Notes and records

The decline of lions in Ghana's Mole National Park

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Introduction

The African lion (*Panthera leo*) is an apex predator of great ecological and cultural significance that increasingly is threatened by conflict with humans, particularly in West and Central Africa (Bauer & Van Der Merwe, 2004; Bauer, Nowell & Packer, 2008). The lion has been classified as regionally endangered in West Africa, with a rough estimate of only approximately 1000 individuals persisting in isolated protected areas (Bauer & Nowell, 2004). Conservation planning has been hindered by a paucity of research on the distribution, abundance and ecology of lions in the region (Bauer *et al.*, 2003), but important Lion Conservation Units were proposed during a 2005 regional priority setting workshop (IUCN, 2006). Mole National Park (MNP) in northern Ghana is one such unit, yet no previous surveys have specifically assessed lions in MNP or elsewhere in Ghana. Here, we report on the recent trend and current status of lions in MNP using data from a long-term law enforcement patrol-monitoring programme combined with recent field and questionnaire surveys.

Material and methods

Mole National Park is the largest of Ghana's protected areas and covers approximately 4600 km^2 in the country's Northern Region (approximately 09°11′–10°06′N,

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01°22′–02°16′W; Fig. 1). Mean annual rainfall is approximately 1100 mm, and the dominant habitat type is open woodland savannah. The park protects regionally significant populations of large ungulates, including buffalo (*Syncerus caffer*), roan antelope (*Hippotragus equinus*) and hartebeest (*Alcelaphus buselaphus*). The Wildlife Division of Ghana (WD) has conducted long-term monitoring of large mammal populations in MNP based on sightings made by field staff during regular law enforcement patrols throughout the park (Brashares & Sam, 2005; Jachmann, 2008). We examined monitoring records spanning the 40-year period from 1968 to 2008 and calculated an annual index of lion abundance as the number of individual lions observed divided by the number of patrols conducted (equivalent to a catch-per-unit-effort index, cf. Jachmann, 2008). We considered the number of patrols to be a reliable measure of monitoring effort as the distance, duration and number of staff for individual patrols were relatively consistent over time (WD, unpublished data). The available dataset included observations from >30,000 patrols summarized in approximately 2000 monthly reports (no data were available for 2002–2003).

To complement the long-term patrol observations, we conducted a camera trap survey from October 2006 to January 2009. Data were obtained from 253 camera stations active for a total of 5469 trap days, with sampling effort highest during dry season periods (November–April) when lions and their prey were expected to concentrate near scarce water sources. Most stations consisted of a single DeerCam DC300 film unit (Non Typical, Inc., Park Falls, WI, U.S.A.) set at a height of approximately 40 cm facing perpendicular to the expected direction of animal travel. Stations were deployed in twenty spatio-temporal groups within which they were spaced systematically at approximately 1-km intervals at features expected to maximize detection probability (e.g., dirt tracks, wildlife trails, water sources, salt licks), and cameras operated continuously until retrieved (typically after 3–4 weeks) or the film was fully exposed.

