SHORT COMMUNICATION

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Movement ecology and post-release success of translocated Western Barred Spitting Cobras in the Khomas Region, Namibia

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ABSTRACT Human-snake conflict is increasing globally as human habitation continues to encroach on natural habitats. To mitigate conflict, snakes are often translocated by snake removal services. In Windhoek, the capital of Namibia, the near-endemic Western Barred Spitting Cobra (*Naja nigricincta nigricincta*) is the second most removed snake from houses and gardens. This research aimed to assess the impact of translocation on the survival, body mass, and movement of such snakes. Three translocated Western Barred Spitting Cobras were fitted with transmitters and tracked over a period of six months post-translocation. All three individuals remained alive and showed body mass gain throughout the study period. While additional studies with greater sample size and resident snakes are needed to support the findings of the study, the post-translocation tracking data revealed a larger home range and greater movement in the male compared to the two females. No evidence of homing behaviour was observed in any of the translocated snakes.

KEYWORDS Human-snake conflict; translocation; spatial ecology; home range; zebra snake; *Naja nigricincta nigricincta*; telemetry; Namibia

INTRODUCTION

Snake translocation by dedicated removal services is increasing globally due to growing human-snake conflict (Sullivan et al. 2015, French et al. 2018, Hauptfleisch et al. 2021). However, since post-translocation monitoring is largely lacking in Africa, the effectiveness of this approach as a management practice remains uncertain (Cornelis et al. 2021, Choquette et al. 2023). To address this gap, our pilot study aimed to expand the knowledge on snake translocation and focused on the Western Barred Spitting Cobra (*Naja nigricincta nigricincta*), a species that frequently comes into conflict with humans in Namibia – especially in urban areas (Hauptfleisch et al. 2021). Following capture in Namibia's capital, Windhoek, we fitted three individuals with trackers, translocated them and monitored their various responses to translocation. This study will form the baseline of a long-term assessment to help improve the current response to human-snake conflict in Namibia.

METHODS

Study species

The Western Barred Spitting Cobra (*Naja nigricincta nigricincta*) is one of the six true cobras found in Namibia and is one of four species able to spit venom when threatened. It is a medium to large-sized snake, reaching over 1.8 m in length (Marais 2022). The snake is easily recognisable by the black and white stripes on the body. It is primarily nocturnal and typically inhabits dry savannas and semi-arid regions, where it preys on small mammals, amphibians, and other reptiles (Marais 2022).

Snake capture

Snake removal callouts were used to collect the animals in the Windhoek area. In total, three snakes were sampled, including two females and one male. Female 1 was removed approximately 5 km away from Female 2, while Male 1 was removed approximately 10 km away from the two females. These snakes were captured using snake hooks and tongs. They were weighed using a digital scale and restrained using clear acrylic tubes (Antonio 2014). Snout-to-vent length, sex, and scale counts were recorded. The data collected ensured that all snakes were large enough to be fitted with a tracker.

Surgical tracker implantation

A miniaturised VHF model SI-2 transmitter (Holohil Ltd, Ontario, Canada), weighing 9 g and measuring 3 cm x 1 cm, was implanted into each snake by a qualified veterinarian at the Veterinary Academic Hospital, School of Veterinary Medicine, University of Namibia. The trackers weighed less than 5% of the body mass of each snake. The snakes were clinically evaluated preoperatively to ensure health status. Once restrained per tube, the snakes were anaesthetised using isoflurane inhalation. The transmitters were surgically implanted intracoelomically under aseptic conditions, using a technique modified from that initially described by Reinert and Cundall (1982). The snakes were monitored postoperatively for 48 hours to allow full recovery, prior to release.

Snake release

Male 1 was translocated 20 km away from its capture site and the two females 10 km from theirs. The translocation area was a 49.83 km² cattle farm located 15 km east of Windhoek, within the highland shrubland region of Namibia, which is characterised by sweet grassveld (Strohbach 2021).

Data collection

The three tagged snakes were followed on a bi-weekly basis with the use of standard telemetry equipment (AR 8200 wide ranging receiver and standard antenna). The GPS locations of each snake were recorded every second week from April 2021 to October 2021. It is worth noting that not all snakes were located on every occasion when tracked. The three snakes were recaptured after the six-month period to evaluate their physical condition, including their body mass.

Data analysis

Spatial analyses were carried out with the standard geographic information system software package ArcView GIS 3.24.1 (ESRI Software, Redlands, CA). Home ranges were determined utilising the minimum convex polygon method (Gregory 2017). The minimum convex polygon method is a home range estimation method that creates the smallest possible convex polygon based on the GPS locations where the animal was recorded during the time of the study.

