation. We include the analysis of activity and size band between seasons because other parameters (i.e. home range size) may differ due to the distribution of resources associated with seasonality (Valenzuela and Ceballos 2000, Valenzuela and Macdonald 2002). Also, band size increases during the birth period, which is in the dry season. It is expected that occupancy and the probability of detection will be greater in sites that are close to bodies of water or areas with human activity (populated areas or crops) due to this species' preference for these resources and its ability to adapt to different environments.

Materials and methods

Study area

The study was conducted in the northern region of Los Chimalapas (17°09′42″ N-94°21′20″ W). The area has tropical rainforest vegetation and a hot and humid climate, with annual temperatures ranging from 22 to 26°C, and an annual precipitation of 2000–2500 mm (Trejo 2004). The rainy season lasts from June to December and the dry season from January to May. The diurnal activity period is from 6:00 am to 8:00 pm, and the nocturnal activity period lasts from 8:00 pm to 6:00 am.

A total of 29 sampling stations were installed from March 2011 to June 2013. Unbaited camera traps were placed at a height of 30 cm above ground. Three camera traps were placed in the rainforest next to rivers, four on trails, five in areas that were close to livestock, and the rest inside the forest. Because of the particular topographical conditions of Los Chimalapas, traps were spaced from 0.5 to 1.5 km apart. The models used were Wildgame IR4 4 MP Digital Game Scouting Camera, ScoutGuard SG550/SG550V 5 MP and Bushnell Trophy Cam 5 MP. All traps were set to remain active for 24 h. The delay period between photographs varied from 3 s to 1 m.

Data analysis

In order to ensure that all events were independent and to avoid pseudoreplication (Tobler et al. 2008), all photographs taken by each sampling station within a 1 h span were considered single records. Relative abundance was calculated as the number of single records of *Nasua narica* in 100 camera-days. All observed individuals on each photo were quantified in order to determine the average size of a group and its range.

Camera traps have a limited detection zone (Rowcliffe et al. 2008) that does not cover the entire area in which groups of *Nasua narica* are found. Therefore, it is possible that some individuals were not recorded; thus, a correction factor had to be applied. First, we calculated a detection area according to Rowcliffe et al. (2008), and then calculated the correction factor (CF): the area covered by a band divided by the area covered by the camera. Because there was no data available about the area occupied by a *N. narica* band, we used the area covered by a band of ring-tailed coatis (*N. nasua* Linnaeus 1756) in Iguazu, Argentina: 16.83 m in length and 11.67 m in width covered by eight to 15 individuals (data from Hirsch 2011). Then, the band size captured by the camera was multiplied by the CF. The area covered by the camera trap was 101 m^2 and the band area was 196.4 m^2, thus the correction factor was 1.94.

The average band size in the dry season was compared with that of the rainy season by means of the Mann-Whitney (U) test (Zar 1999). All tests were accepted as significant at $p \leq 0.05$. Additionally, the results that were obtained from occasional visual observations during the review of camera traps (which were conducted every 2–3 months) were also used to determine group size. In order to provide more information, all data such as the presence of young animals, offspring, or other information about the band was included in this study. Offspring were categorized as small individuals compared to adults, and individuals were considered young if they were medium sized and in-between offspring and adults.

In order to describe activity patterns, the 24-h period was divided into hour-long segments, and each independent record was classified within those intervals. A circular analysis was used to determine the significance of activity differences between the rainy and dry seasons, using the non-parametric Mardia-Watson-Wheeler test (W; Zar 1999). This test was also used to compare the activity patterns of *Nasua narica* with those of its predators. Independent records obtained by the camera traps were used to describe predator activity patterns following the same procedure described for *N. narica*. Predators taken into consideration were *Leopardus pardalis* (n=108 records), *Puma concolor* (n=39) and *Panthera onca* (n=44). Statistical tests were carried out with Oriana version 4 (Kovach Computing Services 2011).

