PUMA ABUNDANCE ON THE COLIMA VOLCANIC COMPLEX, WESTERN MEXICO

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Abstract: Two adult male pumas were captured and monitored via radio-telemetry on the Colima volcanoes, western Mexico. One male occupied the western, north, and eastern slopes of the volcanic complex, whereas the other male was only located on the northeastern and eastern slopes of the volcanoes. Neither of the two males occupied the southern flank of Colima volcano. The two males were never found within close proximity to each other, although occasionally they visited the same localities. Both cats were most frequently located within humid pine-oak forest between 2,300 m and 2,900 m and were never recorded above 3,300 m. An estimated minimum density of 0.9 adult pumas/100 km^2 was obtained for the Colima volcanoes.

Key words: *Puma concolor*, Colima volcano, radio-telemetry, movements.

Palabras clave: *Puma concolor*, Volcán de Colima, radio-telemetría, movimientos.

INTRODUCTION

Although the biology of the puma (*Puma concolor*) has been the subject of numerous detailed studies in the western continental United States (Ackerman *et al.*, 1984; Beier, 1993; Beier *et al*., 1995; Logan *et al*., 1996; Pitmann *et al*., 1999; Grigione *et al*., 2002; Sweanor *et al*., 2004), few studies have been carried out in Mexico. Apart from the work of Luna-Soria and López-González (2005) who studied the food habits and abundance of pumas in the Sierra San Luis, Sonora, the majority of studies in Mexico have focused on the ecology of pumas in tropical lowland habitats (Ceballos *et al*., 2002; Nuñez *et al*., 2000; Aranda and Sánchez-Cordero, 1996). Here I present preliminary data on the movements and abundance of pumas in the ecologically diverse subtropical humid pine-oak forests, and temperate *Pinus hartwegii* forests of the Colima volcanoes, western Mexico.

STUDY AREA

Fieldwork was undertaken from January 1994 to May 1997 on the 3,860 m active Colima volcano and the adjacent 4,260 m extinct Nevado de Colima (Figura 1).

Climate of the study area includes a distinct short summer wet season (June – October) and a prolonged dry season (November – May; Burton *et al*. (2003)). Annual rainfall averages 800 – 1000 mm (Biondi *et al*., 1999).

Vegetation of the Colima volcanoes varies from arid thorn scrub with tropical deciduous forest in deep canyons at lower elevations to humid pine-oak associations at altitudes between 1,800 m to 2,900 m, to a high-altitude stunted *Pinus hartwegii* forest and grassland dominated by the bunchgrass *Calamagrostis tolucensis* above 3,000 m (Burton *et al*., 2003).

During the period of the study, volcanic activity at Colima volcano was characterized by effusion of a viscous lava dome at the summit and occasional block and ash flows resulting from collapse of sections of that dome (Smithsonian Institution, 1998, 1999). Access to the general public is currently restricted to within 6.5 km of the active vent (Smithsonian Institution, 2004; Figure 1).

METHODS

Pumas were captured in modified Aldrich foot snares set along known puma travel routes (determined from tracks, scrapes and scats, and scratch marks on trees). Snared cats were immobilized with 5-10 mg/kg Zoletil (tiletamine hydrochloride/zolazepam hydrochloride mixture: Virbac Laboratories). Weight was estimated for each captured cat and a Telonics VHF (164 MHz) radio-collar fitted. Radio-collared cats were tracked using a flexible H antenna and portable receiver by 4WD vehicle, on foot, and by fixed-wing aircraft.

The sampling scheme followed the work of Kenward (1987, 1990), Pollock (1987), Burton and Olsen (2000), and Burton *et al*. (2003). The position of radio-collared pumas was determined by triangulation from points as near as possible to the signal source. Location via aircraft did not use the null-peak system; instead I pin-pointed the location of the radio-collared cat by having the pilot fly in ever tighter circles, dipping one wing to almost 90°. At least 2 accurate locations (to within 50 m) were obtained per radio-collared cat, every month, over a continuous 12-month period.

The area of suitable habitat available to pumas on the Colima volcanoes was calculated from 1:50,000 topographic maps and aerial photographs. Suitable habitat was defined as continuous forest, scrub, or woodland. Habitat calculations are based on counting the 1 km grid squares on the 1:50,000 topographic maps of the study area. One km grid squares that included settlements or open farmland/agriculture were excluded from the analysis. In general, this method tends to give a conservative estimate of suitable habitat.

