Mechanisms facilitating coexistence between leopards and their competitors in the Okavango Delta, Botswana

Kasim Rafiq

Alice McCosh Trust

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Project background

Leopards (*Panthera pardus*) are a large solitary felid that, despite being the most widespread large predator in Africa, have now disappeared from an estimated 48–67% of their historical range [1,2]. They have the widest habitat tolerance of any wild felid, with the ability to persist in a wide range of habitats, including deserts, rainforests and urban environments [1,3,4]. In Africa, leopards often coexist within the same areas as five other large predator species, lion (*Panthera leo*), spotted hyaena (*Crocuta crocuta*), African wild dog (*Lycaon pictus*), and cheetah (*Acinonyx jubatus*), which are collectively known as the African large predator guild (Fig. 1).

Fig. 1: The five species of the African large predator guild (from top left to bottom right: lion, spotted hyaena, leopard, African wild dog, and cheetah)

'Guild' is a classification used to refer to species within the same areas that compete for similar resources [5], and so competition within guilds is often fierce. Understanding the behaviours and space-use requirements for species to coexist is important because full species communities are thought to be a key component in maintaining an area's biodiversity [6]. Further, a new human-wildlife conflict mitigation strategy under consideration is manipulating carnivore space-use by mimicking areas that species would naturally avoid, and development of such approaches requires an understanding of how species use space relative to one another.

The initial aims of this project were to better understand the mechanisms facilitating the coexistence of leopards with other large African predators in northern Botswana (Fig. 2), and to consider whether there was spatial segregation between the species that could be exploited for conservation purposes. A third aim was added over the course of the project; this was to implement a pilot study of whether photographs taken by wildlife tourists could be used to aid wildlife monitoring.

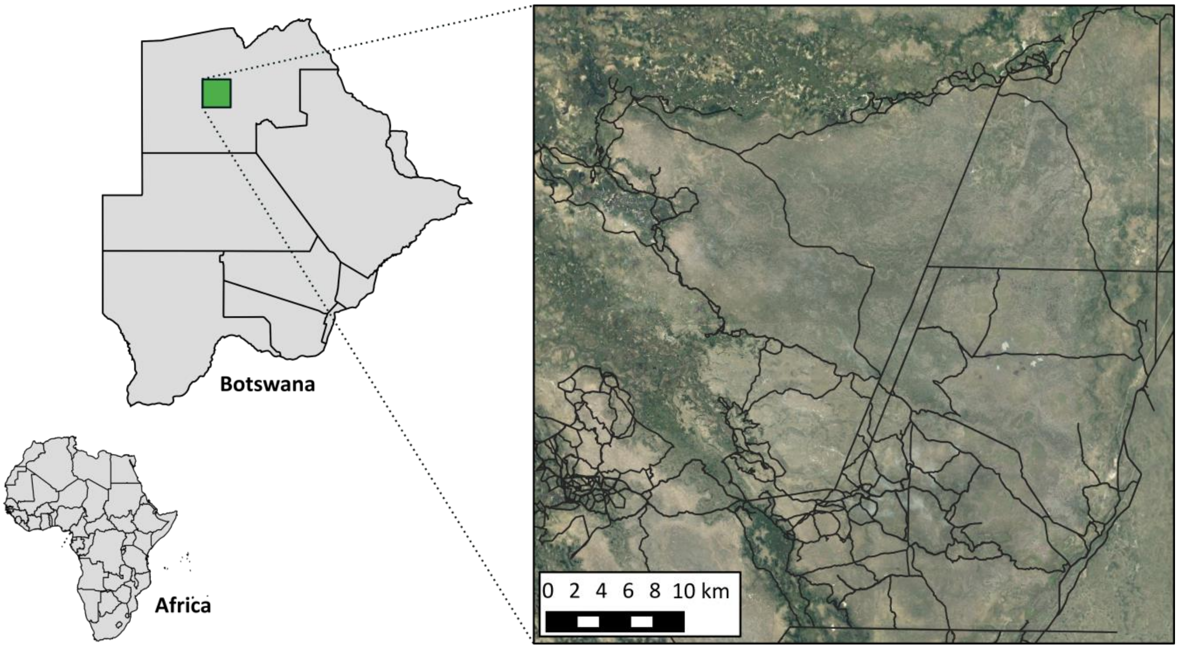

Fig. 2: The study area and its location within Africa and Botswana.