The degree of species occupancy (i.e. the total area of the region covered by a species) and its relationship with the environment and predators were analyzed with occupancy models. These models take into account the fact that a species may not be detected during sampling despite their presence in the area (Mackenzie et al. 2006), and include two parameters: occupancy probability (ψ), the probability of a randomly selected site being occupied by at least one member of that species; and detection probability (p), the probability of at least one individual of a species being detected during the sampling of any particular site, given that the species is present at that site.

In this case, only the second parameter was modeled in order to determine the total area occupied by *Nasua narica*. We evaluated three models in which the detection probability was a function of proximity to 1) the nearest body of water, ψp_{water}, 2) the nearest populated area, $\psi p_{village}$, 3) the nearest crop, ψp_{crop}, 4) predators (i.e. number of photographic records for each site). Predators considered included *Leopardus pardalis* [0–21 records, mean=3.6, standard deviation (SD)=5.46], *Puma concolor* (0–10 records, mean=1.37, SD=2.06) and *Panthera onca* (0–8 records, mean=1.37, SD=2.36). The distance from the camera trap to the nearest body of water varied from 0.1 to 3 km, to the nearest village from 0.3 to 8.2 km and to the nearest crop from 0.2 to 3.1 km.

Presence software, version 5.8, was employed for model construction and analysis (Hines 2006). The best model was selected according to the Akaike Information Criterion modified for small samples (AIC_C; Burnham and Anderson 2004). Environmental variable values were calculated with ArcGis software, version 9.3 (Inegi 2000, Esri 2008) and each value was standardized and expressed as the difference between value and variable average, divided by its standard deviation.

Results

The relative abundance of *Nasua narica* was 0.65 records/100 camera-days. Of the 155 records obtained from cameras, 56 were a single record: 22 were band records, and 34 were records of solitary individuals. The groups were made up of two to 10 individuals. Additionally, three lone individuals and two bands were sighted during the rainy season. The bands were formed by three and 12 individuals (mean=7.5), respectively, including four offspring. The average group size was 9.03 individuals (±0.52, n=24 records) (Table 1). The mean band size during the dry season was 7.11 individuals (±0.84, n=6,), and 9.67 individuals (±0.62, n=18) during the rainy season. The differences between the two seasons were not significant (U=7.5, p=0.33).

With regards to the sex of lone individuals (n=34), five were male and three were female. Due to camera angle, it was not possible to determine the sex of other individuals. Pregnant females (i.e. individuals with a very large belly) were recorded in April, May, and December; offspring were recorded in July, and young individuals were recorded in February, April, May, July, October, and November.

The activity of *Nasua narica* was diurnal, reaching its peak from 9:00 to 11:00 and from 16:00 to 17:00 h (Figure 1), with no significant differences in average activity patterns between seasons (W=0.58, p=0.74). However, the differences between activity patterns of *N. narica* and *Leopardus pardalis* (W=45.75, p=0.00), *N. narica* and *Puma concolor* (W=27.2, p=0.00), and *N. narica* and *Panthera onca* (W=40.5, p=0.00) were significant.

Table 1: Band size of *Nasua narica* in different regions of their distribution area.

Average band size±standard error (range)	Sampling size	Region	Vegetation type	Coordinates	Source
17.00±3.2	8 groups	Arizona, USA	Semi-arid chaparral, grassland	31°25′N; 110°16′W	Hass and Valenzuela 2002
6.30±0.6	3 bands; 110 sighting	Cuixmala, Mexico	Tropical dry forest	19°22′N; 104°56′W	Valenzuela and Macdonald 2002
5.80±0.7	4 bands; 55 sighting	Cumbres, Mexico	Tropical dry forest	19°22′N; 104°56′W	Valenzuela and Macdonald 2002
22.50 (10–25)	8 bands	Los Tuxtlas, Mexico	Tropical rain forests	18°34′N; 95°04′W	Estrada et al. 1993
2.50[a]	23 sighting	Los Tuxtlas, Mexico	Tropical rain forests	18°27′N; 95°03′W	Asensio et al. 2007
9.03±0.52 (2–12)	24 records	Los Chimalapas, Mexico	Tropical rain forests	17°09′N; 94°24′W	This study
19.00 (14–24)	4 bands	Tikal, Reserva Maya, Guatemala	Tropical rain forests	17°13′N; 89°37′W	Booth-Binczik 2001, Booth-Binczik et al. 2004
5.1±0.2 (1–13)	[b]	Palo Verde National Park, Costa Rica	Tropical dry forest	10°18′N; 84°48′W	Burger 2001
15.3±6.1 (6–26)	10 bands	Barro Colorado, Panama	Tropical rain forest	09°09′N; 79°51′W	Gompper 1996, 1997

[a]No data on variation or range.
[b]No data on sampling size.

