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Original contributions and short notes about wild cats are welcome
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Causes of jaguar killing in Panama – a long term survey using interviews

We present quantitative data on reported causes of jaguar (*Panthera onca*) killing in Panama. Between the years 1998 and 2014 we interviewed qualified informants and local stakeholders. Data suggest that from 1989 to 2014 humans killed at least 230 jaguars. Of those 220 died because of retaliation to predation episodes, seven died for the sale of products and as trophies, and three were hunted because of fear to the animal. Information indicates that the existing wildlife protection laws are not enforced. A time-trend analysis suggest that if no interference is exerted killing reports will increase, further endangering jaguar survival in Panama.

Jaguars (*Panthera onca)* range from the southern border of the United States to northern Argentina (Hunter 2011). Maintaining genetic exchange between populations through secure corridors can contribute to the range-wide vitality of the species and combat local extinctions through meta-population dynamics (Zeller & Rabinowitz 2011). Panama plays a key role in the concept of a Panamerican jaguar corridor. Physically, the country is small and narrow, and connects Mesoamerica to South America, thus linking populations between two continents (Moreno et al. 2014). In Panama, jaguars are listed as endangered by the Ministry of Environment (ANAM 2011). Past studies focusing on jaguar ecology and population dynamics (Moreno et al. in press) indicate that the conservation status of the jaguar is critical in many areas. The main problem is habitat loss and fragmentation; however, human related mortality seems to play a significant role. This is the first longitudinal study across Panama that identifies and quantifies the reasons for humans killing jaguars.

Methods

Information was collected during fieldwork in both remote protected sites and human encroached areas throughout the country between 1998 and 2014 (Fig. 1). Data were recorded from reports of killings that happened up to 9 years prior to the first interview (1989). We applied open interviews (Stake 2000) to all available stakeholders: tour guides, government and non-governmental organization employees, park rangers, biology professors and students, indigenous people, hunters, farmers and livestock owners.
We conducted a trend analysis of the data to fit a general trend model and provide a forecast; data were analyzed with Minitab Statistical Software 16 (Minitab Inc., State College, PA, USA).

Results

We collected 230 reports of killed jaguars. The largest numbers of killings were documented in the Darien, Colon and Panama provinces (Fig. 1). Interviews reported that 220 events (98%) happened as a retaliation action for domestic animal predation, mainly on cattle, sheep and dogs. Seven jaguars (3%) were killed for commercialization of products to satisfy the increasing market of large feline parts such as skin, nails or teeth for the Asian market, and three jaguars (1.3%) were killed due to concerns about human safety, motivated by fear. The most common killing method was hunting with dogs and shooting when jaguars returned to feed on a carcass (Fig. 2). Jaguars were rarely poisoned or stabbed with a machete (three events).
The best fit for the time-trend analyzes was a quadratic model, which clearly shows there is an increase of killing reports in time. The forecast also shows an increase (Fig. 3).

Discussion

The data do not present the actual true number of jaguars killed in Panama, but the reports of jaguars killed based on a 16-year time span of interviews with stakeholders. Since Panama´s law forbids the killing of jaguars, interview data most likely under-report the actual situation. Nevertheless, data were obtained through a trust-relationship established with volunteer informants. The survey

