Elephant population trends and associated factors: a review of the situation in western Ghana

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Abstract

The Ankasa and Bia Conservation Areas and the Goaso Forest Block form a significant portion of forest elephant range in western Ghana. This paper reviews historical and recent information on elephant population trends in western Ghana and the factors associated with these trends. We used two methods: 1) monitoring trends in elephant populations using density estimates, and 2) tracking changes in elephant distribution and density due to poaching activity. Our results indicate that most elephant populations have declined in western Ghana, although a few seem to have persisted. Specifically, we recorded positive trends in two protected areas, Ankasa and Bia, where elephants seem to be recovering under good management practices, such as reduced hunting pressure and habitat management. The Goaso elephant populations have suffered major declines in both numbers and range. Currently, elephant range is confined to only a few of the reserves in the northern Goaso Forest Block. These declines were probably as a consequence of accelerated immigration of farmers into Ghana's western region in the 1990s, resulting in increased hunting activity and habitat loss due to unregulated timber extraction and agriculture. We also show that effective elephant range is negatively affected by poaching activity, and that elephants currently do not move across the Ghana–Cote d'Ivoire boundary.

Additional key words: Ankasa, Bia, Goaso Forest, poaching activity, elephant conservation

Résumé

Les aires de conservation d'Ankasa et de Bia et le bloc forestier de Goaso constituent une partie importante de l'habitat des éléphants de forêt dans l'ouest du Ghana. Ici, nous passons en revue les données historiques et récentes sur les tendances des populations d'éléphants dans l'ouest du Ghana et les facteurs y associés. Nous avons utilisé deux méthodes 1) le suivi des tendances des populations d'éléphants en utilisant les estimations de densité et 2) le suivi des changements concernant la distribution et la densité des éléphants par rapport au braconnage. Nos résultats indiquent que la plupart des populations d'éléphants ont diminué dans l'ouest du Ghana, bien que quelques-unes semblent avoir persisté. Plus précisément, nous avons constaté des tendances positives dans deux aires protégées, Ankasa et Bia, où les éléphants semblent se rétablir grâce aux bonnes pratiques de gestion (par exemple, une pression de chasse réduite et une gestion de l'habitat). D'autre part, les populations d'éléphants de Goaso ont subi des baisses importantes en nombre et en habitat. À l'heure actuelle, l'habitat des éléphants se limite à seulement certaines réserves dans le bloc forestier nord de Goaso. Ces baisses étaient probablement une conséquence de l'immigration accélérée des agriculteurs dans la région ouest du Ghana dans les années 1990 donnant lieu à une activité de chasse accrue et une perte de l'habitat due à l'exploitation du bois non réglementée et à l'agriculture. Nous montrons également que l'habitat des éléphants est négativement affecté par le braconnage et qu'actuellement les éléphants ne traversent pas la frontière entre le Ghana et la Côte d'Ivoire.

Mots clés supplémentaires : Ankasa, Bia, la forêt de Goaso, le braconnage, la conservation des éléphants

Introduction

The high forest zone of western Ghana is affected by intensive and varied human influences that have widespread and sometimes devastating effects on elephants (Danquah et al. 2007, 2009a,b). These influences include agricultural intensification, urbanization, water abstraction, land drainage and development. Such intensive land-use changes mean that elephants experience rapid changes in the extent, quality and fragmentation of their habitat, all of which affect their distribution and population size. Data on changes in the distribution and abundance of elephants over time and the factors that affect them are therefore required for a number of reasons, including setting management priorities, measuring the effects of management, managing populations of problem elephants, assessing the effects of agriculture and other human activity, and providing evidence for the need for policy change (Battersby and Greenwood 2004). We thus provide an update on the distribution of elephants in the Bia–Goaso Forest Block, review historical and recent information on elephant population trends in western Ghana, and track changes in elephant distribution and abundance with poaching activity. We hope that this review will generate broader discussion and help conservationists to identify the most appropriate and effective approaches to managing elephants under varying conditions.