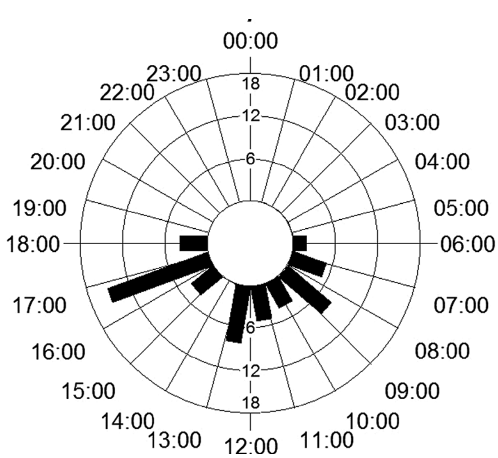

Figure 1: Activity pattern of *Nasua narica* based on independent records of camera trap shots (n=55 records) at Los Chimalapas, Mexico.

The occupancy probability of *Nasua narica* was 0.66. The best model $\psi p_{village}$ was supported by 88% of the data, followed by ψp_{water}, with 3%. The detection probability of *N. narica* was higher in proximity to the village (Figure 2). The other models showed low support at <1% (Table 2).

Discussion

Nasua narica is considered common in some regions, mainly in the tropics, and is among the most gregarious of the Carnivora. In other studies, *N. narica* presents a relative abundance of 0.86 records/100 camera-days in the cloud forests of Jalisco, Mexico (Aranda et al. 2012); 3.98 records/100 camera-days in the tropical rainforests of Quintana Roo, Mexico (Hernández-Díaz et al. 2012); and 4.04 records/100 camera-days in the pine-oak and tropical dry forests of Estado de Mexico, Mexico (Monroy-Vilchis et al. 2011). *Nasua narica* presents a higher frequency of records in places such as Talamanca, Costa Rica (González-Maya et al. 2009), or Peninsula de la Osa, Costa Rica (Bustamante-Ho et al. 2009). In comparison with those studies, the relative abundance of *N. narica* is small at Los Chimalapas.

The band size of *Nasua narica* varies throughout its regions of distribution (see Table 1); and is a reflection of its ecological plasticity and local conditions (Gompper 1996, 1997, Booth-Binczik 2001). The band size recorded visually and with camera traps at Los Chimalapas (n=24, mean=9.03±0.52 individuals) was within the range recorded in other regions. At Los Tuxtlas, Mexico, band size ranged from 2.5 animals (Assencio et al. 2007) to 10 to 25 individuals (mean=22 individuals, range 10–25; n=8; Estrada et al. 1993). At Barro Colorado, Panama, band size varied from 6 to 26 individuals (mean=15.3±6.1 individuals; Gompper 1997), and at Tikal National Park, Guatemala, band size ranged from 14 to 24 individuals (Booth-Binczik 2001, Booth-Binczik et al. 2004). The band size recorded in this study is smaller than previous records from dry habitats, ranging from two to 13 individuals (mean=5.1 individuals) at the National Park of Palo Verde, Costa Rica (Burger 2001), an average group size of 6.1±0.47 individuals (n=165 sights) at Jalisco, Mexico (Valenzuela 1998) and 17.0±3.2 at Arizona, US (n=8 groups; based only

