

GHANA CARNIVORE PROJECT

A Conservation Assessment of Lions and Other Wild Carnivores in Priority Areas of Ghana, West Africa.



Annual Report

29 May 2009

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SUMMARY

The focus of this project was to critically assess the distribution, abundance and viability of lions and other carnivores in and around Mole National Park and other key areas of Ghana, West Africa.

The conservation of large, free-ranging carnivores represents a critical challenge for wildlife managers worldwide. This is particularly true in West Africa, where carnivore populations are poorly known but suspected to have declined considerably and face an increasing threat of regional extirpation. The lion (*Panthera leo*) is now classified as Endangered in West Africa. Mole National Park (MNP), a 4840 km² savanna reserve in northern Ghana, has been identified as an important Lion Conservation Unit for West Africa and is also thought to harbor regionally significant populations of leopard (*Panthera pardus*), spotted hyena (*Crocuta crocuta*), serval (*Leptailurus serval*), caracal (*Caracal caracal*), and side-striped jackal (*Canis adustus*). However, prior to this project, no survey of carnivores had been undertaken in MNP, nor in any of Ghana's other reserves thought to harbor carnivore populations.

From October 2006 to January 2009, we conducted extensive field surveys to document the occurrence and relative abundance of carnivores and their prey in MNP. We relied primarily on the use of camera traps and obtained data from 255 camera stations active for 5,235 trap-days in different portions of the park and during different seasons. Of 16 carnivore species recorded historically in MNP, only 9 were detected by our multi-year sampling. Two large carnivores—spotted hyena and leopard—were among the more frequently photographed species, while caracal and side-striped jackal were detected but relatively uncommon. No unambiguous detections of lions were made, indicating that their status in the park is dire. Other carnivores, such as serval, were also not detected and are thus likely very rare or locally extinct within MNP. Common prey species included kob (*Kobus kob*), bushbuck (*Tragelaphus scriptus*), olive baboon (*Papio anubis*), warthog (*Phacochoerus africanus*), hartebeest (*Alcelaphus buselaphus*) and waterbuck (*Kobus ellipsiprymnus*), and a significant amount of illegal human activity (primarily hunting) was also documented.

To gain further insight into the status of carnivores in MNP, we organized and examined anti-poaching patrol monitoring records from 1968 through to May 2008. These records indicate a decline in lion observations over time, with the most recent sighting recorded in April 2007 (although we are currently investigating a reported lion sighting in May 2009). Park records also document cases of human-lion conflict, including the illegal killing of a lion in August 2004. Occasional instances of human-lion conflict were also noted during 68 interviews we conducted with key informants from 27 villages around MNP in 2007 and 2008. Many villagers stated that lions were of considerable traditional importance, such as for medicinal, ceremonial and spiritual uses, but very few indicated that they had recently seen a lion (e.g. within the last five years) and many suggested that lions no longer occur or have declined significantly in the area.

Limited camera-trap surveys in two other protected areas—Gbele Resource Reserve and Ankasa Conservation Area—did not detect large carnivores, although leopard tracks and several smaller carnivores were documented in Ankasa. A review of the limited information available for other areas in Ghana (e.g. patrol records, management plans, consultant reports) does not provide reliable evidence for the persistence of viable populations of lions or other large carnivores. A reported lion sighting in February 2009 near Kalakpa Resource Reserve in southeastern Ghana has attracted attention to that area, and a potential patrol sighting of a lion in Digya National Park in October 2008 is being followed up on. Recent evidence of spotted hyena and leopard in Bui National Park is worthy of further attention, although the ongoing construction of a large hydroelectric dam is a challenge to research efforts and wildlife in that park.

As part of this project, we organized Ghana's first national meeting on carnivore conservation in January 2009 to bring attention to the plight of lions and other carnivores in the country and to initiate discussion of management actions required to protect and restore carnivore populations. Ghana's top wildlife managers and representatives from the country's wildlife protected areas, as well as several conservation NGOs and academic institutions, participated in the meeting and a carnivore management committee was formed. It is our hope that this group will lead an expanded and sustained effort to promote further research, monitoring and management action focused on the conservation and restoration of Ghana's regionally important carnivore populations.

PROJECT ACTIVITIES & PROGRESS:

The primary objectives of the project are to (a) conduct field surveys targeting lions, leopards and other carnivores in Mole National Park; (b) assess Ghana Wildlife Division (GWD) monitoring records on carnivores, prey, and the threat from illegal hunting; (c) document villager interactions with carnivores; and (d) improve local capacity for carnivore conservation. A summary of activities and achievements is provided for each of these objectives under the headings below (additional details can be found in the previous interim and annual reports dated 15 January 2007, 31 July 2007, and 31 May 2008). I also provide a summary of field surveys and local information for other relevant areas and a broader assessment of the status of lions in Ghana.

A. Field surveys of lions, leopards and other carnivores in Mole National Park

i. Survey Methods

The field program was active through 2008 and completed in January 2009. Survey effort remained focused on camera trapping, with sampling sites chosen to target key areas of expected carnivore occurrence while covering a wide range of variation in factors potentially limiting carnivore distribution and abundance (e.g., habitat type, water availability, hunting pressure). Sites surveyed during 2008 were chosen to fill gaps in sample coverage as well as provide temporal replicates of previously sampled areas. In total, data were obtained from 255 camera stations over a survey effort of 5,235 camera-trap days. Most stations consisted of a single DeerCam DC300 unit, however a subset of stations had paired units to simultaneously capture both sides of individually identifiable species (for mark-recapture analysis). A few different camera trap models were also deployed in 2008-09 (following discontinuation of the DeerCam model by the manufacturer), including Leaf River C-1BU (film), StealthCam MC2-GV (film), Reconyx RC55 and Silent Image (digital), CamTrakker Environmental Unit (film), and Cuddeback Excite and Capture 3.0 (digital).

The approximate spatial coverage of field surveys in MNP is represented in Figure 1, which shows 100km² grid cells within which camera stations were established and spoor searches were made (excluding a few more isolated stations and limited searches). Four of the grid cells were surveyed at a higher intensity with an average of 34 camera stations each (range 28-43), and the other 13 cells contained an average of 7 stations each (range 3-14). Stations within a cell were set systematically at approximately 1km intervals at features expected to maximize capture probability for carnivores and prey (eg. trails, water holes, salt licks). Sampling occurred across a range of seasonal conditions, although effort was higher during the drier periods between November and March. A lack of infrastructure (e.g. roads, camps, water sources) severely limited access to certain portions of the park, particularly the far north (an attempt to establish camera stations near the Kulpawm river at the northern edge of the park did not result in any animal captures).