Study area

The study area is located in the high forest zone in western Ghana and comprises two wildlife reserves—the Ankasa and the Bia Conservation Areas (CAs)—and an extensive network of nine forest reserves and three shelterbelts referred to as the Goaso CA Forest Block (FB). The area extends from latitudes 6′15º to 7′20ºN and longitudes 2′24º to 3′16ºW, south of Sunyani to the west of the Tano River and to the Ghana–Cote d'Ivoire border (Figure 1).

The Ankasa CA (referred to simply as 'Ankasa') comprises the Ankasa Resource Reserve (RR) and the Nini-Suhien National Park (NP). These two adjacent forested areas cover 509 km^2. The Bia CA (referred to simply as 'Bia') comprises Bia FB in the north and the adjacent Bia RR in the south, forming a block of 306 km^2. The Goaso FB (referred to simply as 'Goaso') forms an extensive area of some 5,000 km^2.

The natural land cover of the western region corresponds to the Guinea-Congolian forest vegetation area (Hall and Swaine 1981; Hawthorne and Musah 1993). At Goaso in the north, the vegetation is both moist and dry semi-deciduous; more southwards at Ankasa, the vegetation changes to the wet evergreen type (Hall and Swaine 1981). This matches with Taylor's (1960) *Celtis zenkeri–Triplochiton scleroxylon* association. Key commercial species of these forests are *T. scleroxylon, Entandrophragma utile* and *E. cylindricum,* with the climbing palms *Ancistrophyllum secundiflorum* and *Calamus deerratus* being characteristic of swampy areas. The mean elevation is 200–550 m, with generally undulating topography. Mean annual rainfall is 680–1450 mm/

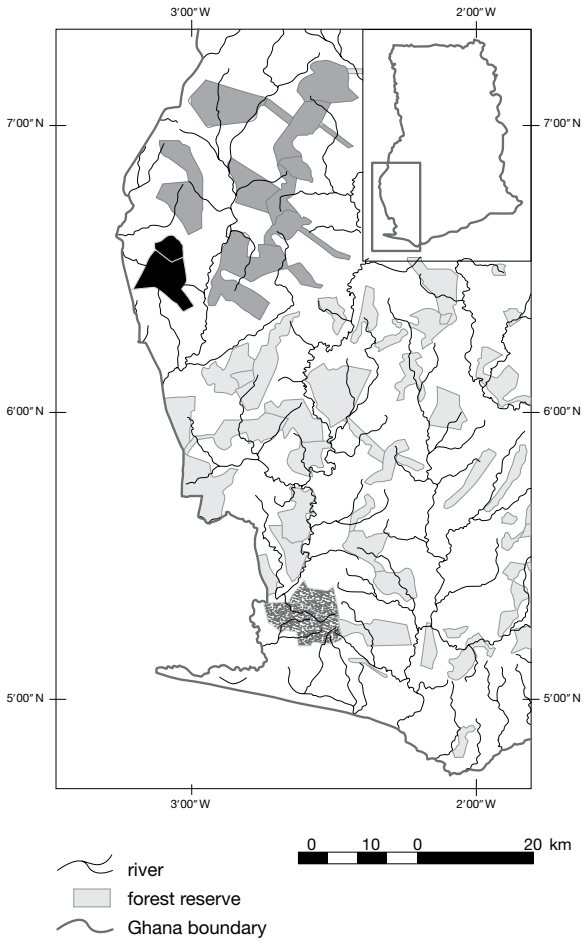

Figure 1. Western Ghana showing the location of Ankasa (dotted), Bia (black) and the Goaso Forest Block (dark grey). Inset: location of the study area in Ghana.

year characterized by a bimodal wet season from March to July and September to November, and a major dry season from December to February. High species richness and levels of endemism characterize the area (PADP 2000, 2001).

Methods

Review of elephant population trends and poaching activity

We reviewed publications—organizational documents and reports, journal articles and books—from the field of conservation as part of our overall synthesis of secondary data. We concentrated primarily on elephant research related to the study areas. In addition, we interviewed key informants from different conservation institutions to identify and obtain recommendations on key publications to review.