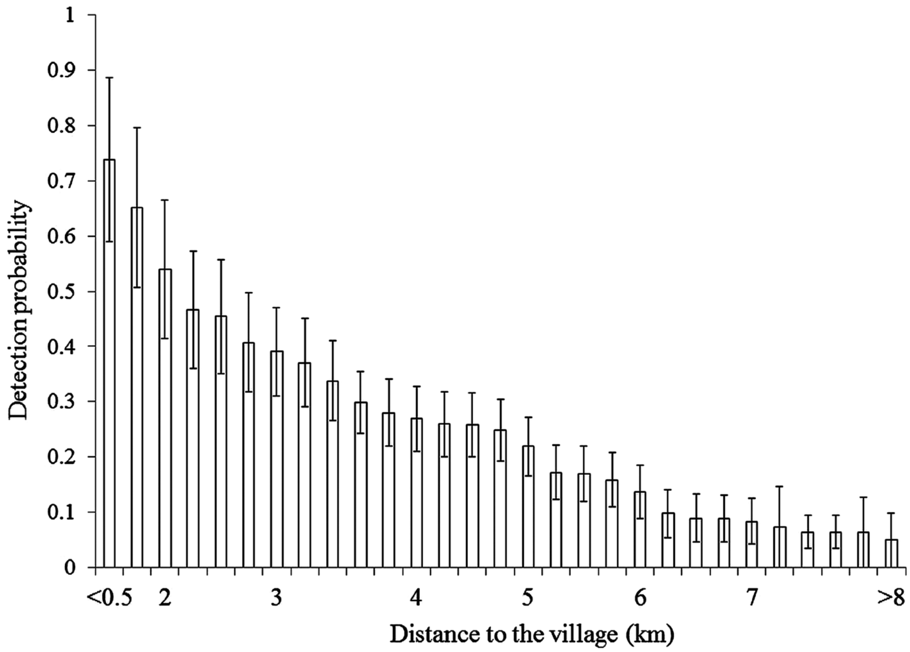

Figure 2: Detection probability of *Nasua narica*, according to the best occupancy model ($\psi p_{village}$).

Table 2: Occupancy models of *Nasua narica* at Los Chimalapas, Mexico.

Model	AICc	Delta AICc	AICc weight	No. of parameters
$\psi p_{village}$	114.2	0	0.8835	3
ψp_{water}	117.7	6.2	0.0398	3
ψp	120.4	7.2	0.0268	2
ψp_{crop}	122.09	7.86	0.0196	3
ψp_{puma}	122.69	8.46	0.0145	3
ψp_{jaguar}	120.83	8.60	0.0135	3
ψp_{ocelot}	120.33	8.83	0.0121	3

AICc, Quasi Akaike information criterion; weight of the AICc, relative contribution of each model; ΔAICc, difference of each model in respect to the best model.

on groups that were simultaneously followed by radiotelemetry; Valenzuela and Macdonald 2002).

The presence of pregnant females and offspring shows that the population at Los Chimalapas appears to be reproductive. The offspring were sighted in the dry season and young animals were sighted in the rainy season. The breeding season varies, possibly due to the periods of greatest food availability in each region. In Mexico, the estimated months of birth are June or July in Chihuahua; July in Sinaloa; July, August, or September in Guerrero; May in Chiapas (Leopold 2000); May or June in Colima (Aranda et al. 2012); and March and April in Jalisco (Valenzuela 1998). In Panama, breeding occurs in January and February, and in the tropical rainforest of Tikal National Park, Guatemala, the mating season takes place in May (Booth-Binczik et al. 2004), therefore births occur in July or August.

The number, size, distribution and transit of *Nasua narica* groups are associated with the abundance and location of resources; primarily fruits, arthropods and water. This is most evident in environments with seasonal resource availability, such as tropical dry forests (Gompper 1995, Valenzuela and Ceballos 2000, Valenzuela and Macdonald 2002). In contrast, food availability is greater, less variable in time, and more widely available in rainforest environments. In the South American rainforest, *N. nasua* has a year-round food supply (Alves-Costa et al. 2004, Beissiegel and Mantovani 2006, Hirsch 2009).

Additionally, band size offers anti-predator benefits for *Nasua narica*. A study with populations of *N. narica* in Arizona, USA and Jalisco, Mexico shows predation rates were significantly higher on lone adults than on adults in groups, and higher on smaller groups than on larger groups (Hass and Valenzuela 2002). In a dry forest at Palo Verde National Park, Costa Rica, larger groups remained in dangerous sites for longer periods of time than smaller groups (Burger 2001). As band size is relatively small at Los Chimalapas in comparison to other regions, future studies may reveal factors that affect band size in the region.