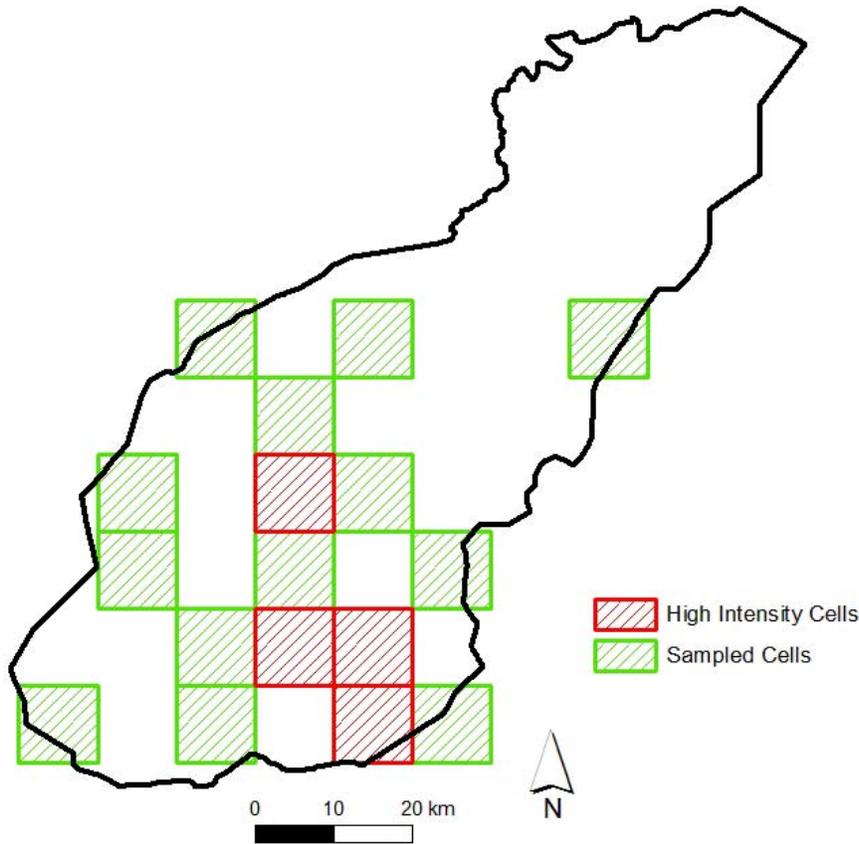


Figure 1. Spatial coverage of field surveys in Mole National Park, showing the main areas (100 km² grid cells) where camera stations and spoor searches were concentrated (see text for details).

Observations of tracks and scat of focal carnivores were recorded during foot and vehicle travel around and between the camera sampling sites, and systematic transects recording the occurrence and relative abundance of all mammal species were walked in high intensity cells. Sightings of prey species were also recorded during repeated vehicle transects along the park's main roads. In addition, five call-in stations and three nighttime spotlight transects were completed; however, it was determined that the utility of these survey methods was greatly limited by the dense vegetation (i.e. poor visibility) and the difficulty of traveling within the park by vehicle at night (very poor or non-existent roads). Additional data collected during MNP field surveys included signs of illegal activity (particularly hunting) and general habitat characteristics (such as vegetation type and coverage, water availability, extent and intensity of burning).

Efforts to finalize the project databases are nearing completion, including calculation of site- and species-specific covariates for use in testing hypotheses about factors potentially limiting carnivore occurrence and abundance. For the purpose of comparing our survey results with a historical baseline, a list of expected carnivore species for Mole National Park was constructed based on records assembled and assessed by Peter Grubb and colleagues in *Mammals of Ghana, Sierra Leone and the Gambia* (Tendrine Press, UK, 1998), as well as the checklist included in the 2005 MNP Management Plan.

ii. Survey Results

A total of 33 mammal species were detected by the camera trap surveys in MNP, including nine carnivore species. Table 1 lists these species in decreasing order of relative abundance across the 255 camera stations, excluding a single photo each of a domestic goat and an unidentified microchiropteran bat (note that these simple calculations of relative abundance may not represent unbiased indices of absolute abundance). Only two mammal species detected by other survey methods were not captured

by the camera traps: Geoffroy's pied colobus (*Colobus vellerosus*; one direct sighting) and African hedgehog (*Atelerix albiventris*; several tracks and one direct sighting). The camera traps also captured at least 25 bird species (including the Near-threatened Denham's Bustard, *Neotis denhami*) and four reptile species (savannah monitor - *Varanus exanthematicus*, Nile crocodile – *Crocodylus niloticus*, and two unidentified lizards).

Species composition and relative abundance along track transects were qualitatively similar to the camera trap surveys, although species identification was more ambiguous, particularly for medium and smaller carnivores and in the many areas where tracking substrate was poor. Direct sightings of most species were quite rare due to dense vegetation, wary behavior, and low densities in the park (with the exception of some prey species in the relatively well-protected area around park headquarters). Call-in surveys and nighttime spotlight transects yielded few observations and were deemed to be of limited effectiveness for the time being.

Table 2 lists the nine carnivore species detected in this study, along with seven other carnivores that potentially occur in MNP based on Grubb et al (1998). According to data from the 2008 IUCN Global Mammal Assessment (<http://www.iucnredlist.org/mammals>) the current ranges of an additional seven carnivore species include Mole National Park. However, we found no evidence that these species have ever occurred in the park and thus have not included them on our list. [A less conservative assessment might consider African clawless otter (*Aonyx capensis*) and wild cat (*Felis silvestris*) as potentially occurring in MNP, but not likely the other species indicated by the IUCN GMA (banded mongoose, *Mungos mungo*; common genet, *Genetta genetta*; zorilla, *Ictonyx striatus*; spot-necked otter, *Lutra maculicolis*; and striped hyena, *Hyaena hyaena*.)]

Among the carnivore species detected, there was considerable spatial variation in the location and relative frequency of camera-trap captures. Figure 2 shows spatial patterns for the two large carnivores (leopard and spotted hyena), indicating that captures were generally clustered in the center and southeastern parts of the park. We are currently undertaking further analysis of these patterns as well as individual-based mark-recapture density estimation.

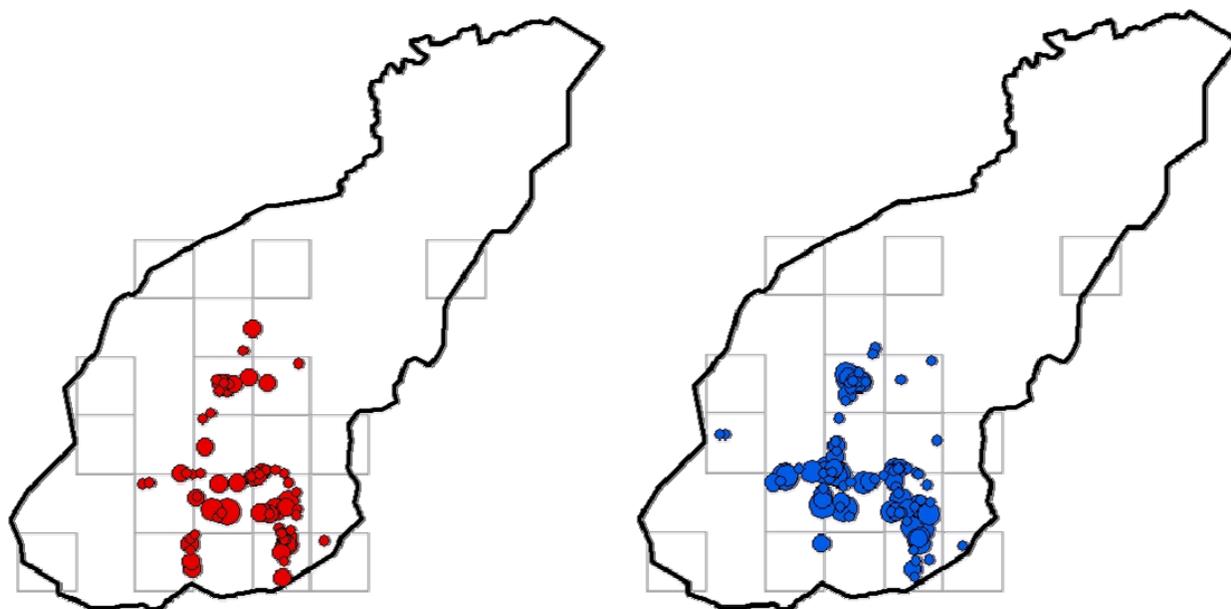
A significant amount of illegal activity was documented within the park, including numerous photos of hunters and other signs of hunting activity (e.g. hunting camps). Several camera stations were also stolen while set within the park during the course of the project.

Table 1. Mammal species detected in camera trap surveys in decreasing order of detection frequency (number of independent photos). Carnivore species are highlighted in bold.