We analysed the literature to identify key trends in elephant densities, distribution patterns and poaching activity in the three focal areas over the years. Subsequently, we concentrated on elephant research that incorporated a combination of elephant abundance and poaching activity data. Elephant distribution in Ankasa, Bia and Goaso for specific survey periods was described using a geographic information system (GIS, ArcGIS version 9.2, ESRI Inc.). Elephant distribution was defined as land cover actively used and occupied by elephants, and this was scored using a grid overlay with a resolution of 0.25 km^2. This grid overlay was expressed as a percentage of each elephant range and was termed the effective elephant range (EER) of each of these areas. EER was then regressed against poaching activity within each site for different survey periods.

We operated under the implicit assumption that increased management effort in the three focal elephant ranges would often lead to decreased poaching activity and therefore improved trends in elephant abundance patterns.

Update on elephant distribution and poaching activity

The Bia–Goaso FB is about 100 km x 100 km. We laid a grid of cells each 10 km x 10 km over a map of the area, resulting in 100 cells. Of these cells, we systematically selected 43% and recorded data on elephant presence and absence from them. Teams spent four survey days in each cell following paths and trails on predetermined compass bearings and recording elephant signs (dung, footprints and feeding signs) and poaching activity, estimated as poaching indices (presence of spent cartridges, wire snares, poacher camps, etc.) as and when possible. We calculated distance walked with a global positioning system (GPS). Surveys took place in the wet season months of April–July and dry season months of November–February, from 2008 to 2009.

We noted all areas elephants and poachers used and recorded their coordinates using GPS. We digitized these areas in a geographic information system format (GIS, ArcView Spatial Analyst version 3.1, ESRI Inc.), which then provided an elephant distribution map.

Results

Review of elephant estimates

Bia Conservation Area

In western Ghana, Bia has received the most attention in terms of elephant surveys (Table 1). In a first study based on track identification, Sikes (1975) estimated 52–82 elephants in Bia, giving a density of 0.25 elephants/km^2. Martin (1982) followed with an estimate of between 200 and 250 for the 'Bia Group of Forest Reserves', which was previously 1,500 km^2 and included Bia but is currently totally degraded leaving only Bia intact and with elephants. Based on his elephant densities, he provided an estimate of between 89 and 113 elephants (0.29–0.37 elephants/km^2) for Bia. This compared well with the estimated density of 0.33/km^2 (40 to 135 elephants) presented by Short (1983). Heffernan and Graham (2000) later estimated 137 elephants (0.45 elephants/km^2), which was shortly followed by 127 elephants (0.42 elephants/km^2) provided by Sam (2000).

Later in 2004, Sam et al. (2006) conducted a line transect elephant survey in the Bia-Goaso FB. They used two estimation models (Rainfall and Steady State Assumption) to generate two different estimates for the Bia range. These estimates were merged (Norton-Griffiths 1978) and gave 126 elephants (0.41 elephants/km^2) for Bia. In 2007, Danquah et al. (2009a) conducted a retrospective elephant survey in the same area. Their merged estimate in both the dry and the wet seasons was 135 elephants (0.44/km^2) for Bia. Danquah et al. (2007) again provided two estimates for Bia in 2007 but this time based on the Rainfall and Steady

Table 1. Sequential elephant estimates for elephant ranges in western Ghana,1975–2009

Source	Estimation model	Year	Elephant estimate / range		
			Ankasa	Bia	Goaso
Sikes (1975)		1975		67	
Range				52–82	
Martin (1982)		1982		101	
Range				89–113	
Short (1983)		1983		88	
Range				40–135	
Dickinson (1990)		1990			225
Range					200–250
Heffernan & Graham (2000)		1999		137	
Sam (2000)		2000		127	
Danquah et al. (2001)		2001	21		
Sam et al. (2006)	Rainfall model	2004		115	57
Sam et al. (2006)	Steady State Assumption	2004		146	72
	Merged estimate	2004		126	65
Forestry Commissin, Ghana (FC 2005)		2005	68		
Range		2005	66–70		
Danquah et al. (2009a)	Wet season	2007		133	90
Danquah et al. (2009a)	Dry season	2007		137	83
	Merged estimate	2007		135	87
Danquah et al. (2007)	Rainfall model	2007	41	133	
Danquah et al. (2007)	Steady State Assumption	2007	38	128	
	Merged estimate	2007	40	131	
Danquah et al. (2009b)	Rainfall model	2009	61	139	
Danquah et al. (2009b)	Steady State Assumption	2009	56	133	
	Merged estimate	2009	59	136	

State Assumption models. The merged estimate from the two estimation models was 131 elephants (0.43/km^2). They repeated the survey in 2009 (Danquah et al. 2009b), which resulted in a merged estimate of 136 elephants (0.44/km^2).