Nasua narica activity patterns vary from those of its predators. *Nasua narica* peak activity occurs in the morning (7:00–10:00) and in the afternoon (16:00–17:00), whereas activity of *Puma concolor* and *Panthera onca* reaches its peak in the afternoon and at night (17:00–21:00 and 18:00–06:00, respectively). This species is diurnal. Therefore, little nocturnal activity was registered for lone males (Caso 1994, Valenzuela and Ceballos 2000). This separation in diurnal activity and a reduced nocturnal activity helps lower the risk of predation.

The abundance of predators may be a risk factor for *Nasua narica* at Los Chimalapas. In terms of predators present in the region, *Leopardus pardalis* showed medium abundance compared to other regions of South America (22 individuals/100 km^2; Pérez-Irineo and Santos-Moreno 2014). In this study, four individuals of *Panthera onca* and four individuals of *Puma concolor* were identified in an area of 22 km^2 (unpublished data). This shows a great abundance of predators of *N. narica*, although the effect has not been measured at Los Chimalapas. In other regions, results have shown that between 20 and 50% of mortality is due to predation by *P. onca* and *P. concolor* (Valenzuela 1998, Hass and Valenzuela 2002, Bustamante-Ho et al. 2009).

Nasua narica was present in 66% of the sampling sites at Los Chimalapas. The use of an occupancy approach may be an alternative variable in population studies due to the fact that at an appropriate scale both occupancy and population size should be positively correlated given the fact that populations with a high abundance cover a greater number of sites compared to those with a small abundance (Mackenzie and Nichols 2004). Also, the effort required to estimate occupancy may be smaller when compared to the evaluation of population size. In this study, the occupancy approach was used to evaluate the total area of the region covered by *N. narica*. There are no studies on the occupancy level of *N. narica* in other regions. At Los Chimalapas, the distance to the nearest village, the presence of water, or the quality of forest habitat were not significant factors for occupancy of *N. narica*. In the case of *N. nasua* the density is high in the Pantanal and Brazilian Amazonia (Desbiez and Borges 2010), and showed highest occupancy in a nearby region in the southern Brazilian Amazonia (83%; Michalski and Peres 2005).

Nasua narica is an important species within terrestrial mammal communities and is a source of food for both animal and human populations. The present study enabled us to obtain information about this species' occupancy, activity and band size, as well as its relationship with other species and the environment. The *N. narica* population at Los Chimalapas shows certain differences in comparison to other tropical forest populations, but further study is required to identify the causes of variations in population size across its latitudinal distribution, as well as between habitats.

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References

Alves-Costa, C., G. Da Fonseca and C. Christófaro. 2004. Variation in the diet of the brown-nosed coati (*Nasua nasua*) in Southeastern Brazil. J. Mammal. 85: 478–482.

Aranda, M., F. Botello and L. López-de Buen. 2012. Diversidad y datos reproductivos de mamíferos medianos y grandes en el bosque mesófilo de montaña de la Reserva de la Biosfera Sierra de Manantlán, Jalisco-Colima, México. Rev. Mex. Biodivers. 83: 778–784.

Arriaga, L., J. Espinoza-Rodríguez, C. Aguilar-Zuñiga, E. Martínez-Romero, L. Gómez-Mendoza and E. Loa. 2000. Regiones terrestres prioritarias de México. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Ciudad de México. pp. 609.

Assencio, N., V. Arroyo-Rodríguez and J. Cristóbal-Azkarate. 2007. Feeding encounters between a group of howler monkeys and white-nosed coatis in a small forest fragment in Los Tuxtlas, Mexico. J. Trop. Ecol. 23: 253–255.

Beissiegel, B. and W. Mantovani. 2006. Habitat use, home range and foraging preference of the coati *Nasua nasua* in a pluvial tropical Atlantic forest area. J. Zool. 269: 77–87.

Booth-Binczik, S.D. 2001. Ecology of coati social behavior in Tikal National Park, Guatemala. Ph.D. thesis, University of Florida, Gainesville.