A third assessment of lion occurrence in MNP was provided through semi-structured interviews of 68 key informants from 27 villages adjacent to the park (Fig. 1).
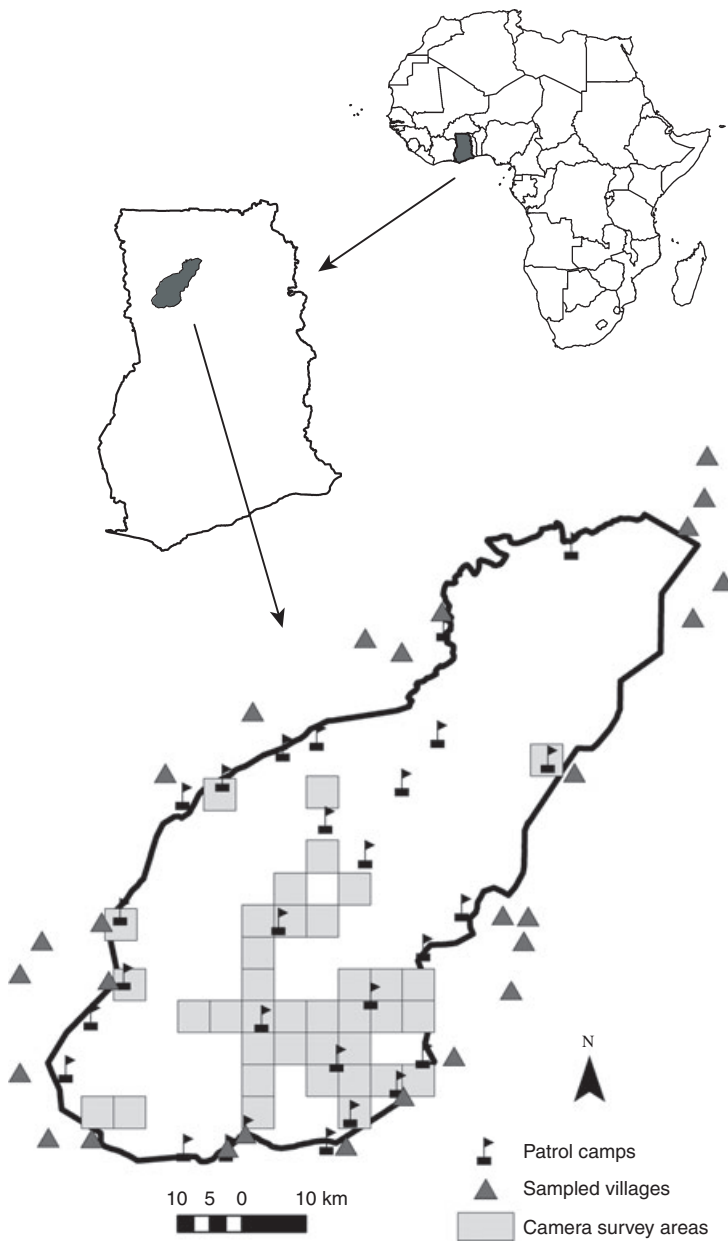
Fig 1 Map of Mole National Park, showing its location within Ghana and Africa and the spatial distribution of village interviews, camera trap sampling and law enforcement patrol camps (from which patrol observations were available)

Respondents were asked to name all wildlife species they knew to occur in the area around their village, as well as those that used to occur but no longer did and those they thought had declined over recent decades. They were also shown a photo of a male and female lion and asked if they had seen this animal in the area and, if so, when their last observation was made. Interviews were conducted between November 2006 and November 2008.

Finally, we searched for direct and indirect evidence (i.e., spoor) of lions during extensive travel by foot (>330 km) and vehicle (>1400 km) throughout most of the park (travel was very limited in the far northern portions), and we followed up on any reports of lion evidence from park staff during our period of intensive field work (October 2006–January 2009). Call-in station surveys were also implemented in March–April 2007 at five locations in the

centre and south-east of the park using a protocol adapted from Ogutu & Dublin (1998).

Results

The number of lion sightings per patrol declined significantly in MNP from 1968 to 2008 (Spearman's rank correlation $r_s = -0.47$, $P = 0.003$, n = 39 years; Fig. 2). This index of abundance fell from an average of 2.0 lions/100 patrols over the first 5 years of monitoring to only 0.07 lions/100 patrols (corresponding to only three sightings) over the last 5 years. No lion detections were obtained during the camera trap survey, despite frequent detection of other large mammals, including two large carnivores (spotted hyaena, *Crocuta crocuta*: 6.5 detections/100 camera trap days; leopard, *Panthera pardus*: 2.9 detections/100 trap days) and many prey species (e.g., kob, *Kobus kob*: 9.6 detections/100 trap days; hartebeest: 3.3 detections/100 trap days). No unequivocal evidence of lions was collected during the extensive searches by foot and vehicle, and no detections were made during call-in surveys. Forty-eight (71%) of the village interview respondents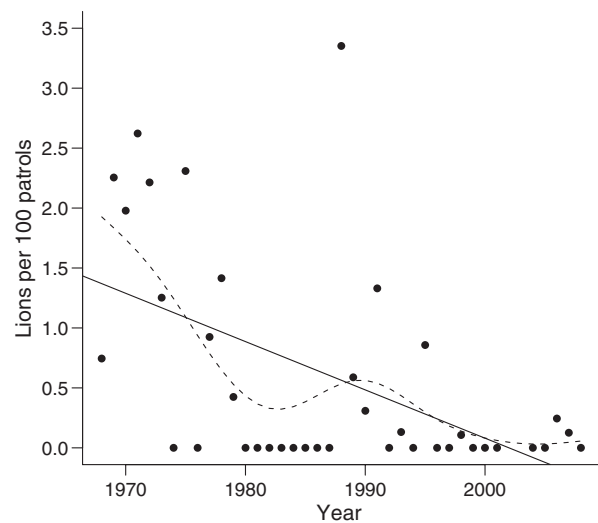 reported having seen lions in the area, though only 8 (11%) indicated having seen one within the last 5 years. Twelve respondents (18%) suggested that lions no longer occur in the area, and another 11 (16%) stated that they had declined over time.