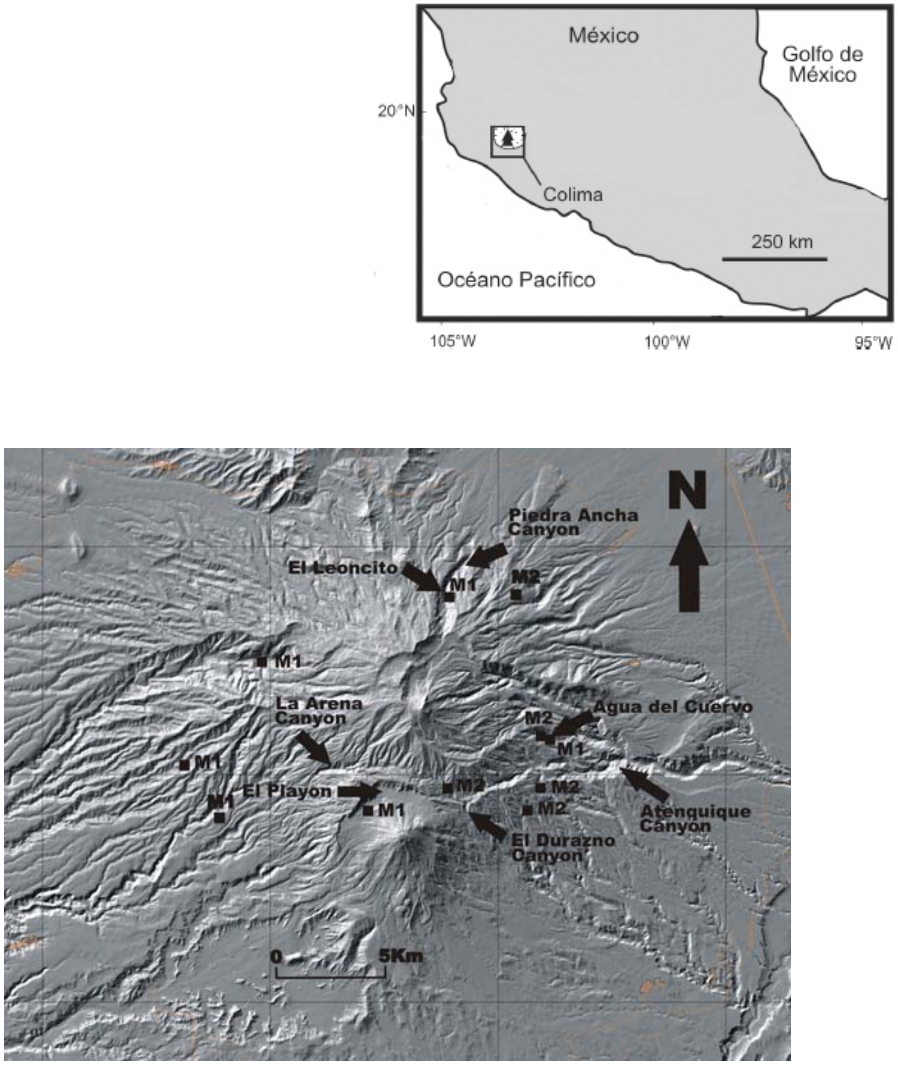

Figure 1. Digital Elevation Model (DEM) of the Colima Volcanoes showing principal locations (multiple radio-fixes) of the radio-collared Pumas M1 and M2, and place names mentioned in the text. Summit of Colima Volcano in bottom center, summit of Nevado de Colima in middle center. DEM modified from Gavilanes (2004). Locality map for Colima Volcano modified from Macias *et al*. (2006).

RESULTS

Three adult male pumas were captured and fitted with radio-collars. However, one of the adult males had been severely injured due to intraspecific fighting. After 4 independent locations were obtained over 4 weeks of monitoring, the radio-collar on this adult male (55 kg +/- 5 kg) sent a mortality signal from a fixed position. Therefore location data for this cat is not considered. Locating radio-collared pumas proved to be extremely problematic due to radio interference from VHF/UHF repeater towers and microwave repeater towers. Therefore, it was not possible to obtain an asymptotic curve for radio-fixes; therefore, range analysis has not been attempted.

Adult male 1 (65 kg +/- 5 kg) was captured within the area known as "El Playon" which fills the caldera of the previous Colima volcano, whereas adult male 2 (45 kg +/- 5 kg; Figure 2) was captured at the head of the El Durazno Canyon. Both cats were captured at an altitude of 3,100 m but at different localities.