Booth-Binczik, S., G. Binczik and R. Labisky. 2004. Lek-like mating in white-nosed coatis (*Nasua narica*): socio-ecological correlates of intraspecific variability in mating systems. J. Zool. 262: 179–185.

Burger, J. 2001. Visibility, group size, vigilance, and drinking behavior in coati (*Nasua narica*) and white-faced capuchins (*Cebus capucinus*): experimental evidence. Acta Ethol. 3: 111–119.

Burnham, K. and D. Anderson. 2004. Multimodel inference. Understanding AIC and BIC in model selection. Sociol. Method. Res. 33: 261–304.

Bustamante-Ho, A., R. Moreno and J. Sáenz. 2009. Depredación de un pizote (*Nasua narica*) por una puma (*Puma concolor*) en el sureste de la Península de Osa, Costa Rica. Acta Biol. Panamensis. 1: 39–45.

Caso, A. 1994. Home range and habitat use of three neotropical carnivores in northeast Mexico. Dissertation, Texas University.

Desbiez, A.L.J. and P.A.L. Borges. 2010. Density, habitat selection and observations of South American coati *Nasua nasua* in the central region of the Brazilian Pantanal wetland. Small Carnivore Conserv. 42: 14–18.

Esri. 2008. ArcGis version 9.3. Available from http://www.esri.com/software/arcgis.

Espinoza-García, C., J. Martínez-Calderas, J. Palacio-Núñez and A. Hernández-SaintMartín. 2014. Distribución potencial del coatí (*Nasua narica*) en el noreste de México: implicaciones para su conservación. Therya 5: 331–345.

Estrada, C. 2008. Dieta, uso de hábitat y patrones de actividad del puma (*Puma concolor*) y el jaguar (*Panthera onca*) en la selva Maya, Centroamérica. Rev. Mex. Mastozool. 12: 113–130.

Estrada, A., G. Halffter, R. Coates-Estrada and D. Merit. 1993. Dung beetles attracted to mammalian herbivore (*Alouatta palliata*) and omnivore (*Nasua narica*) dung in the tropical rain forest of Los Tuxtlas, Mexico. J. Trop. Ecol. 9: 54–54.

Gompper, M. 1995. *Nasua narica*. Mamm. Species 487: 1–10.

Gompper, M. 1996. Sociality and asociality in white-nosed coatis (*Nasua narica*): foraging cost and benefits. Behav. Ecol. 7: 254–263.

Gompper, M. 1997. Population ecology of the white-nosed coati (*Nasua narica*) on Barro Colorado Island, Panama. J. Zool. 241: 441–455.

González-Maya, J., J. Schipper and A. Benítez. 2009. Activity patterns and community ecology of small carnivores in the Talamanca region, Costa Rica. Small Carnivore Conserv. 41: 9–14.

Hass, C. and D. Valenzuela. 2002. Anti-predator benefits of group living in the white-nosed coatis (*Nasua narica*). Behav. Ecol. Sociobiol. 51: 570–578.

Hernández-Díaz, M., P. Ramírez-Barajas, C. Chávez, B. Schmook and S. Calmé. 2012. Presencia y abundancia relativa de carnívoros en una selva dañada por el huracán Dean (2007). Rev. Mex. Biodivers. 83: 790–801.

Hines, J. 2006. Presence. Software to estimate patch occupancy and related parameters. Available from http://www.mbr-pwrc.usgs.gov/software.html.

Hirsch, B. 2009. Seasonal variation in the diet of ring-tailed coatis (*Nasua nasua*) in Iguazu, Argentina. J. Mammal. 90: 136–143.

Hirsch, B. 2011. Spatial position and feeding success in ring-tailed coatis. Behav. Ecol. Sociobiol. 65: 581–591.

Inegi. 2000. Red hidrológica escala 1:50 000 y modelo digital de elevación 1:50,000, Available from http://www.inegi.org.mx.

Kovach Computing Services. 2011. Software *Oriana* version 4. Available from http://www.kovcomp.co.uk/oriana/oribroc.html.