Goaso Forest Block

In the Goaso area, pre-1995 densities indicated between 200 and 250 elephants (Dickinson 1990). After over a decade in 2004, Sam et al. (2006) produced a merged estimate (based on the Rainfall and Steady State Assumption models) of 65 elephants (0.09/km^2) for the northern half of Goaso (Mpameso area, 700 km^2). In 2007, Danquah et al. (2009a) also provided a merged estimate (dry and wet seasons) of 87 elephants (0.12/km^2) for the same area. Neither survey recorded any elephant activity in the southern half of Goaso.

Ankasa Conservation Area

Danquah et al. (2001) estimated 21 elephants in the first-ever standard survey of Ankasa. Later in 2005, the Forestry Commission (FC 2005) estimated between 66 and 70 elephants for Ankasa based on wildlife patrol sightings. In 2007, Danquah et al. (2007) provided a merged estimate of 40 elephants (0.08/km^2) based

on two estimation models. They repeated the survey in 2009 (Danquah et al. 2009b), which resulted in a merged estimate of 59 elephants (0.12/km^2).

Elephant population trends

Though there is insufficient historical data on elephants in all three focal study areas to make conclusive decisions, available data suggest an increasing elephant density in Ankasa and Bia while elephant numbers may have declined drastically in Goaso (Figure 2). In both Ankasa and Bia, there seems to be a threshold increase in elephant numbers in 2005, beyond which elephant densities appear to have stabilized.

Review of elephant distribution and poaching activity

Ankasa Conservation Area

In 2001, Danquah et al. (2001) found elephant distribution restricted to the central parts of Ankasa along the Suhien River, which demarcates the Nini-Suhien NP from the Ankasa RR. Effective elephant range (EER) was just about 20% of Ankasa. Although they did not investigate the factors likely to cause this type of clumped distribution, they recorded a lot of poaching activity along the periphery of the park, particularly in the northern and southern sectors of Ankasa, which could have negatively affected elephant distribution. A number of small settlements dotting the park's boundary are a possible source of general human disturbance, including poaching activity. Mean poaching encounter rate was 0.95 activities/km (Danquah et al. 2001).

In 2007, elephant distribution was more widespread from the Suhien River southwards along the Volta River Authority's power line, down to the Nkwanta Camp and towards the Ankasa Camp. EER had improved to 50% of Ankasa and poaching activity had declined to 0.44 activities/km (Danquah et al. 2007). Poaching was again peripheral and concentrated in the northern and southern sectors of Ankasa. By 2009, poaching activity had declined significantly to 0.12 activities/km and elephant range had increased significantly to 71% (Danquah et al. 2009b). There was a significant downward trend (Kruskal-Wallis test: $H = 18.24$, df = 2, $P < 0.01$) in poaching activity in Ankasa for the three successive survey periods and from a wide range of poaching indices (presence of wire snares, spent cartridges, carbide spots and poacher camps) in 2001 to the use of only wire snares for hunting in 2009.

