

Movement ecology of Asiatic cheetah and Persian leopard in Bafq protected area using environmental variables

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Extended abstract

Introduction

The movement of predators with respect to prey, and of prey with respect to predators, is fundamental to the respective success of both predator and prey. Simultaneous and sympatric data on movements of predator and prey are rare, and the tools to analyze dependent movement are still a work in progress. Here, we analyze and compare the home range, behavior and the interaction of three rare, highly endangered big cats in the Bafq desert of Iran; a coalition of two male Asiatic cheetah *Acinonyx jubatus venaticus* and a Persian leopard *Panthera pardus saxicolor*. The animals were GPS tracked for several months at a relatively low temporal resolution of eight hours.

The Asiatic cheetah *Acinonyx jubatus venaticus* is restricted to central Iran, with a population of only 50-70 individuals in the wild, making it the most critically endangered member of the cat family Felidae. Their home ranges are large, around 4000 km², typically larger than the network of existing protected habitat reserves. Their habitat has ungulates, hares, and other mammals as prey, plus competitors, such as Persian leopards, jackals, and wolves. The Persian leopard *Panthera pardus saxicolor*, also known as the Caucasian leopard or Central Asian leopard, is the largest leopard subspecies. It is native to Iran, the Caucasus region, southern Turkmenistan, parts of western Afghanistan, and northern Iraq. The subspecies are listed as Endangered on the IUCN Red List, with a population of 871-1290 mature individuals. Of these, the majority of Persian leopards (estimated 550-850) live in Iran, mainly in the northern parts. In tandem with a decline in numbers, recent studies indicate that the Persian leopard distribution may be splitting into a northern and a southern range. The geographic range of the Persian leopards overlaps extensively with that of the Asiatic cheetah, both of which are solitary stalk and ambush predators, although the male cheetahs often form coalitions. However, little is known about the home range, movement behavior and spatial interaction of these cats.

Materials & Methods

This study took place in Bafq desert. The Bafq PA is characterized by desert with scant rainfall (average annual rainfall less than 1 mm), high temperature and degraded landscape. Bafq is identified as one of five important protected areas for the conservation of Asiatic cheetah by the Conservation of Cheetah Project (CACPP). In Bafq, the presence of human infrastructure such as highways, cities, villages and pathways has made dispersal more difficult for the cats. The transportation network around the animals' home ranges has increased the risk of mortality through road accidents; at least 7 out of 50-70 cheetahs have died due to vehicle collisions in this region.

We excluded the outliers in the movement data and computed the animals' home range using the 100% minimum convex polygon (MCP) of the tracks. We then computed the spatial intersection of the two MCPs and the area of all resulting polygons to obtain an estimate of the animals' home range and overlapping area.

We defined two behavioral states: a moving behavior, explained by a more transitional movement and an encamped behavior, characterized by greatly reduced or zero movement during an observation interval. We fitted a hidden Markov chain model to estimate these two behaviors at the animals' observed locations and computed the proportion of the observations being classified as moving state.

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To analyze the interaction dynamically using a distance-based approach, we used linear regression with the C1-C2 distance as the response and C1-leopard distance as a predictor to see if the major separation of the cheetahs coalition was correlated by the proximity of the leopard.

Discussion of Results & Conclusions

After 512 trap nights, one leopard (age 7-10) and two male cheetahs (C1-C2, age 3-5) were captured using foot snares, under permits from the Iran Department of Environment (DOE), in the Bafq PA, Yazd Province. They were instrumented with GPS collars (Vectronics, Germany) and the collars were programmed to transmit locations every eight hours (at 00:00, 08:00 and 16:00). The data were retrieved periodically by uploading to a hand-held receiver via UHF radio link. The C2, C1 and leopard were collared on 26, 27 and 28 of February 2007 and their collars transmitted for 130, 137 and 282 days respectively. There were relatively few missing points for C1 and C2 (4.5% and 7% respectively) and the gaps were mainly one-step (16 h interval) with very few two-step gaps (24 h interval). For the leopard, 34% of the observations were missing, with 153 one-step and 47 two-step gaps; the numerous gaps could have been due to the leopard residing and ambushing under the bushes and rocks that block the visibility of GPS satellites or the more moving state of the animal preventing its GPS receiver to orient and obtain a fixed position. The leopard, C1 and C2 tracks had 846, 443 and 410 observations respectively after the linear interpolation of missing points.

The two cheetahs were members of a likely sibling coalition, a typical social grouping among cheetah brothers born in the same litter who stay together after weaning. The home ranges of the cheetahs were identical. C1's home range was three times bigger (1137.15 km²) than that of the leopard (407.85 km²) using MCP and the cheetahs' home range overlapped with 95% of the leopard home range in the intersecting time-frame. As identified by their GPS tracks, the movements of the two cheetahs were almost identical with median, mean and maximum distance of 12 m, 560 m and 13 km, respectively.

Approximately 68% of location fixes for the C1 were classified as moving compared to 71% of fixes for the leopard in the overlapping time-frame (Fisher test p -value < 0.001). Total displacement of both animals varied linearly with their stay duration in the behavioral bouts (i.e. moving or encamped bouts; c). The estimated speed (displacement/ duration) of C1 in the moving bouts was 0.46 km/h, slightly higher than the 0.35 km/h for the leopard when encamped, the C1 was again more mobile than the leopard (0.09 km/h versus 0.03 km/h).

In early June, the leopard started to exhibit a periodic attraction to C1, as emphasized by the linear regression analysis. Consequently, this attraction, among other habitat elements including elevation and distance to water, may have contributed to the separation of the two cheetahs. Looking for mates to breed or being influenced by the presence of other male cheetahs are possible catalysts of their separation yet very unlikely, as the number of cheetahs in the region is very limited.

Studying extremely rare animals in the wild is a challenge, and observing inter-species interactions among rare species is that much more difficult. Without the benefit of direct observations of chasing, harassing, attacking and killing, researchers are left by extracting as much as possible from remotely sensed data coupled with advanced statistical methods. The dataset of a coalition of two cheetahs and one leopard obtained in this study is unique, as it documents the movements and interactions of one very rare and two extremely rare felid predators, one of which falls prey to the other. However, the data were limited by a relatively short time span of a few months and relatively coarse (8 h) temporal resolution. Thus, a comprehensive and rigorous quantitative analysis relies on a densely integrated suite of GIS, habitat, and movement analysis tools.

Keywords: computational movement analysis, data mining, GIS, spatial ecology.