Leopold, A. 2000. Fauna Silvestre de México. Aves y mamíferos de caza. Ed. Pax, Ciudad de México. pp. 600.

Mackenzie, D. and J. Nichols. 2004. Occupancy as a surrogate for abundance estimation. Anim. Biodivers. Conserv. 27: 461–467.

Mackenzie, D., J. Nichols, J. Royle, K. Pollock, L. Bailey and J. Hines. 2006. Occupancy estimation and modeling. Inferring patterns and dynamics of species occurrence. Elsevier, CA. pp. 324.

Michalski, F. and A. Peres. 2005. Anthropogenic determinants of primate and carnivore local extinctions in a fragmented forest landscape of southern Amazonia. Biol. Conserv. 124: 383–396.

Monroy-Vilchis, O., M.M. Zarco-González, C. Rodriguez-Soto, L. Soria-Díaz and V. Urios. 2011. Fototrampeo de mamíferos en la Sierra Nanchititla, México: abundancia relativa y patrón de actividad. Rev.Bio. Trop. 59: 373–383.

Novack, A., M. Main, M. Sunquist and R. Labisky. 2005. Foraging ecology of jaguar (*Panthera onca*) and puma (*Puma concolor*) in hunted and non-hunted sites within the Maya Biosphere Reserve, Guatemala. J. Zool. 267: 167–178.

Nuñez, R., B. Miller and F. Lindzey. 2000. Food habits of jaguar and pumas in Jalisco, Mexico. J. Zool. 252: 373–379.

Pérez-Irineo, G. and A. Santos-Moreno. 2014. Density, distribution, and activity of the ocelot *Leopardus pardalis* (Carnivora: Felidae) in Southeast Mexican rainforests. Rev. Biol. Trop. 62: 1421–1432.

Rose, L., S. Perry, M. Panger, K. Jack, J. Manson, J. Gros-Louis, K. Mackinnon and E. Vogel. 2003. Interspecific interactions between Cebus capucinus and other species: data from three Costa Rican sites. Int. J. Primatol. 24: 759–796.

Rowcliffe, J., J. Field, S. Turvey and C. Carbone. 2008. Estimating animal density using camera traps without the need for individual recognition. J. Applied Ecol. 45: 1228–1236.

Sáenz, J.C. 1995. Ecología del pizote (*Nasua narica*) y su papel como dispersador de semillas en el bosque seco tropical, Costa Rica. M.S. Thesis, Universidad Nacional, Costa Rica.

Tobler, M.W., S.E. Carrillo-Percastegui, R. Leite, R. Mares and G. Powell. 2008. An evaluation of camera traps for inventorying large- and medium-sized terrestrial rainforest mammals. Anim. Conserv. 11: 169–178.

Trejo, I. 2004. Clima. In: (J. García-Mendoza, M. Ordoñez and M. Briones-Salas eds.) Biodiversidad de Oaxaca. Instituto de Biología, UNAM, Fondo Oaxaqueño para la Conservación de la Naturaleza and Word Wildlife Fund, Ciudad de México, IL. pp. 67–85.

Valenzuela, D. 1998. Natural history of the white-nosed coati, *Nasua narica*, in a tropical dry forest of western Mexico. Rev. Mex. Mastozool. 3: 26–44.

Valenzuela, D. and G. Ceballos. 2000. Habitat selection, home range, and activity of the white-nosed coati (*Nasua narica*) in a Mexican tropical dry forest. J. Mammal. 81: 810–819.

Valenzuela, D. and D. Macdonald. 2002. Home-range use by white-nosed coatis (*Nasua narica*): limited water and a test of the resource dispersion hypothesis. J. Zool. 258: 247–256.

Valenzuela, D. and L.B. Vázquez. 2008. Prioritizing areas for conservation of Mexican carnivores considering natural protected areas and human population density. Anim. Conserv. 11: 215–223.

Wilson, D. and R. Mittermeier. 2009. Handbook of the mammals of the world. Vol. 1. Carnivores. Lynx, Barcelona. pp. 727.

Zar, J. 1999. Biostatistical analysis. Prentice-Hall, NJ. pp. 623.