Approvals and permissions

An ethical clearance and research permit was provided by the National Commission on Research, Science and Technology (AN 202101050). All research adhered to the guidelines for use of live amphibians and reptiles in the field and laboratory, as per the American Society of Ichthyologists and Herpetologists (Beaupre et al. 2004), ensuring humane treatment and minimal stress to the animals involved.

RESULTS

All three snakes survived the study period.

Male 1 had an initial body mass of 1 098 g which increased to 1 178 g six months after translocation. The snake had the largest home range, covering a total area of 1.45 km² (Figure 1), and utilised the same burrows on more than one occasion. Male 1 was observed foraging near a rock hyrax den and rodent burrows on five occasions in the field.

Female 1 had an initial body mass of 718 g which increased to 839 g six months after translocation. The home range covered an area of 0.26 km^2 (Figure 1). Female 1 was observed foraging on three occasions, raiding rodent burrows and rock hyrax dens.

Female 2 had an initial body mass of 674 g which increased to 741 g six months after translocation. Female 2 had a home range of 0.17 km^2 (Figure 1) and was observed on one occasion foraging near a rock hyrax den.

Differences in home range sizes between Male 1 and the two females were noted. The home range of Male 1 was approximately 5.6 times larger than that of Female 1 and approximately 8.4 times larger than that of Female 2. Additionally, the home range of Female 1 was approximately 1.5 times the size of the range of Female 2.

The home ranges of these snakes overlapped (Figure 1). The home range of Female 2 overlapped almost completely with that of Female 1. Almost half of the home range of Female 1 overlapped with that of Male 1. The home ranges of Female 2 and Male 1 showed little overlap.

DISCUSSION

In the context of the growing human-snake conflict, three Western Barred Spitting Cobras were translocated and tracked for six months. All three individuals remained alive and showed an increase in body mass throughout the study period. Male 1 exhibited a larger home range and greater movement compared to the two females. No homing behaviour was observed during the six-month period.