Adult male 1 occupied the western, north, and eastern slopes of the volcanic complex. Adult male 2 only used the northeastern and eastern slopes of the volcanoes and was never located within "El Playon" (Figure 1). The two males were never found within close proximity, although they visited the same localities such as the spring "Agua del Cuervo" near the head of the west branch of the Atenquique Canyon during the dry season. The two males also used the same pass that runs between Nevado de Colima and Colima volcano, which to the west connects with the head of the La Arena Canyon and to the east connects with the head of El Durazno Canyon. Scrapes, scats, and scratch marks, were abundant along this pass. During the dry season, male 1 was often located near to the head of the Piedra Ancha Canyon in the vicinity of the spring "El Leoncito". Adult male 2 was often located in the west branch of the Atenquique Canyon near to the spring "Agua del Cuervo" and in the vicinity of the Paso de los Bueyes (Figure 1). Neither of the two males occupied or visited the southern flank of Colima volcano. Given the difference in weight between male 1 and male 2, and that male 2 was only located on the northeastern and eastern slopes of the volcanoes, I consider that male 1 was the dominant male, and male 2 a young male between 2-3 years old.

The cats were most frequently located within humid pine-oak forest between 2,300 m and 2,900 m on the volcanoes. The cats were never located at altitudes above 3,300 m. Suitable habitat available to pumas on the volcanoes was calculated as 375 km^2 after excluding approximately 25 km^2 of habitat above 3,300 m. In addition to the monitored male pumas, two individual adult female pumas were known to inhabit the volcanoes but were not captured (one female triggered a snare but avoided capture). This gives an estimated minimum density of 0.9 adults per 100 km^2.

Figure 2. Adult male puma (M2) captured at 3100 meters on Colima Volcano (head of El Durazno Canyon), December 1995.

DISCUSSION

Although an asymptotic curve could not be obtained for radio-locations due to the difficulties encountered in locating the radio-collared cats, the fact that locations were taken over a 12-month period of sampling can be considered sufficient to give a preliminary picture of overall movements and preferred habitat of the pumas.

That the cats were most often located within humid pine-oak forest at altitudes between 2,300 m and 2,900 m probably reflects the distribution of their principal prey: Mexican white tailed deer (*Odocoileus virginianus mexicanus*). As determined by droppings, bedding areas, and tracks, deer were abundant within the humid pine-oak forest at these altitudes. Puma scats that were opportunistically collected during radio-tracking were almost wholly comprised of the hair of white-tailed deer, and to a lesser degree collared peccary (*Tayassu tajacu*). The cats were never located above 3,300 m in the high-altitude *Pinus hartwegii* forest and grassland, despite an abundance of lagomorphs and other secondary prey in that habitat.

The observed preference of the cats to inhabit the humid pine-oak forest between 2,300 m and 2,900 m on the Colima volcanoes has important conservation implications. The current boundary of the national park (Parque Nacional Volcan Nevado de Colima) is a result of modifications made in 1940 by the then Mexican President Lazaro Cárdenas (DOF, 1940; CONANP, 2006) who reduced the original declared protected area of 22,200 hectares to 6,554.75 hectares (CONANP, 2006); nearly all of this protected area is above the 3,350 m contour. Therefore the habitat occupied by the pumas and their preferred prey; Mexican white-tailed deer and collared peccary, is not afforded any legal protection.

The estimated density of 0.9 adults/100 km^2 for the Colima volcanoes is less than the density of pumas recorded by Sweanor *et al*. (2004) for southern California (2.3-2.8 adults/100 km^2) but greater than the density of pumas recorded from Big Bend Ranch State Park, Texas, by Pittman *et al*. (1999) (0.26-0.59 adults/100 km^2). However, the high density of 2.3-2.8 adults/100 km^2 initially reported by Sweanor *et al*. (2004) declined to 0.8 adults/100 km^2. Other studies have reported densities of 2.0-2.2 adults/100 km^2 (Ross and Jalkotzy, 1992; Logan and Sweanor, 2001). Given the forested habitat of the Colima volcanoes and the abundance of white-tailed deer, the figure of 0.9 adults/100 km^2 could be considered low. However, more frequent sightings of individual pumas, including a female with year-old cub in the vicinity of Montegrande Canyon on the southern flank of Colima volcano, and an increased abundance of tracks and scats (pers. obs.) suggests that the population may have increased in recent years. Ironically this increase does not appear to be related to increased conservation/law enforcement on the Colima volcanoes, but rather, increased volcanic activity by Colima volcano resulting in restricted access.

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