The overall project was split into three components:

1. Investigating leopard space use and activity patterns
2. Investigating direct encounters between leopards and other large African predators.
3. Investigating whether tourist photographs could be used to aid wildlife monitoring.

Project component summaries

Leopard space-use and activity patterns

Understanding the mechanisms facilitating coexistence between species is a key consideration for conservation because intact guilds are thought to be a critical component in maintaining full ecosystem function [6]. We explored the extent that leopard space-use and activity patterns are influenced by predator avoidance. Using high-resolution (5 minute fixes) GPS radio collar data from lions, leopards, wild dogs, cheetahs, and a single spotted hyaena (Fig. 3), we measured leopard overlaps in intensively used areas with other large predators and overlaps in activity patterns. Our results suggested that leopard space-use and the times when they are active are not primarily shaped by predator avoidance, with aspects of the leopard's ecology and behaviour likely aiding its ability to thrive in close proximity to competitors.

Figure 3: Example of a GPS radio collar on a male leopard

Direct encounters between leopards and large African predators

Encounters between predator species can have implications for a range of processes, including disease transmission, information transfer, and competition [7–9]. For large carnivores, however, relatively little is known of the drivers and outcomes of direct encounters. We used radio collar data from 53 large carnivores from 2012 to 2017 to investigate encounter onsets and impacts of encounters on leopard behaviours and movements. We found that encounters between leopards and other large African predators increased during periods of shared activity overlap. However, leopards were relatively resilient to direct encounters, with limited or no changes in behaviours and movements. Leopard instigated encounters with (likely) dominant predator species also appeared to reflect decision making with limited information, primarily occurring within habitats with limited visibility.

Considering project components 1 and 2 together, our results suggest that despite high levels of spatial and activity overlap with other predators, leopards are able to coexist alongside competitors with minimal costs. Thus, deterrents to manipulate leopard space-use would probably be best developed from signals (acoustic or scent-based) from other leopards rather than those from other large predator guild species. In other words, the leopard's ecology and life history, can allow them to coexist in close proximity to other large predators, and as such, within areas where there is little habitat fragmentation and a healthy prey base, there seems to be limited spatial avoidance that we could exploit to create deterrent signals.

Using tourist-photographs to aid wildlife monitoring

Biodiversity is rapidly declining and the resources available for conservation are finite [10]. As such, wildlife monitoring is a critical component of conservation because it can provide the necessary evidence to identify and prioritise conservation actions. Protected areas are a cornerstone of conservation; yet 60% of these areas lack the infrastructure and resources for monitoring [11,12]. Citizen-science is increasing in popularity and has been suggested as a solution to the finite resources available for wildlife monitoring [12]. However, questions surrounding cost-effective data collection, accuracy, and processing have limited its adoption into monitoring programs, and wildlife tourists remain an often overlooked source of information. We found in a validation study comparing tourist-photograph, camera trapping, spoor tracking, and call-in station (Fig. 5) monitoring methods of large carnivores that the tourist-photograph method: (i) was the only one to detect the presence of all five large carnivore species within the study area; (ii) provided robust density estimates for the same number of target species as most other methods; and (iii) was the cheapest program to implement. Our results demonstrate how tourist contributed data could be used to facilitate wildlife monitoring in protected areas and provide a framework that can be applied to other taxa and regions for monitoring of charismatic fauna.

Fig. 5: Setting up the equipment for the call-in station monitoring

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