COMMON NAME	SCIENTIFIC NAME	No. photos	Photos/100 trap-days	No. stations	Proportion of stations
Kob	<i>Kobus kob</i>	500	9.55	59	0.23
Spotted Hyena	<i>Crocuta crocuta</i>	357	6.82	107	0.42
Bushbuck	<i>Tragelaphus scriptus</i>	351	6.70	124	0.49
Olive Baboon	<i>Papio anubis</i>	306	5.85	105	0.41
Warthog	<i>Phacochoerus africanus</i>	228	4.36	96	0.38
African Elephant	<i>Loxodonta africana</i>	219	4.18	80	0.31
Human	<i>Homo sapiens</i>	192	3.67	70	0.27
Hartebeest	<i>Alcelaphus buselaphus</i>	172	3.29	56	0.22
White-tailed Mongoose	<i>Ichneumia albicauda</i>	170	3.25	65	0.25
Leopard	<i>Panthera pardus</i>	162	3.09	74	0.29
Large-spotted Genet	<i>Genetta pardina</i>	156	2.98	57	0.22
Green Monkey	<i>Cercopithecus aethiops</i>	145	2.77	54	0.21
Waterbuck	<i>Kobus ellipsiprymnus</i>	123	2.35	57	0.22
Crested Porcupine	<i>Hystrix cristata</i>	120	2.29	51	0.20
Aardvark	<i>Orycteropus afer</i>	86	1.64	55	0.22
African Buffalo	<i>Syncerus caffer</i>	76	1.45	33	0.13
Red-flanked Duiker	<i>Cephalophus rufilatus</i>	63	1.20	30	0.12
Patas Monkey	<i>Cercopithecus patas</i>	57	1.09	35	0.14
Roan Antelope	<i>Hippotragus equinus</i>	57	1.09	33	0.13
Scrub Hare	<i>Lepus saxatilis</i>	52	0.99	19	0.07
Grey Duiker	<i>Sylvicapra grimmia</i>	45	0.86	31	0.12
African Civet	<i>Civettictis civetta</i>	32	0.61	23	0.09
Caracal	<i>Caracal caracal</i>	20	0.38	12	0.05
Marsh Mongoose	<i>Atilax paludinosus</i>	19	0.36	11	0.04
Marsh Cane-rat	<i>Thryonomys swinderianus</i>	8	0.15	7	0.03
Striped Ground Squirrel	<i>Euxerus erythropus</i>	6	0.11	4	0.02
Gambian Mongoose	<i>Mungos gambianus</i>	5	0.10	4	0.02
Oribi	<i>Ourebia ourebi</i>	3	0.06	3	0.01
Senegal Galago	<i>Galago senegalensis</i>	3	0.06	3	0.01
Side-striped Jackal	<i>Canis adustus</i>	3	0.06	3	0.01
Giant Pouched Rat	<i>Cricetomys gambianus</i>	2	0.04	2	0.01

Table 2. Occurrence and relative abundance of carnivore species for which there are previous records from Mole National Park.

Common Name	Scientific Name	Relative Abundance (photos/100 trap-days)
Spotted Hyena	<i>Crocuta crocuta</i>	6.82
White-tailed Mongoose	<i>Ichneumia albicauda</i>	3.25
Leopard	<i>Panthera pardus</i>	3.09
Large-spotted Genet	<i>Genetta pardina</i>	2.98
African Civet	<i>Civettictis civetta</i>	0.61
Caracal	<i>Caracal caracal</i>	0.38
Marsh Mongoose	<i>Atilax paludinosus</i>	0.36
Gambian Mongoose	<i>Mungos gambianus</i>	0.10
Side-striped Jackal	<i>Canis adustus</i>	0.06
Lion	<i>Panthera leo</i>	Not detected
Wild Dog	<i>Lycaon pictus</i>	Not detected
Honey Badger	<i>Mellivora capensis</i>	Not detected
Serval	<i>Leptailurus serval</i>	Not detected
Large Grey Mongoose	<i>Herpestes ichneumon</i>	Not detected
Slender Mongoose	<i>Herpestes sanguineus</i>	Not detected
Hausa Genet	<i>Genetta thierryi</i>	Not detected

**Figure 2.** Location and relative frequency of camera-trap captures for leopard (red, left panel) and spotted hyena (blue, right panel) in Mole National Park. Grid cells within which camera-trap sampling occurred are shown.

iii. Survey implications

The nine carnivore species detected in this survey represent a range of families, body sizes and other ecological attributes. The two large carnivores, leopard and spotted hyena, were detected relatively frequently and across a fairly high proportion of the sampled sites (Table 1). Two smaller carnivores, white-tailed mongoose and large-spotted genet, were also detected frequently, providing valuable data on species that are poorly studied within the region. The other medium and small carnivores appear to be rarer in the park, particularly the side-striped jackal for which only three detections were made. The photographs of caracal are of particular significance as its status in the park was uncertain: the 2005 management plan stated that there were “unconfirmed reports only”.

Given the spatial and temporal limitations of our survey, it cannot be definitively concluded that the seven undetected carnivore species no longer occur within MNP. However, considering that our survey effort was adequate to detect the other nine carnivores of comparable body sizes and ecological characteristics, it suggests that the undetected species are at least very rare and perhaps functionally or fully extirpated from the park ecosystem. The fact that the presence of lions could not be confirmed is particularly troubling (and addressed in more detail in section F below). It is also surprising that serval were not detected and further assessment of their status in the region is urgently needed. The lack of wild dog detections lends support to their IUCN Red List assessment of “possibly extinct” in Ghana (McNutt et al 2008, <http://www.iucnredlist.org/details/12436>). The honey badger (ratel) is thought to generally occur at low densities, and thus may be difficult to detect, so its status in MNP remains uncertain. The problem of detectability (or false absence) could also be an important issue for the smaller carnivores that weren't detected (*Herpestes ichneumon*, *H. sanguineus* and *Genetta thierryi*), given that their smaller body sizes might be less likely to trigger camera traps or leave noticeable tracks, and that their small home ranges might translate into proportionally more unsampled but potentially occupied area within the spatial sampling gaps. Nevertheless, the fact that similarly sized and related species were frequently detected (e.g. *Ichneumia albicauda*, *Genetta pardina*) lends support to the notion that these species are either rare or extirpated from MNP. We are currently conducting a more rigorous analysis of the potential intrinsic (i.e. ecological and life history traits) and extrinsic (i.e. environmental) factors influencing the detectability and persistence of carnivore species in the park.

B. Assessing Ghana Wildlife Division monitoring records

i. Historical records

Sightings of carnivores and other large mammals have been recorded by Ghana Wildlife Division (GWD) park staff during anti-poaching patrols in MNP (and other savanna reserves) over the past 40 years. Unfortunately, these historical records were poorly organized and at risk of being lost (many original reports do in fact seem to be lost). Our team led an effort to organize and enter existing data into a database that can be used to better understand population trends of carnivores and their prey in MNP, as well as trends in conservation threats such as illegal hunting. This database contains records from 2,311 monthly reports covering 27 MNP patrol camps over the period 1968-2001, and includes data from ~18,400 counts of 35 mammal species. There are 98 occasions where lions were counted, with a total of 289 lions observed (note that the same individuals could have been counted on multiple occasions over time). Based on a rough index of relative abundance (lions observed per unit effort), the lion population in MNP appears to have been low throughout the monitoring period, but to have

declined considerably from a relative abundance of ~ 1.3 lions observed per 100 patrols in the 1970s to only ~ 0.27 lions per 100 patrols in the 1990s, with the last observation recorded in 1998. The data also suggest a corresponding increase in the frequency of illegal hunting activity detected in the park over this period. Patchy observation records of ten other carnivores also exist in the historical dataset, including wild dog and species detected during our field surveys (Table 3).