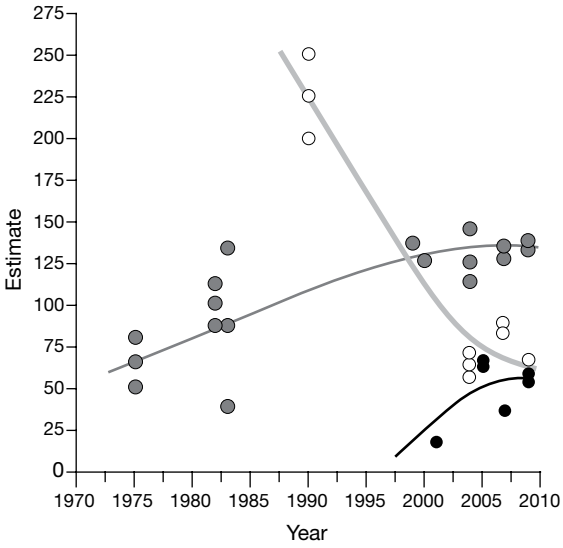

Figure 2. Elephant population trends (1975–2009) for Ankasa (black; $r^2 = 0.601$, $P < 0.01$), Bia (grey; $r^2 = 0.658$, $P < 0.05$) and Goaso (white; $r^2 = 0.651$, $P < 0.01$).

Bia Conservation Area

Elephants were originally found throughout Bia (Martin 1982; Short 1983). However, the creation of secondary vegetation conditions in Bia RR as a result of logging activities in the early 1980s might have initially attracted elephants into the reserve (de Leede 1994; Barnes 1996; Sam 2000; Heffernan and Graham 2000). Further destruction and illegal conversion to cocoa farms of the Sukusuku and Bia Tawya FRs in southern Bia might have skewed elephant distribution further southwards (Martin 1982). Higher poaching activity in the Bia NP compared with the Bia RR (Sam 2000; Sam et al. 2006; Danquah et al. 2007, 2009a) might have contributed to this type of distribution. Incidentally, a greater number of settlements border Bia NP compared with Bia RR. EER in 2004 was 45% of Bia (Sam et al. 2006) while mean poaching activity was at 0.74 activities/km.

Records of elephant activity since 2004 show a gradual spread of elephants back into Bia NP (Danquah et al. 2007, 2009a). By 2007, EER had increased to 58% while poaching activity had stabilized at a mean rate of 0.76 activities/km. By 2009, poaching activity was much reduced and elephant range extended to the

northern limits of the park (Danquah et al. 2009b). Poaching activity had also reduced considerably to 0.26 activities/km and elephant range had increased greatly to 78% of the park (Danquah et al. 2009b). This indicates a significant downward trend (Mann-Whitney U-test: $U = 1{,}634$, $P < 0.05$) in poaching activity in Bia from 2007 to 2009 and from a wide range of poaching indices (snail harvesting, presence of wire snares, spent cartridges, carbide spots and poacher camps) in 2004 to mostly snail harvesting and hunting with wire snares in 2009.

Goaso Forest Block

Originally, the largest forest elephant population in the region was confined to the forests of Goaso. Pre-1995 and early post-1995 densities indicate widespread elephant distribution in the area (Dickinson 1990; de Leede 1994; Parren et al. 2002). By 1999, Wildlife Division staff and farmers reported regular to frequent crop-raiding cases in seven of nine forest reserves (78%) in the Goaso FB and there was regular elephant movement between the reserves (Parren et al. 2002; Parren and Sam 2003).

Surprisingly, by 2003, apart from the northern sectors (Mpameso, Bia Tano, Bia North, Asukese, Bonkoni and Bia Shelterbelt FR) that showed signs of elephant presence, all the other forest reserves in the Goaso area showed virtually none (BP Conservation Awards 2003). There was absolutely no sign of elephant movement between reserves except from Mpameso to Bia Tano through the Bia Shelterbelt. Sam et al. (2006) confirmed this observation in 2004. Apart from the northern reserves, particularly in the Mpameso–Bia Tano area, they recorded no elephant activity in the southern sectors. Estimated EER was 33% of the Goaso area. Poaching activity was higher in the southern sectors (1.52 poaching activities/km) compared with the northern sectors (1.48 poaching activities/km). Mean encounter rate was 1.50/km. Sam et al. (2006) heard three gunshots on a single day while investigating a transect.

In 2007, Danquah et al. (2009a) again observed that elephants were patchily confined to the Mpameso area of the Goaso FB. Poaching activity was higher than in 2004 (encounter rate: northern reserves = 1.73/km, southern reserves = 1.71/km; mean encounter rate: 1.72/km) and EER had decreased to 27% of the Goaso area. Danquah et al. (2009a) heard 12 gunshots in the night during the entire survey.

