

# Hyaena-mediated landscapes of fear: The influence of active spotted hyaena (*Crocuta crocuta*) den sites on the detection probability and occupancy probability of a mammal community

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Received 1 February 2025, To authors for revision 3 April 2025, Accepted 12 May 2025

## Abstract

African ecosystems support a diverse variety of predator species and have the highest diversity of large carnivores on earth. Apex predators play a crucial role in these ecosystems. Through hunting and creating a landscape of fear, apex predators influence the populations and behaviours of smaller predators and prey. According to the mesopredator release hypothesis, the absence of an apex predator leads to an increase in mesopredator populations, resulting in higher predation pressure on their prey and a subsequent decline in prey populations. The spotted hyaena (*Crocuta crocuta*) is a key apex predator with several activity hotspots, the largest being the den, where landscapes of fear may be most pronounced. While there is substantial literature on factors influencing hyaena den site selection, the impact of these dens on the presence of potential prey and competitively inferior species remains underexplored. This study aimed to examine the influence of perceived risk associated with hyaena dens on the occupancy and detection probabilities of prey species within the ecosystem. We used camera traps set up around dens to assess these probabilities, providing a detailed analysis of mesopredator and prey species' responses to hyaena activity. Our results indicate a correlation between increased hyaena activity and reduced occupancy

and detection probabilities in mesopredator and prey species. These findings suggest that hyaena dens create landscapes of fear, influencing mesopredator and prey species' distribution and behaviour.

**Keywords:** spotted hyaena den, predator hotspots, perceived risk, landscape of fear, camera traps.

## Introduction

Dens are core locations for ecological interactions and den location has a strong influence on the space use of hyaenas (Kolowski & Holekamp, 2006). Dens cause hotspots of spotted hyaena activity (Oriol-Cotterill *et al.*, 2015), which could result in the suppression of mesopredators and prey nearby (Ritchie & Johnson, 2009). A study on the effect of wolf (*Canis lupus*) dens on coyote (*Canis latrans*) densities found increases in coyote activity further away from dens. Predators, such as spotted hyaenas, have limiting effects on prey species (Oriol-Cotterill *et al.*, 2015; Ripple *et al.*, 2014), while other large carnivores don't remain unaffected, as M.G. Mills (1984) found that brown hyaenas (*Parahyaena brunnea*) avoided hotspots of spotted hyaena activity, potentially because of resource competition. There is a variety of existing literature on the factors that influence spotted hyaena den site selection (Kushata *et al.*, 2018; Pokines & Kerbis Peterhans, 2007) such as predation risk (Périquet *et al.*, 2016) and availability of food resources (Boydston, Kapheim & Holekamp,

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2019) but literature on the effects of spotted hyaena dens is scarce. The aim of this project was to determine the impact of active spotted hyaena den sites on the occupancy and detection of a mammal community.

**Methods**

Madikwe Game Reserve is 75 000 ha Big 5 game reserve located in the North West province of South Africa. The dens from two spotted hyaena clans were studied here during the two survey periods. The Molatedi clan, which had an estimated 20 individuals and the Thlou clan had an estimated 18 individuals (Honiball, pers comm. 2024). The Molatedi clan inhabited two known dens in the area during this survey period while the Thlou clan inhabited one.

*Data collection*

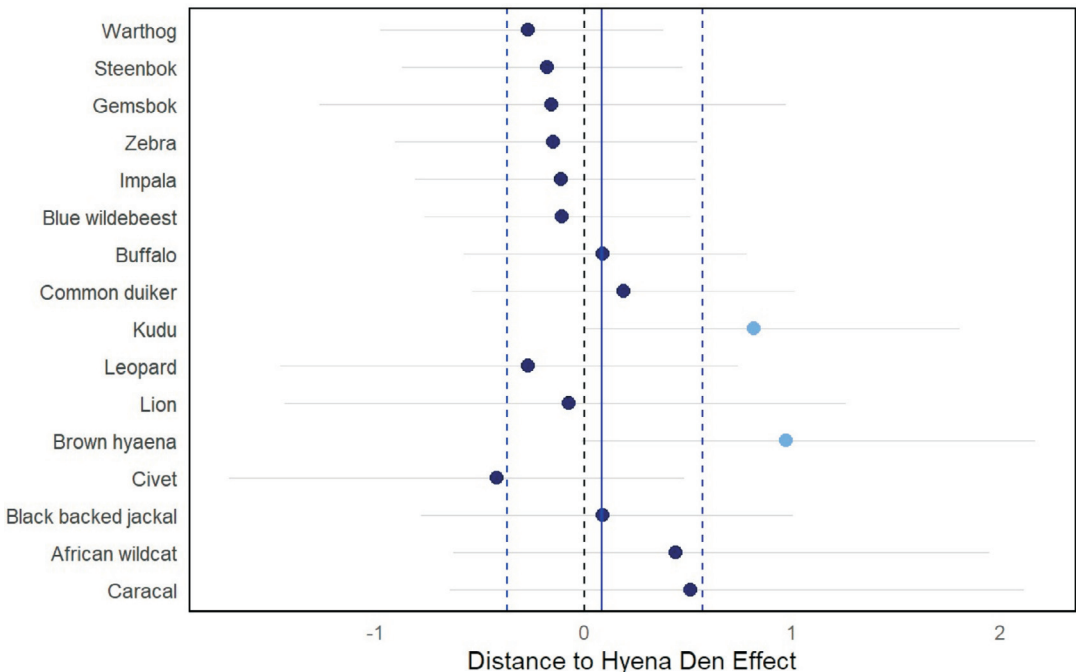
Camera traps were set up at different distances from den sites. White-flash Cuddeback cameras were used for the surveys. The cameras were secured onto trees using protective metal casings and locks. They were set to take three consecutive images per trigger event, with 1-minute delays