It is important to note that these long-term observation data are incomplete and subject to many potential sources of error (e.g. variable observer ability and motivation, uneven spatial and temporal sampling effort, detection bias, species misidentification, missing records) and should thus be treated with caution. They may be particularly unreliable for rare and elusive species such as carnivores, yet the potential observer bias should be less severe for the larger and more conspicuous carnivores like lion and hyena, and the data provide otherwise unavailable information on trends over time. We are currently exploring analytical tools that can be used to identify and estimate the influence of observation error in the historical counts and, thereby, improve their reliability for inferring trends.

ii. Modern records

Beginning in late 2004, MNP's monitoring protocol was adapted to the Management Information System (MIST), which incorporates GPS locations to provide spatially explicit data on wildlife sightings, patrol effort and illegal activities in the park. We collaborated with MNP's Law Enforcement and Monitoring Unit to enter and quality check a backlog of patrol data corresponding to a period covering most of the project's field surveys. These data not only provide a continuation of the long-term monitoring dataset useful for trend analysis, but they also afford a means of comparing and extending the data obtained from our field surveys. As noted above, these data are subject to various forms of error and bias, and thus need to be treated with caution when making inference.

The MIST dataset entered and quality checked for this project covers a period from October 2004 to May 2008 and includes data from over 2,700 patrols extending across much of Mole National Park. The dataset includes 19 records of lion evidence, of which 3 were direct sightings, 3 were observations of scat, and 13 were observations of tracks. The indirect evidence (scat and tracks) must be treated with caution as we witnessed several instances in the field of patrol staff misidentifying spotted hyena tracks as those of lion. On the other hand, we also noted that patrol staff did not always diligently record supposed evidence of lions or other carnivores, including vocalizations, in their patrol observations (we only learned of it upon questioning them afterward). It is therefore difficult to say whether the records in the database might over- or underestimate the indirect evidence of lions (and other carnivores) observed during patrols. However, we expect that any direct sightings should be more reliable (and consistently recorded) and thus represent the best evidence. The last of the three lion sightings occurred on 7 April 2007, suggesting that lions may indeed have been present during the period of our field surveys, but that they are increasingly rare if in fact they do continue to persist in the park (as a very rough index of relative abundance potentially comparable to the historical monitoring records, 3 sightings over 2,754 patrols would correspond to ~ 0.11 lions observed per 100 patrols). [Note that we are currently following up on an apparent lion sighting by patrol staff in May 2009.] Observations of only three other carnivore species (spotted hyena, leopard and side-striped jackal) are included in the MIST database (Table 3). More than 2,100 observations of illegal activity were recorded by the patrols over this period, including at least 82 direct sightings of hunters and much more indirect evidence of hunting (e.g. traps, camps, footprints, shotgun cartridges).

Table 3. Evidence of carnivore occurrence in Mole National Park contained within Ghana Wildlife Division monitoring records. Indirect evidence in the MIST dataset includes tracks and scat.

Species	MIST (2004-2008)		Historical (1968-2001)	
	Direct Sighting	Indirect Evidence	Observations	Year of last
Lion	3	16	99	1998
Spotted Hyena	13	32	4	1993
Leopard	7	10	84	1999
Side-striped Jackal	8	-	1	1976
Wild Dog	-	-	5	1995
Caracal	-	-	1	1991
Civet	-	-	8	1977
Marsh Mongoose	-	-	24	1998
Genet	-	-	15	1981
Long Nose Mongoose	-	-	21	1994
Dwarf Mongoose	-	-	3	1986

When comparing the carnivore records from the GWD monitoring datasets with those from our field surveys, it is obvious that the patrol observations are biased toward under-reporting carnivore occurrence, particularly for smaller carnivores. It is also interesting to note that the only carnivores included in the monitoring records that we did not detect are lion and wild dog (assuming that the genet and mongooses are the same, although this requires further scrutiny and “dwarf mongoose” may be the slender mongoose). Both of these large carnivores may now be locally extinct in the park, though if this is true for lion it would obviously represent a very recent loss. The fact that there are so few hyena observations in the historical dataset suggests a very low detectability for this species from the patrols, although the possibility that it could reflect an increase over time in the hyena population warrants further investigation.

iii. Other GWD information sources

As a means of gaining further insight into local knowledge of carnivores that may not be captured by the anti-poaching patrol monitoring program, we conducted numerous informal interviews with MNP field staff as well as ten questionnaire-based interviews (similar in nature to the village questionnaires detailed below). Some field staff conveyed personal stories of encounters with lions in the past and most agreed that the population had likely declined, though many believed that some lions persisted within the park. Of the ten staff that completed the questionnaires, seven reported having seen a lion in the park, with the last of their reported sightings occurring in 2004. Seven of the respondents indicated that lion no longer occurred in the park and two of the other three suggested the species had declined.

During project activities we documented anecdotal reports of lion evidence, and on several occasions our team followed up on reported lion kills or tracks but only found tracks of spotted hyena. One patrol team reported hearing lion roars in March 2008; however, a follow up track and camera-trap survey failed to confirm the lion’s presence, demonstrating the difficulty of verifying such anecdotal evidence. (We are currently following up on a report that we have just received about a lion sighting by patrol staff on 23 May 2009.) There seemed to be a common misperception among many staff that

hyenas do not kill large ungulate prey, and thus that any ungulate carcasses encountered must have been killed by lions.

Aside from the interviews and anecdotal evidence, we obtained official reports of the last two human-lion conflicts documented in the park, including one lion wounded in February 2004 and another killed in August 2004 (Fig. 3).



Figure 3. Head of a lion (likely a young male) killed in 2004 in Mole National Park by hunters from an adjacent village (photo provided by D. Kpelle and Ghana Wildlife Division).

C. Documenting interactions between carnivores and local villagers

Approximately 30,000 people live in 29 villages located within 10 km of the Mole National Park boundary. These rural, farming communities are very dependent on local natural resources and undoubtedly hold considerable knowledge of wildlife populations and other ecological attributes of the area. The attitudes and relations of local residents towards wildlife and the park will also ultimately determine the success of conservation efforts. We therefore endeavored to collect data on the human population surrounding MNP, including specific information on local villagers' knowledge of, and interactions with, carnivores and other wildlife.

Semi-structured interviews based on a standardized questionnaire were conducted to investigate local community relationships with carnivores and other wildlife (Fig. 4). The primary goal of this survey was to gather complementary information from local villagers on the presence, distribution and trend of carnivore species potentially occurring in the greater MNP landscape. It was also designed to collect information on conflict with, and uses of, carnivores (e.g., livestock depredation, bushmeat and other traditional use), as well as basic information on local attitudes toward conservation. A total of 68 interviews were completed with key informants from 27 villages adjacent to MNP (mean = 2.5 interviews per village, range = 1-8).



Figure 4. Project leader C. Burton conducting an interview in Grubagu village adjacent to Mole National Park (Photo: D. Kpelle).

The interview data have not yet been analyzed in detail, but a preliminary assessment indicates that respondents shared considerable information on lions and other carnivores. For example, over half of respondents included the lion on a list of species occurring in the general area and reported having seen it. However, very few of these indicated that they had seen a lion recently (e.g. within the last five years) and several suggested that lions no longer occur or have declined significantly. Lions were noted by many to be of considerable local importance for traditional uses (such as medicinal, ceremonial and spiritual), while several others reported conflict with lions over livestock.

In addition to the village interviews, we are assessing information obtained during Community Profile focus group discussions conducted in 24 villages surrounding Mole by the park's Collaborative Management Unit. These profiles provide valuable insight into the considerable variation in population size, ethnicity, religious and cultural practices and other socio-economic characteristics of the communities around MNP. For example, estimated village sizes range from 117 to 5,000 inhabitants (mean 1,134), with more than ten ethnic groups and three broad religious categories well represented (Muslim, Christian and Traditional/Ancestral). The village profiles also contain specific details relevant to carnivore conservation in the area. For instance, profiles for 21 of the 24 villages listed lion as a species that has “disappeared” from the area, while 20 also listed leopard and 13 listed hyena. Nine village profiles noted traditional medicinal uses of lion, and seven for leopard.