Update on elephant distribution and poaching activity

Bia Conservation Area

Generally, the highest elephant activity occurred in Bia RR, especially around the mid-portions (Figure 3). Similar to Danquah et al. (2009b), current elephant activities seem to be more widespread compared with earlier studies like Danquah et al. (2007, 2009a) and Sam et al. (2006). Records of elephant activity were made from the southern sections right up to the northern fringes of Bia NP, confirming a more widespread elephant distribution towards the north (Danquah et al. 2009b). Elephant crop-raiding incidents were recorded in farms along the northwestern boundaries of Bia NP

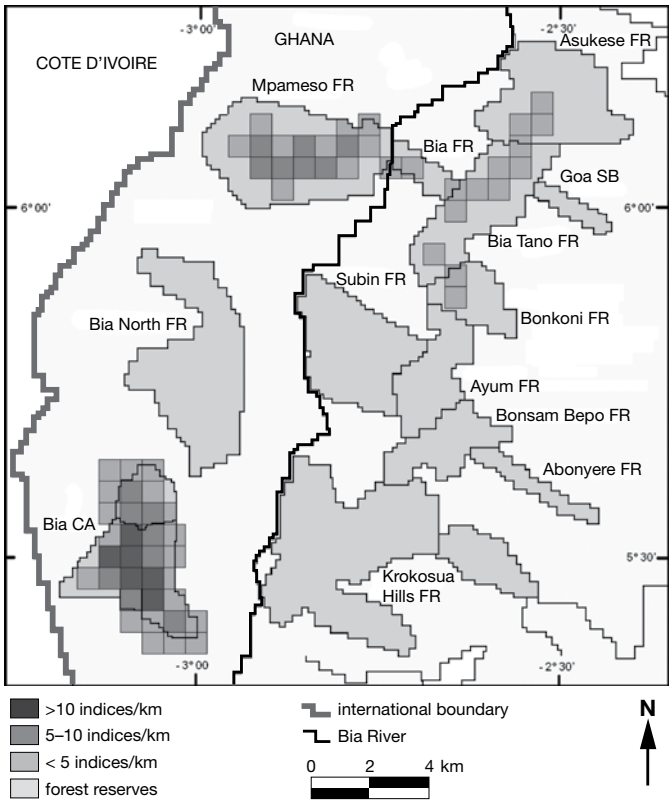

Figure 3. Distribution of elephant signs in the Bia–Goaso Forest Block.

for the first time after a long absence since the early 1980s (de Leede 1994).

Poaching activity in the Bia CA was similar to rates encountered in 2009 (encounter rate: Bia NP = 0.16/km, Bia RR = 0.46/km; mean: 0.31/km) and EER had increased to 89% of Bia compared with the 78% estimated by Danquah et al. (2009b). Poaching activity in the study area consisted mostly of snail harvesting and presence of wire snares (79%). Other poaching indices were presence of spent cartridges (11%), carbide spots (6%) and poacher camps (4%). Current observations suggest that most of the poaching activities are for small game and not targeted at large mammals.

Goaso Forest Block

The current distribution of elephants in Goaso does not differ significantly from the findings of Sam et al. (2006) and Danquah et al. (2009a). Elephant activity was mainly encountered in the northern reserves, especially at Mpameso and adjacent reserves including the Bia Shelterbelt and Bia Tano, Asukese and Bonkoni FRs (Figure 3). The distribution of elephant signs suggests that elephants occasionally migrated from Mpameso into adjacent reserves through the Bia Shelterbelt, possibly in the dry season.

However, poaching activity was slightly lower than in 2007 (encounter rate: northern reserves = 1.42/km, southern reserves = 1.48/km; mean: 1.45/km) and EER had remained stable at 30% of the Goaso area compared with the 27% estimated by Danquah et al. (2009a). Poaching activity in the study area consisted mostly of wire snares (69%). Other poaching indices were presence of empty cartridges (17%), carbide spots (8%) and poacher camps (6%).