between triggers and they were set up for a total of  $\geq 40$  days. Images were annotated using the Traptagger application by WildEye. Images were manually annotated. A hierarchical adaptation of a community occupancy model with data augmentation was used in order to determine community as well as species-specific responses in terms of occupancy and detection probability (Dorazio & Royle, 2005).

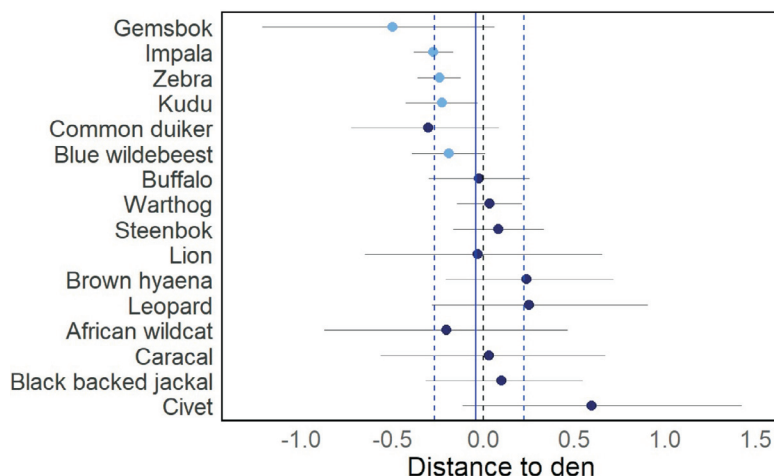
**Results**

The mammal community may be more likely to occur at sites further away from active spotted hyaena dens; the effect was, however, uncertain (Fig. 1). Both brown hyaenas and kudu (*Tragelaphus strepsiceros*) were more likely to occupy sites further away from active spotted hyaena dens.

The effect of the distance to the nearest spotted hyaena den on the mammal community detection was uncertain (Fig. 2). Some species indicated strong responses. Blue wildebeests (*Connochaetus taurinus*), kudu, zebras (*Equus burchellii*), impalas (*Aepyceros melampus*) and gemsbok (*Oryx gazella*) were more likely to be detected near spotted hyaena dens.



**Fig. 1.** The effect of the distance to the nearest spotted hyaena den on the mean mammal community occupancy probability (indicated by the solid lines) as well as species-specific occupancy, with -1 indicating a negative effect and 1 indicating a positive effect. 0 represents no effect. The dashed coloured lines represent the mean mammal community BCIs at 2.5 % and 97.5%.



**Fig. 2.** The effect of distance to den on the mean mammal community detection probability (indicated by the solid lines) as well as species-specific detection probability, with  $-1$  indicating a negative effect and  $1$  indicating a positive effect.  $0$  represents no effect. The dashed coloured lines represent the mean mammal community BCIs at 2.5 % and 97.5%.

## Discussion




The results indicate that the direct effects of spotted hyaena dens on the mammal community may be lower than expected. However, brown hyaenas and kudus indicated signs of den avoidance. Resource competition between spotted hyaenas and brown hyaenas (Honiball 2021; Vissia, Virtuoso, Bouman & Van Langevelde, 2023; Vissia, Wadhwa & van Langevelde, 2021) as well as the dominance of spotted hyaenas (Mills and Mills 19821; Vissia *et al* 2021) may ultimately result in brown hyaenas avoiding spotted hyaena dens, reducing the risk of potential encounters. Kudus are a common prey species of spotted hyaenas, particularly in Madikwe Game Reserve (Honiball, 2021) potentially causing kudus to avoid spotted hyaena dens in order to reduce predation risk. The effect of dens on detection probabilities of the mammal community may have been affected by the camera trap placement. This along with the herd and body size of animals affected might have increased the detection probabilities of these animals near dens. Increased survey effort is suggested for more conclusive effects of spotted hyaena dens. This is, however, the first study to explore the effects of spotted hyaena dens on the mammal community, opening the floor for more research on this topic.

## Acknowledgements

We would like to acknowledge Madikwe Game Reserve, North-West Parks Board and Piet Nel for the opportunity to conduct research on the reserve

and for the provision of accommodation and a research vehicle during the two years spent there. Everyone in Madikwe that assisted during fieldwork. AICE for providing me with trapping equipment to conduct my surveys. REHABS and the Wildlife Ecology Lab for covering survey expenses. Nelson Mandela Postgraduate Research Scholarship and the National Research Foundation for funding during the study period.

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Responsible Editor: L. Behrendorff