Additional details relevant to human-carnivore relations and the socio-economic context of conservation in MNP are being assembled from several unpublished reports obtained from the Wildlife

Division. For example, a 1994 assessment of park-community relations noted that several communities around Mole had local taboos on killing hyenas as it was considered to bring bad luck, and a 2005 report on Problem Animal Management includes several instances of cattle depredation by hyenas. Official Incident Reports filed in MNP document two instances of human-lion conflict that occurred in 2004, in which one lion was killed (Fig. 3) and the other was at least seriously injured.

All of these sources of information will be used to provide the socioeconomic context critical for understanding conservation challenges and identifying opportunities to improve effectiveness. Based on our preliminary assessments to date, these data demonstrate considerable local knowledge of carnivores and reinforce the inference from field surveys that lions have declined and are now very rare or locally extinct in the Mole ecosystem.

D. Building local capacity for carnivore conservation

In general, very little research or management attention has focused specifically on carnivores in Ghana. A major objective of our project was therefore to help build capacity for carnivore conservation within the country. We strove to achieve this objective through three general and interrelated approaches: effective communication and collaboration, technical training and assistance, and facilitated acquisition of conservation resources.

We worked closely with Ghana's Wildlife Division (GWD, the government authority responsible for managing wildlife and protected areas) throughout the project, forming relationships across levels of management, from the Executive Director to the park patrol staff. This increased our understanding of GWD's broad management priorities, capacities, and challenges, while also opening more channels for collaboration and effective communication of the need for a focus on carnivore conservation. We involved GWD managers in the planning and implementation of project activities, and worked closely with park field staff in MNP and other locations. We also involved several students from two of Ghana's main universities: Kwame Nkrumah University of Science and Technology (KNUST), which has the country's only program in Wildlife Ecology and Management, and the University of Development Studies (UDS) in Tamale, which is the closest institution to Mole National Park. Furthermore, we communicated and collaborated with several local NGOs working on conservation.

Project activities and results have been communicated through several presentations and discussion groups. Most significantly, we organized Ghana's first national meeting on carnivore conservation and management, which was held at Shai Hills Resort on January 22nd, 2009 (Figs. 5, 6). This meeting had 45 participants, including representatives from the Wildlife Division's head office (including the Executive Director) and all of their wildlife protected areas, as well as other representatives from the Forestry Commission, three local NGOs and two of Ghana's universities. Project leader C. Burton gave a presentation covering general issues in carnivore conservation, knowledge of carnivores in Ghana, and specific results of the Carnivore Project. After the presentation, collaborators M. Sam and D. Kpelle led a discussion on management implications and potential responses. The culmination of the discussion was the formation of a five-member national carnivore management committee, chaired by M. Sam, with the goal of creating a national action plan for the conservation of lions and other carnivores in Ghana. C. Burton subsequently prepared and distributed a background document on Carnivore Conservation in Ghana to assist the committee's activities.



Figure 5. Participants in Ghana’s first national meeting on carnivore conservation, held at Shai Hills Resort in January 2009 (Photo: C. Burton).



Figure 6. Project leader C. Burton giving a presentation at the national meeting on carnivore conservation (Photo: H. Hubertz).

Aside from the national carnivore meeting, presentations on carnivore conservation have been given within Ghana to MNP senior staff, members of an international World Bank-sponsored Northern Savanna Biodiversity Conservation Project team, a senior undergraduate class in resource management from the University of Development Studies, and at the 1st Regional Meeting of the Africa Section of the Society for Conservation Biology (held in Accra in January 2009). We have also distributed summary reports, camera-trap photographs, and educational posters in order to raise awareness and increase the impact of project activities. For example, we made available a database of wildlife photos from the camera traps for use by the MNP Tourism Unit, and we created and printed photo posters that are now prominently displayed in the Executive Director's office at the Wildlife Division's headquarters. Our project also spearheaded and partially funded entry and organization of important wildlife monitoring data in Mole National Park that otherwise was at risk of being lost.

Through involving several students and field staff in the project activities, we provided hands-on technical training in carnivore survey methodology and data management. We organized several workshops to train GWD field staff and other Ghanaian biologists and students in the use of camera traps (Fig. 7), and we have shared our protocol and experience with other NGOs and researchers beginning to use this methodology within the country. We have also provided technical assistance with database organization, GIS, and statistical analysis, as well as academic advice to local students.

The Carnivore Project also built local conservation capacity by assisting in the procurement of locally scarce technical resources and funding. We helped GWD managers prepare proposals that were successful in raising funds to support conservation activities, including further work on lion conservation in MNP (through the IUCN-Netherlands Ecosystems Grant Programme) and the acquisition of much-needed field equipment (e.g. binoculars, GPS units, camera traps, wildlife field guides). We also facilitated access to technical resources such as scientific publications, survey methodology manuals, field guides, statistical software, and field equipment.



Figure 7. Participants in a project workshop on camera trapping methods at Mole National Park (photo: R. Dave).

E. Surveys in other protected areas

Mole National Park was the main focus of project activities due to its status as Ghana's largest savanna park and the expectation that it harbored the country's largest remaining populations of lions and other large carnivores. Nevertheless, a thorough investigation of carnivore conservation in Ghana needs to consider the potential of other protected areas and unprotected habitats. Based on local knowledge and expert opinion (e.g. 2005 Range Wide Priority Setting Workshop for African Lions in Western & Central Africa), other savanna areas of potential importance include Gbele Resource Reserve, Bui National Park, and Digya National Park (Fig. 8). Furthermore, Ghana's forest parks, such as Ankasa Conservation Area, have not been surveyed for carnivores yet may provide important habitat for species like leopard and golden cat. In this section I briefly summarize some survey results and local information relevant to these other areas in Ghana. (Unfortunately, we have not yet received responses to a short questionnaire on carnivore populations that was circulated to all GWD protected area managers prior to the national carnivore conservation meeting in January 2009.)

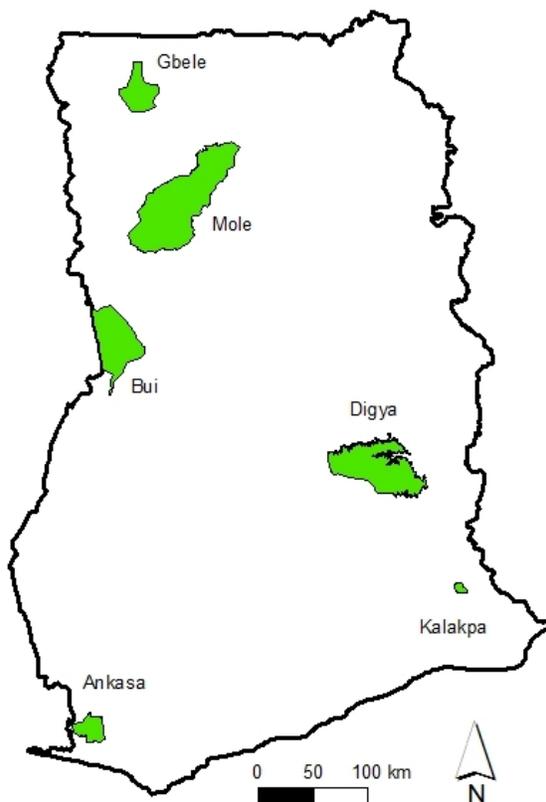


Figure 8. Location of protected areas in Ghana for which further details are discussed in the text.