Discussion

Our results suggest a significant decline in the lion population of MNP over the last 40 years. This decline is apparent across multiple lines of evidence: a marked decrease in sightings by patrol staff, a lack of camera trap detections or other verifiable evidence despite extensive field work, and an increasing sense of scarcity conveyed by local village residents. While surveying rare and elusive carnivores is challenging and each of the methods used in our study has limitations, we have no reason to suspect that any methodological shortcomings biased the outcome. Internannual variability in patrol numbers likely affected the probability of detecting lions, thus introducing error into the observed trend, but considerable patrol effort was expended in recent years (e.g., approximately 2700 patrols from 2005 to 2008), and the same patrol-based abundance indices did not decline for many other species (C. Burton, unpublished data). Similarly, camera traps detected 33 other mammal species in MNP and have been successfully used to survey lions elsewhere (e.g., Pettorelli *et al.*, 2010). Many previous lion surveys have focused on call-in stations and spoor searches, but we found these methods to be less practical in MNP because of limited access, low visibility and poor tracking substrate. Given gaps in our survey coverage and anecdotal reports from villagers and park staff, we cannot rule out the possibility that a small lion population persists in MNP. However, the available evidence implies that this species is now at best extremely rare in the park and likely functionally if not fully extirpated. The ecological consequences of losing this apex predator have not yet been assessed but are potentially severe for the long-term functioning of the MNP ecosystem (e.g., Terborgh & Estes, 2010). Socio-cultural implications are also significant as lions could attract needed tourist revenue and are of considerable local traditional importance.

There are likely many interacting drivers underlying the apparent lion decline, and further inquiry is warranted. Prey depletion because of illegal bushmeat hunting is of widespread concern in West Africa (Brashares *et al.*, 2004), and the patrol monitoring programme has documented considerable hunting pressure in MNP (Jachmann,

Fig 2 Index of lion abundance (sightings per 100 patrols) from long-term law enforcement patrols in Mole National Park, Ghana, showing a significant decline over the period 1968–2008 (Spearman's rank correlation $r_s = -0.47$, $P = 0.003$). The solid line indicates the linear trend ($R^2 = 0.27$), and the dashed curve represents a nonparametric smoother fit using a generalized additive model ($R^2 = 0.35$)

2008; WD, unpublished data). While a detailed assessment of prey biomass is needed, many medium- and large-bodied ungulates appear to be relatively abundant within portions of the park and support other large carnivore populations (see Results), so it is not clear that lions are limited by an inadequate prey base. Direct persecution is an important threat to many lion populations (Bauer *et al.*, 2003), and instances of illegal lion killing have been recorded by the MNP law enforcement programme as recently as 2004 (Fig. 3). Furthermore, more than half (55%) of our village interview respondents reported traditional consumptive uses of lions (for ceremonial, medicinal or nutritional purposes) and 45% related experiences of lion livestock depredation, including several cases of retaliatory killing. We also noted the sale of lion skins and claws in a market in Tamale, the regional capital (approximately 80 km from MNP). These observations suggest that direct killing of lions in and around MNP likely played a role in the population decline. Other factors that may have contributed include disease, intraguild competition, inbreeding depression and Allee effects, but we currently lack the data necessary to evaluate their importance.

In conclusion, our results call attention to the broader crisis facing lion populations in Ghana and much of West and Central Africa. MNP was expected to be the country's last lion refuge, and lion declines have recently been reported for other protected areas in the region (Bauer *et al.*, 2003; Henschel *et al.*, 2010; Tumenta *et al.*, 2009). There is thus an urgent need for targeted management efforts to protect remaining lions and alleviate threats, both through increased capacity for effective law enforcement and improved collaborative management with local communities who must live with lions. Ultimately, a long-term vision must be created for landscape-level conservation planning and restoration of this regionally endangered apex predator.

Acknowledgements

Fig 3 Photograph of a lion killed by local hunters at the edge of Mole National Park in August 2004 (credit: Wildlife Division of the Forestry Commission of Ghana)

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