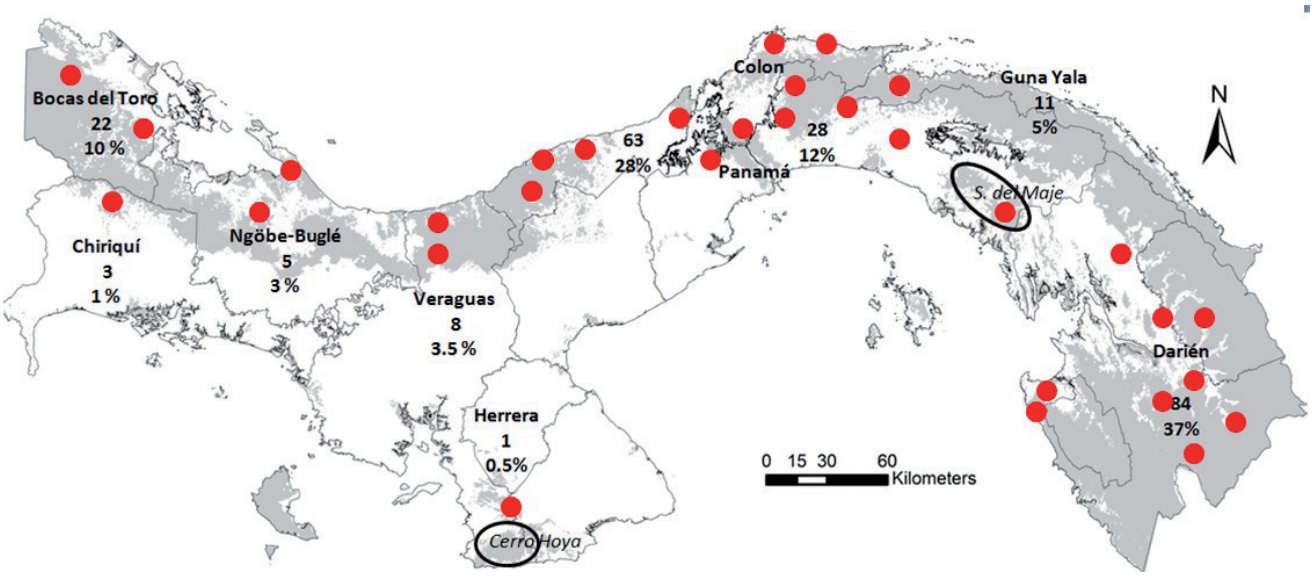

Fig. 1. Map of Panama presenting forested areas (grey), isolated jaguar populations (black ovals), interview sites (dots) and number and percentages of killed jaguars reported in each province from 1989 to 2014.

was not conducted following a pre-set interview design in which all subjects and areas were surveyed with the same intensity and at the same time, which could have produced a misrepresentation of cases by provinces. However, the interview based information allowed us to record the reasons humans presented for killing jaguars.

The time trend model (Fig. 3) indicates that if environmental, social, law enforcing and educational conditions do not change, the reporting of killing of jaguars may increase. From the information gathered during the interviews, we deduce that either the informants tend to report more, indicating an increase in trust which gives more power to the information, or that the number of killings has actually increased. We favor the second hypothesis as during the 1970's, farmers and ranchers were encouraged to migrate to Panama, Colon and Darién provinces, which at the time were completely forested (Heckadon-Moreno 2009). Agriculture, urban expansion and development projects (mines and dams) resulted in the reduction and fragmentation of jaguar habitat, now limited almost exclusively to mountainous areas. The fragmentation has a threefold effect: (a) due to large home ranges, jaguars must travel through fragments, and thus increase livestock predation by jaguars and the risk of being hunted; (b) the isolation of two jaguar populations (Cerro Hoya and Sierra del Maje) (Fig. 1, oval circles) (Fort et al. 2014); (c) an increase in human consumption of jaguars main prey species such as peccaries *Pecari tajacu* and *Tayassu pecari*, deers *Mazama temama* and, *Odocoileus virginianus* and paca *Cuniculus paca* (Moreno 2008, Moreno & Meyer 2014, Wright et al. 2000), exacerbating the need for jaguars to predate on domestic animals. Additionally, the international market for feline parts, including oriental traditional medicine, has reached jaguars, increasing poaching activity (Moreno et al., *in press*).

Since our trend forecast predicts that jaguar killing reports will increase (Fig. 3), we propose the following measures in an attempt to reduce jaguar mortality: (a) enforcement of the law and the Jaguar National Action Plan (ANAM 2011) guidelines; (b) environmental education programs to create awareness about the ecological importance of large predators in healthy ecosystems; these programs should target every community in the distribution area of jaguars in Panama, especially those communities in which the killings seem to be higher (i.e. Darien, Colon and Panama Provinces); (c) extension programs based on livestock husbandry and anti-predation strategies proven to reduce conflicts delivered to key stakeholders, i.e. cattle owners with predation problems (Hoogesteijn & Hoogesteijn 2014); (d) economic incentives for rural communities who suffer from jaguar predation. For example, communities in Quebrada Ancha have successfully overcome losses due to predation by selling jaguar tracks plaster casts to tourists (R. Moreno, unpub. data).

We suggest the creation of multi-institutional alliances that unite non-government and governmental institutions to deliver these interventions in key areas to reduce jaguar mortality in this country so vital to Panamerican jaguar connectivity.

Fig. 2. Recording information of killed female jaguar specimen during field work.

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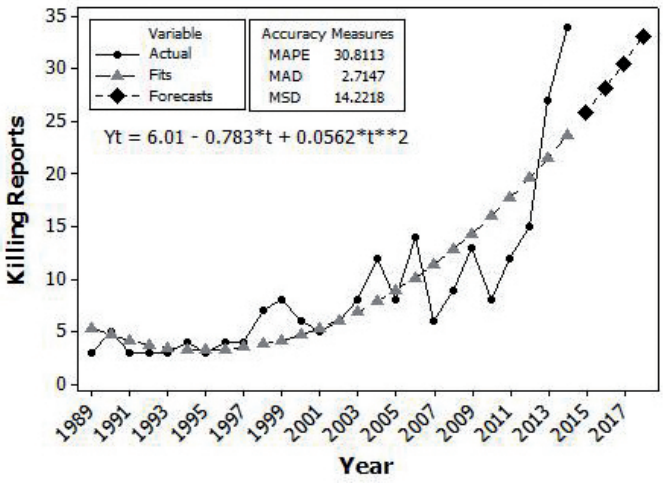

Fig. 3. Best-fit (quadratic) trend analysis plot for reported jaguar kills in Panama from 1989 to 2014 and forecast scenario if socio-environmental conditions do not change.

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