Gbele Resource Reserve

We initiated preliminary field surveys and capacity building in Gbele Resource Reserve. In April 2008, project staff conducted a training workshop on the use of camera traps for 22 field staff and 3 senior officers at Gbele. A foot survey for carnivore spoor was undertaken, and 10 camera stations were established on 17 April at sites with evidence of wildlife activity within a southeastern portion of the reserve. The stations were active for one month (to 23 May 2008) and one camera was stolen before

retrieval. Capture rates were very low, with only three of the stations capturing any wildlife photos, and no carnivores were detected (species detected were bushbuck, waterbuck, kob, warthog and olive baboon). Although this was only a limited survey, the results reflect evidence from our other sources of information (i.e. informal staff interviews, unpublished consultant reports) that Gbele currently contains a very limited abundance of large mammal species, and is unlikely to support a viable population of lions or other large carnivores (though further survey work is needed to confirm this). This view was also reinforced by a focus group discussion held in April 2008 in the village of Wellembele near the eastern edge of Gbele reserve, wherein participants named lion and leopard as species which no longer occurred in the area.

We assisted the GWD Regional Manager (M. Komoah; Northern, Upper East and Upper West regions) and Gbele Reserve Manager (M. Anongura) in obtaining camera traps and other field equipment through the award of funds from the Northern Savannah Biodiversity Conservation Project. Their stated intention was to conduct more thorough camera trap surveys throughout the reserve, and we offered to provide technical support and field assistance. Unfortunately, it seems that the GWD efforts in Gbele have been delayed for various reasons and it is uncertain if more surveys have yet been implemented.

Bui National Park and Nyankamba-Boachiye area

The Government of Ghana has decided to construct a large hydroelectric dam on the Black Volta river that will create an extensive (440 km²) reservoir within Bui National Park, thereby flooding 21% of the total area of park habitat (including grassland, savanna woodland, and riverine gallery forest). We proposed to GWD to conduct an initial camera trap survey of Bui NP, prioritizing the area designated to be flooded. Furthermore, project member D. Kpelle prepared a detailed proposal to conduct more thorough ecological and socioeconomic surveys in Bui and adjacent areas between Bui and Mole NP to the northeast. These intervening lands (e.g. Nyankamba-Boachiye area) have been identified as potentially important habitat for wildlife (including large carnivores), particularly in terms of providing connectivity between the two national parks (which might be increasingly important as animals are displaced from Bui when habitat is flooded). Unfortunately, our proposals were not approved during the period of project activity, apparently due to the initiation of dam construction and a lack of available funds to support GWD involvement. We still deem a large carnivore survey in Bui NP to be a priority, particularly considering that hyena tracks and a leopard vocalization were noted during bird surveys conducted by F. Dowsett-Lemaire and R. Dowsett in March 2005.

A local conservation NGO (Nature Conservation Research Centre, NCRC) has initiated wildlife surveys in the Nyankamba-Boachiye area between Bui and Mole national parks, and we have provided NCRC staff with training and technical assistance for the deployment of camera traps. Their team has detected leopard tracks and there have also been anecdotal reports of lion observations from the area, but to date no photos of any larger carnivores have been captured.

Digya National Park

It has not been feasible for us to initiate surveys in Digya National Park to date due to budget and logistical constraints. We have held discussions with the park manager (B. Asamoah-Boateng) and with Ghanaian researchers who have recently completed elephant surveys throughout much of the park (B. Kumordzi and colleagues), and they report that they have not observed any evidence of larger carnivores in the park. However, at the national carnivore meeting in January 2009, the Digya park manager stated that one of his patrol teams had recently (October 2008) reported a lion sighting. He

said it was the first credible report of a lion that he had received during his nine years as Digya manager, and that it was currently under further investigation. Unfortunately the information was not relayed to Carnivore Project team members in time for us to provide technical assistance or initiate our own camera trap survey, but both should be considered in future efforts.

Ankasa Conservation Area

We continued our previous efforts to detect leopards, golden cats, and other forest wildlife in Ankasa Conservation Area (ACA) in southwestern Ghana. Surveys in this protected area have been motivated and facilitated by efforts of the Wildlife Division (in particular our collaborator Moses Sam) to prioritize wildlife surveys there as part of their ongoing Protected Areas Development Program (PADP 2).

A total of 42 camera stations have been deployed in ACA and are being compared with foot transects conducted by E. Danquah and team as part of a PADP 2 mammal survey. Databases of wildlife sightings and signs of illegal activity made during anti-poaching patrols from 1988-2008 have also been created, and semi-structured interviews have been conducted with 16 key informants from eight villages around the park and with four experienced patrol staff.

Results of the ACA surveys have not yet been analyzed in detail, but thirteen mammal species have been captured by the camera traps, including bongo (*Tragelaphus euryceros*) and three smaller carnivores: African civet, marsh mongoose, and large-spotted genet. Only three sets of leopard tracks were observed and no sign of golden cat has been detected. There are also very few leopard and no golden cat observations included in the patrol monitoring dataset, but there are five records of honey badger and several of the more common smaller carnivores. Only three of the 16 villager respondents reported ever having seen a leopard, and only one of those said he had seen a golden cat, and none of the sightings had occurred within the past 10 years.

F. Additional considerations regarding the status of lions in Ghana

Improving knowledge of the status of lions in Ghana was a primary objective of this project. Most of the emphasis was focused on Mole National Park, which was thought to harbor the largest and perhaps only remaining viable population of lions in the country (Chardonnet 2002, Bauer & Der Merwe 2004). It is thus disconcerting that our results indicate that this population has declined significantly over recent decades and is now facing an imminent threat of local extinction (if indeed it persists at all). No unambiguous detections of lions were made during our extensive field surveys in the park, very few lion observations were recorded by the MNP patrol monitoring system (with the last reported sighting in April 2007, although we note a new but yet unverified sighting from May 2009), and interviews with local villagers indicate that any interactions with lions have become increasingly rare. It is thus important to broadly consider the prospects for lion persistence in Ghana in light of potential limitations of the surveys in MNP and any information available for other areas.

Mole National Park

Firstly, it is important to recognize that our field surveys were not exhaustive in their spatial or temporal scope. We focused our sampling on areas in the center and southeast of the park (Fig. 1) that were known to contain the highest concentrations of ungulate prey (based on previous aerial surveys) and were expected to be most insulated from the effects of hunting and habitat degradation emanating

from surrounding villages. Access difficulties meant that many areas of the park were sampled lightly or not at all, and that wet season sampling was particularly limited. It is thus possible that any existing lions had a low probability of being detected in our surveys because they occupied these poorly sampled areas and/or moved more extensively in the wet season. However, we consider these scenarios to be unlikely given that: i) evidence from our surveys and the anti-poaching patrol records support the notion that prey (and other carnivore) densities are lower and human impacts higher in the peripheral and northern portions of the park, ii) lions would be expected to visit the important dry-season water sources that we sampled, and iii) the large home ranges and more conspicuous behavior typical of lions should have translated into relatively high detectability. We can think of no compelling reason other than scarcity for the detectability of lions to be so much lower than that for spotted hyenas or leopards. Nevertheless, continued and expanded surveys should be considered before concluding that lions have been extirpated from MNP.

Given that lions have declined to the point of potential (and functional) extinction within MNP, it is important to consider what intrinsic and extrinsic factors may have contributed to the decline. Factors identified for other lion populations (e.g. Bauer et al 2003, Ray et al 2005) include habitat degradation and isolation, prey depletion, direct persecution, interspecific competition, disease, inbreeding and other deleterious effects associated with small population size.

The savanna woodland habitat within MNP appears to be relatively intact, and thus habitat degradation in the park was not likely a contributing factor, although the effects of frequent and extensive dry-season burning are poorly known. Conversely, habitat surrounding the park is variably altered or degraded by human settlement, farming and livestock grazing, and this has undoubtedly resulted in the increasing isolation of park habitat and the incursion of edge effects, which, in turn, would constrain the effective size of the lion population. Detailed data on home range size is lacking for lions in West Africa, but a conservative estimate of non-overlapping 400 km² territories would suggest that MNP should be large enough to support at least 10 prides, so park size alone should not be the limiting factor.