Relation between elephant distribution and poaching activity in western Ghana

Generally, poaching activity negatively impacted the effective range elephants used in western Ghana. As poaching activities increased, effective elephant ranges decreased (Figure 4).

Discussion

Elephant population trends

It appears that there has been a general increase in elephant numbers in Ankasa and Bia and that both elephant populations might have more than doubled over the years; elephant numbers in both areas might have stabilized within the last decade. This trend seems more evident in the Bia population. Even so, the number of elephants killed recently in Ankasa and Bia is not certain and may represent a small percentage of the population. There is no other evidence to indicate that these populations are not increasing or, worse, have declined. In terms of size, the Bia elephant population seems a more viable population than does the Ankasa population. However, with sustained wildlife protection, the Ankasa population might also have a good chance of survival in the long term, simply because Ankasa is bigger and elephant range extends into the adjoining Draw River Forest Reserve on the east. Both populations are currently considered as 'pests' in some fringe communities where elephants cause crop damage.

The elephant population trend in Goaso is less favourable than that of Ankasa and Bia. We observed negative trends in elephant numbers in the Goaso population (Table 1, but see also Figure 2). For instance, the average elephant density provided by Dickinson (1990) for the area was 0.10 elephants/km^2. This figure continued to decline progressively and significantly in the 1990s. Now, it rarely exceeds 0.03 elephants/km^2 for the entire Goaso FB, only a third of the level estimated in 1990 (Dickinson 1990).

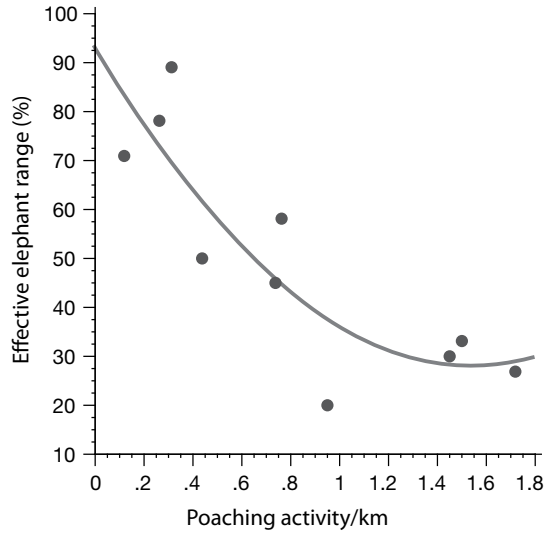

Figure 4. Relationship (r^2 = 0.758, P < 0.05) between poaching activity and effective elephant range for 10 survey periods in western Ghana (four in Bia and three each in Ankasa and Goaso areas).

Though Sam et al. (2006) and Danquah et al. (2009a) estimated 0.09 and 0.12 elephants/km^2 respectively for the northern half (Mpameso area, 953 km^2) of Goaso, neither survey recorded any elephant activity in the entire southern half (1,341 km^2). We interviewed conservation managers and local hunters in the area to gather additional information concerning recent elephant trends. The interview results agreed with the findings obtained during the field surveys: most of the managers and hunters (86%) believed that elephant populations in the Goaso area were still declining. Danquah et al. (2009a) obtained similar results in 2007 for the Bia-Goaso FB, where only the Bia elephant population showed evidence of an increasing trend between 2004 (Sam et al. 2006) and 2007.

Current elephant distribution and movement pattern

Scientists have suggested a large elephant population and a wide elephant range for the Goaso forest complex in western Ghana (Dickinson 1990; Sam 2000; Parren et al. 2002; Blanc et al. 2007). However, we show that elephant range in western Ghana is restricted to Ankasa, Bia and a small number of reserves (Mpameso, Bia Tano, Asukese and Bonkoni FRs) in the northern Goaso FB. In contrast to the high incidence of crop raiding reported by de Leede (1994), we observed that elephant crop-raiding activity in the area has reduced drastically and is currently confined to specific areas in the southern and northwestern boundaries of Bia, and a small portion of Mpameso close to the Bia River. Danquah et al. (2009b) and BP Conservation Awards (2003) also showed that elephant range has drastically reduced from the 14 reserves in which they formally roamed in the Bia–Goaso FB to only 5 reserves.