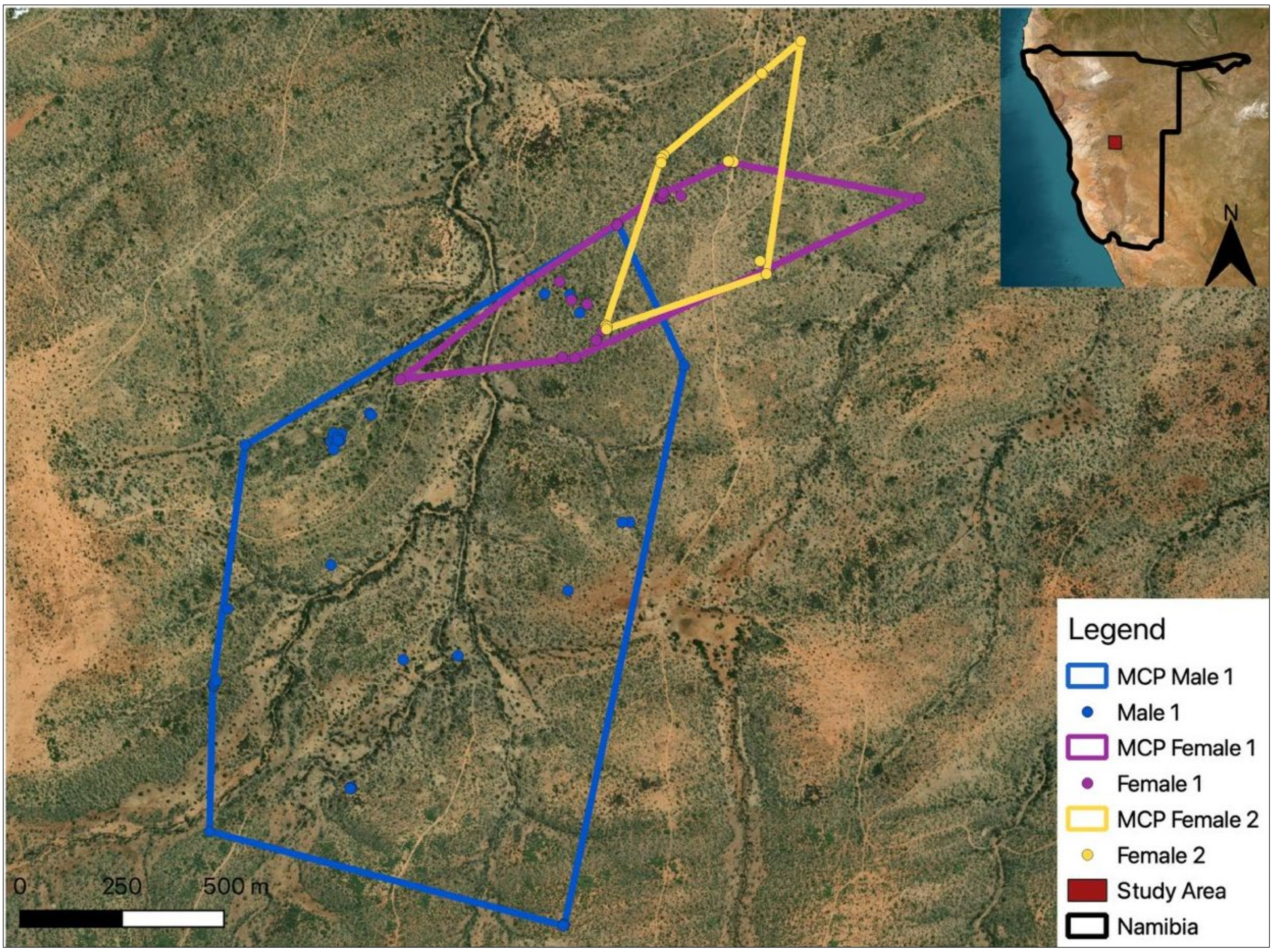

Figure 1 Study location (red square) within Namibia (top right) and minimum convex polygons (MCP) of three Western Barred Spitting Cobras over a six-month period post-translocation. The points represent the bi-weekly GPS locations of the snakes, and the lines connect the outermost points, forming the boundary of their home range.

The survival of all three snakes over the six-month post-translocation period aligned with findings suggesting that translocation does not necessarily lead to immediate mortality (Barve et al. 2013). Considering that the three snakes gained body mass, it is reasonable to assume that all three individuals were feeding during the study period. While the results are promising and could suggest that short distance translocation may be used as an ethical management practice, complementary studies need to be undertaken to confirm the current findings.

Male 1, translocated 20 km away from its initial capture point, established a home range of 1.45 km², while the home ranges of the females, both translocated 10 km away, were considerably smaller (Female 1 with 0.26 km² and Female 2 with 0.17 km²). Two primary hypotheses may explain the differences in movement and home range sizes. First, the distance at which the snake was translocated from the capture site may impact its movement (Cornelis et al. 2021). Secondly, sex could also be a factor in the observed differences (Sperry & Weatherhead 2009, Dubey et al. 2008). The difference between the translocation distances were between 10 km and 20 km and every snake was moved out from their initial home range, suggesting that males may inherently travel more in search of mating opportunities, food, and hibernacula, thereby explaining the longer distances travelled during the night. These findings imply that sex differences may be a key factor in movement patterns.

Translocation aims to mitigate conflict by removing the snake from human proximity. This tool not only ensures the survival of the snake through relocation to a safer environment but also safeguards humans using an approach considered humane and non-lethal (Massei et al. 2010). The absence of homing behaviour observed in this study therefore supports the primary aim of translocation. The potential impact of snake translocation on the trophic interactions at both interspecific and intraspecific levels warrants consideration (Stepkovitch et al. 2022). However, a larger sample size and inclusion of resident snakes are required to confirm the study results.

LIMITATIONS

Several limitations were encountered during this study. The primary limitation was the small sample size of three snakes, with only a single male, due to the lack of available snakes big enough for the transplantation. The minimum body mass required was 500 g and, in most cases, snakes removed during the period of the study had a body mass of approximately 300 g. Consequently, the generalisability of these findings remains restricted until a larger population sample can be investigated. Additionally, the six-month monitoring period may also limit the understanding of long-term behavioural changes post-translocation, particularly in response to seasonal variations and food availability. Finally, typical home range size and movement of this species are unknown. Future studies could improve knowledge by including data from resident, non-translocated snakes, which would provide a baseline comparison and enable differentiation between typical and translocated-induced behaviours.

CONCLUSION

The observed survival and established home ranges of the translocated snakes align with findings from other studies (Cornelis et al. 2021), suggesting that short distance translocation may be a viable tool for mitigating human-snake conflict. The study results show promise, as all individuals survived. Further studies employing identical translocation distances and larger sample sizes would help to validate the results from this study.

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