Prey availability is obviously a critical determinant of lion persistence, and the evidence of long-term hunting of ungulates within MNP (e.g., from anti-poaching patrol records) suggests that prey populations could have been driven below a threshold required to sustain a viable lion population. On the other hand, results from our surveys and the patrol records suggest that several large ungulate species remain relatively abundant in many parts of the park, and indeed appear to be sufficient to support a population of spotted hyenas (although its long term viability is uncertain). We are currently trying to use the best available data on MNP's prey populations to estimate prey biomass and the associated "carrying capacity" of the park for lions in order to gain further insight into the potential contribution of prey depletion to the lion's demise. Further insight may come from careful analysis of spatial and temporal trends in the patrol counts of lions and prey.

Direct killing of lions has been documented in and around MNP and has certainly represented an important threat to the population. As noted above, official incident reports on file in MNP document that conflict with local villagers led to the death of one lion and the injury (and probable death) of another in 2004 (Fig. 3). Our village interviews and market surveys suggest that lions may be directly targeted by hunters since their body parts (e.g. skin, claws, organs, meat) are valued for traditional ceremonial, medicinal and nutritional purposes. The interviews also indicate that conflict over livestock depredation has occasionally led to the retaliatory killing of lions. Death or injury to lions has also likely resulted from the widespread use of "gin" (leg-hold) traps on farms adjacent to the park boundary and

within the park. The potential impact of poisoning by Fulani cattle herdsman, as has been noted elsewhere in the region, requires further investigation around MNP.

Other factors which may have contributed to the lion population decline, but for which we don't currently have sufficient evidence, include interspecific conflict, disease, and Allee effects. Spotted hyenas are known to compete fiercely with lions, and the fact that hyenas were detected relatively frequently in our field surveys implies that competition could have adversely affected a small population of lions, however more investigation is needed to rigorously assess this hypothesis. Disease has caused significant mortality in lion populations elsewhere in Africa (e.g. canine distemper virus in the Serengeti), and can be transferred from populations of domestic animals surrounding the park. We consider it plausible that disease played a role in MNP's lion decline, but we are not aware of any data on disease risk in lions or other wildlife in Ghana, so further research is needed to assess this threat. Finally, a small and isolated population of lions could be subject to various problems related to small population size, including inbreeding depression, demographic stochasticity, and reduced predation efficiency. Given that MNP's lion population has likely been small for at least several decades (i.e. less than 100 individuals), it is expected that such factors could have had a detrimental effect; however, we lack the data necessary to assess the extent of this effect.

Other areas in Ghana

The potential causes of lion population decline discussed above for Mole National Park are also relevant for other areas of Ghana. As noted above, Mole was expected to harbor the largest—and perhaps only—remaining population of lions in the country based on its relatively large size and prey populations, low surrounding human density, and previous records of lion sightings. Little evidence is available from elsewhere in Ghana, and we did not conduct detailed field surveys in any other protected areas. Nevertheless, we have collated information from interviews, reports, and monitoring records from GWD staff and other researchers, which we summarize here. In general, the picture is not very promising for the persistence of viable lion populations in the country, but there are several areas deserving of further survey and monitoring.

An unexpected instance of human-lion conflict was reported in February 2009 near the small (320 km²) Kalakpa Resource Reserve in southeastern Ghana, close to the Togo border (Fig. 8). This seemingly reliable evidence came as a surprise as lions were not known to currently occur in this area and it was not included among the areas identified by the 2005 Range Wide Priority Setting Workshop for African Lions in Western & Central Africa. A report was made to the Kalakpa management about a local hunter attacked by a lion outside the reserve, and upon investigation the GWD staff and Carnivore Project team member D. Kpelle observed signs of the lion and took photographs and measurements of tracks (Fig. 9) There was evidence that the hunter had shot at and likely hit the lion with a low quality shotgun, but the lion had since fled the area. Subsequent reports from hunters and park staff indicated that the lion had entered the reserve. Other reports from nearby villages suggested that six lions had been sighted and that two cows had been killed. GWD officials alerted local communities to the presence of a lion (via village visits and a radio broadcast with the Ghana Broadcasting Corporation) and discouraged any attempts at retaliatory killing. Our Carnivore team offered technical assistance and proposed a follow-up tracking and camera trap survey of the area. Unfortunately, we were not granted permission to survey and have not received further information despite several inquiries, thus the current status of the Kalakpa lion situation is unknown. The reliability of the evidence for more than one lion is uncertain, and we do not know whether this occurrence represents a small resident population or rather one or more transients dispersing from other populations (possibly from Kyabobo

national park or the adjacent Fazao-Malfakassa park in Togo, or perhaps from Digya National Park around Lake Volta?).



Figure 9. Photograph of an apparent lion print near Kalakpa Resource Reserve. Measurements taken on one of the front prints by GWD field staff were reported as 165mm long and 78mm wide. (Photo provided by D. Kpelle and Ghana Wildlife Division)

Very little reliable evidence on lions emerged from the national carnivore conservation meeting held in January 2009. A brief questionnaire on the status of lions and other carnivores was circulated to all of Ghana's protected area managers prior to the meeting, but unfortunately none were completed. During the meeting, all participants were asked about their knowledge of lions in Ghana, and the general consensus was that Mole was the only park to contain a population. Anecdotes of lion sightings from two other areas were conveyed, one from Digya National Park (as noted above) and the other from the Boachipe area south of Mole, but the reliability of these reports is uncertain.

Mammal observations made during anti-poaching patrols conducted between 1969 and 2003 in six savanna parks have been collated from GWD records by project collaborator J.S. Brashares. Excluding Mole National Park (covered in detail by this study) and Shai Hills reserve (for which no lion observations were recorded), the last lion sighting for each park within this dataset is as follows: 1979 for Kalakpa Resource Reserve, 1983 for Gbele Resource Reserve, 1993 for Bui National Park, and 1995 for Digya National Park. It is important to note that these data do not come from a systematic survey effort targeting lions. Furthermore, indirect evidence of potential lion presence (e.g. tracks) has been noted up to at least 1998 in all four parks, but the reliability of this evidence has not been ascertained and it must be treated with caution (based on our observations of tracks being frequently misidentified in Mole NP). In general, these data support the other lines of evidence in suggesting that lions have become very rare or locally extinct within Ghana's protected areas.

Other potential sources of information on the status of lions that we were able to obtain and review included recent GWD protected area management plans and several unpublished consultant reports on

wildlife surveys. The only management plans that mention the presence of lion are those for Mole (2005) and Gbele (2006 draft), with the latter giving no specific detail other than to include lion on a checklist of mammal species purported to occur within the reserve. The species is listed as “locally extinct” in the plan for Kyabobo National Park (2005) and is not mentioned at all for Shai Hills (2006), Kogyae (1994) or Digya (1995). No management plan was found for Bui National Park, but an Environmental Impact Assessment for the proposed hydroelectric dam (Environmental Resources Management 2007) referred to interviews that were conducted in 2001-2002 in which local hunters indicated that lions had been observed “within the last five years” (i.e. ~1996).

Ornithological surveys were recently completed in all of Ghana’s protected areas as part of the Wildlife Division Support Project (WDSP), and the report authors (F. Dowsett-Lemaire & R.J. Dowsett, 2005) also included summaries of their observations of larger mammals. Based on their discussions with GWD field staff (but not on any direct evidence), they suggest that there have been recent reports of lions in Digya and Bui national parks. As part of the Northern Savanna Biodiversity Conservation Project (NSBCP), P. Bouche conducted an aerial survey of Gbele Resource Reserve and coordinated ground transects of potential wildlife corridor areas in northern Ghana during June 2006. No lions or other carnivores were observed during the Gbele survey (and only a few signs of jackal occurrence were recorded in the corridor surveys), but Bouche’s report noted anecdotal evidence from GWD staff of a lion observation along the Kulpawn river 3 km south of Gbele (presumably in 2006) and another from within Gbele in 1998. Another brief wildlife survey conducted in Gbele by C. Lungren during April-May 2007 (also under the auspices of the NSBCP) did not record any evidence of lions or other carnivores during reconnaissance walks covering a substantial portion of the reserve.

In summary, the available evidence suggests that lions are now very rare or perhaps already extirpated from all of Ghana’s protected areas. Even areas identified as “known” or “probable” lion range during the 2005 Priority Setting Workshop in Douala may no longer have lions, or at least not populations large enough to be viable over the long-term. The implication is that immediate management attention is needed to more effectively document and protect any remaining lions in Ghana, and that the longer-term management focus needs to shift towards restoration of the country’s lions, perhaps including careful reintroduction (or augmentation) of populations in areas like Mole if the key threats can be diagnosed and treated.

PROBLEMS AND CONSTRAINTS

Some of the challenges and constraints to project activities have been noted above and in previous reports, and thus do not need to be belabored here. The challenges to surveying for rare and elusive species are well known, and difficult logistical conditions are common to many field projects. Access proved to be a significant challenge to effective sampling in the remote areas of Mole National Park, typified by a lack of roads and infrastructure, extensive flooding in the wet season, and excessive heat, fire, and water shortage during the dry season. We were also plagued by vehicle problems that led to lost time and funds, and camera theft and malfunction were a frequent source of frustration. While we made great strides in building local awareness of carnivore conservation and capacity in survey methodology, effective carnivore management in Ghana will require a concentrated and sustained effort in both areas. Lions and other carnivores have not been a priority for wildlife managers, students, and NGOs, and thus their ecological importance and conservation predicament appear to be underappreciated, and relevant technical skills in field methods and data management are still being acquired. There also remains a persistent perception of carnivores as competitors for bushmeat or threats to local livelihoods among many staff and residents in and around protected areas. Finally, there

have been relatively few extended, field-based wildlife research and conservation projects in Ghana, particularly in the savanna areas, and the country's Wildlife Division is generally poorly funded and lacking political support. An increase in support for managing wildlife and protected areas—both in general and specific to research and monitoring—would most likely translate into greater effectiveness of individual conservation research projects.

FUTURE GOALS/ACTIVITIES

Our short-term project priorities are focused on detailed analysis of existing data and preparation of manuscripts for publication in peer-reviewed scientific journals. As the project results are disseminated we will also be seeking further funding to continue our field-based efforts in carnivore conservation and research in Ghana and its neighboring countries. Building on project accomplishments thus far, our objectives for future field work include:

- Continued monitoring of the carnivore populations documented in Mole National Park, including more detailed investigation of the conservation ecology of focal species (e.g. leopard, spotted hyena, caracal and side-striped jackal), possibly including scat analysis and the use of radio- and/or satellite-collars.
- Further surveys for lions and other carnivores, prioritizing the following areas: the unsampled northern portions of MNP and along the Kulpawn river; Digya and Bui national parks and the potential corridor linking Bui and Mole; the areas in around Kalakpa Resource Reserve.
- Collaborating on carnivore surveys in nearby protected areas, such as Comoe National Park in Cote d'Ivoire, and on potential transboundary corridor areas.
- Developing and testing habitat suitability and connectivity models for regional carnivore populations.
- Conducting more detailed assessments of human-carnivore conflict and the conservation potential of Community Resource Management Areas (CREMAs) around MNP and other protected areas.
- Instituting a program to promote further involvement of Ghanaian undergraduate and graduate students in the study of carnivore ecology and conservation.

CONSERVATION ACCOMPLISHMENTS & EVALUATION

While much more remains to be done, the Ghana Carnivore Project has achieved significant conservation outcomes. At the outset, very little was known about the current condition of carnivore populations in Mole National Park or across most of Ghana. Our surveys have highlighted the dire status of lions in the country and we hope that the results are helping to focus more attention on the pressing need for lion conservation in West Africa. We have provided valuable information on regionally significant populations of leopard, spotted hyena, caracal and side-striped jackal in MNP, and have documented the potential loss of other members of the park's carnivore community. Our results have generated considerable awareness and interest among wildlife managers and conservation practitioners in Ghana, and our efforts helped train several students and protected area staff. In particular, our project introduced camera trap methodology to a wide range of managers, researchers and students. Through the organization of Ghana's first national meeting on carnivore conservation (and the related presentation and background document), we provided a much needed forum for discussion of management actions required to protect and restore the country's carnivores. The formation of a national carnivore management committee and the awarding of a grant to GWD to support further lion conservation work around Mole NP are two examples of significant developments facilitated by the project. Our activities have also led to improvements in wildlife monitoring in MNP

and other protected areas, and have provided support for WD efforts in law enforcement and community outreach. Despite such significant accomplishments, more profound and lasting conservation outcomes will only stem from sustained and expanded efforts on the ground.

LIST OF PUBLICATIONS & PRESENTATIONS:

We are currently preparing manuscripts describing project results for submission to peer-reviewed scientific journals. Aside from the previous progress reports prepared for the Kaplan Award Program, the following project-related reports and presentations have been made (copies and/or details on each are available from C. Burton):

- Burton, C. 2009. *Carnivore community dynamics in an impacted West African protected area*. Paper presented at the 3rd Graduate Research Symposium in Environmental Science, Policy & Management, 24 April 2009, University of California, Berkeley.
- Burton, C. 2009. *The status and conservation of carnivores in Mole National Park, Ghana*. Paper presented at the 10th Student Conference on Conservation Science, 25 March 2009, Cambridge University, UK.
- Burton, C. 2009. *Carnivore Conservation in Ghana*. Background document for the Ghana Carnivore Management Committee, 9 February 2009. 7 pp.
- Burton, C., E.B. Buedi, C. Balangtaa, D.G. Kpelle, M.K. Sam and J.S. Brashares. *The status and conservation of carnivores in Mole National Park, Ghana*. Paper presented at the 1st Regional Meeting of the Africa Section of the Society for Conservation Biology, 29 January 2009, Accra, Ghana.
- Burton, C. *Carnivore Conservation and Management in Ghana*. Presentation given at the national meeting on carnivore conservation and management, 22 January 2009, Shai Hills Reserve Resort, Ghana.
- Burton C. 2007. *Assessing the conservation status of lions and other large carnivores in Ghana, West Africa*. Invited presentation to the Golden Gate Chapter of Safari Club International, 17 October 2007, Pleasant Hill, California.
- Burton, C., C. Balangtaa, M. Sam and J. Brashares. 2007. *Conservation status of felids in Mole National Park, Ghana*. Poster presented at the Felid Biology & Conservation Conference, 17-20 September 2007, University of Oxford, UK.
- Burton, C., C. Balangtaa, M. Sam and J. Brashares. 2007. *Tracking Ghana's ghosts: a camera-trap survey of carnivores in Mole National Park*. Poster presented at the 21st Annual Meeting of the Society for Conservation Biology, July 2007, Port Elizabeth, South Africa.
- Burton, C. 2007. *Carnivores, camera traps and conservation in Ghana*. Presentation given in the Wildlife & Conservation Biology Seminar Series, 19 January 2007, University of California, Berkeley.
- Burton, C. 2007. *Mole Carnivore Project: a collaborative effort to study and protect Mole's larger carnivores*. Presentation given to the University of Development Studies (Tamale) student field trip, Mole National Park, March 2007.
- Burton, C. 2006. *Carnivore conservation and "camera traps" in Mole National Park*. Presentation given to the Northern Savannah Biodiversity Conservation Project team at Mole National Park, 3 December 2006.

In addition, public attention was called to the potential ecological and social consequences of population declines in Ghana's carnivores and other wildlife through an episode ("Dangerous Catch") of the National Geographic/PBS series "Strange Days on Planet Earth" that aired on April 23, 2008. Members of the Carnivore Project team participated in and contributed to this documentary.