We found no evidence of elephant movement between the Ankasa, Bia and Goaso elephant populations. However, we observed signs of elephant movement between some reserves in the northern section of Goaso, specifically from Mpameso via the Bia Shelterbelt to Bia Tano, Asukese and Bonkoni FRs. According to farmers in the area, it seems a small group of elephants numbering not more than three is involved in this movement, making appearances once in a while. The movement is largely determined by the dry season and was confirmed by local residents in Agravi, a small community fringing the Bia Shelterbelt (BP Conservation Awards 2003). The team also observed several signs of elephant activity around an elephant pool in Bia Shelterbelt that was regularly visited by elephants during the dry season. Fresh elephant signs were also observed in some parts of Bia Tano FR. The Mpameso population in the northern Goaso area is unique and has persisted for several reasons, mainly that there was a relatively higher level of protection at Mpameso FR than in other forest reserves due to its nearness to Dormaa Ahenkro where the district forest headquarters was situated. Hence, protection was maximized.

We did not find signs of elephant activity in any of the reserves (Krokosua Hills, Bonsam Bepo, Ayum, Subim, Bia North and Abonyere Shelterbelt FRs) in the southern section of the Goaso FB. Though Parren et al. (2002) found elephant signs in the Ayum and Subin FRs, interactions with fringe communities indicated that elephants have not been reliably sighted in these areas for more than a decade. The general absence of elephants in most of the southern reserves of the Bia-Goaso FB can be attributed to the difficult topography of the area. The Krokosua Hills and Bonsam Bepo FRs especially have very hilly and difficult terrain and are not easily negotiable in certain locations, militating against access by elephants to the forest's interior. Danquah et al. (2007) indicated that large mammals, particularly elephants, avoided climbing hills to save energy when they could. We found no evidence of elephant migration across the border to neighbouring Cote d'Ivoire. Farmers and households close to the boundary noted that elephants had not used the area as passage into Cote d'Ivoire over the past decade.

Factors associated with elephant population trends

Several factors may have favoured the persistence of elephants in Ankasa and Bia over the past few decades. First, the Ankasa and Bia CAs are fully protected areas, hence wildlife protection is enforced by the Ghana Wildlife Division. Second, both Ankasa and Bia have benefitted from several conservation-oriented projects. Notable projects include the just-ended European Union–funded Protected Areas Development Programme Phase II under which research and law enforcement were increased and more patrol staff trained and equipped with improved monitoring and research techniques. Major reductions in mean poaching encounter rates in Ankasa and Bia and associated significant increases in effective elephant range occurred under the project lifespan

from 2006 to 2009 (Danquah et al. 2007, 2009a,b). Hence, both elephant populations seem to have recovered best in these reserves in which improved wildlife management strategies were applied regularly and simultaneously. It is difficult to explain why the significant increases in elephant range for the period did not result in corresponding increases in elephant numbers. Increased random elephant movements arising from decreased human disturbance are more likely to have increased elephant range than are increased population numbers because it is doubtful if elephant numbers could have increased tremendously in less than four years.

The Goaso range of reserves is managed by the Ghana Forestry Division, which does not focus on conserving wildlife. Thus the area has not benefitted from any major wildlife conservation-related projects as most of the management priorities are directed at sustaining logging regimes. The area has also not benefitted from any major wildlife conservation-related project. Moreover, more than a decade of excessive commercial hunting in the 1990s has severely reduced the populations of elephants and several other large mammals. Recent confirmed reports (Sam et al. 2006; Danquah et al. 2009b) as well as observations by naturalists and Wildlife Division staff give substantial indications that there have been massive declines in both elephant numbers and range, especially over the past decade, primarily as a result of illegal hunting for ivory. Reports from the field indicate that elephant poaching in the area is fuelled by professional elephant hunters from nearby Cote d'Ivoire, who easily transport the ivory across the border. Most large mammal species have not been reliably observed for several years, and this is suspected to reflect population changes, resulting from high hunting pressure (Danquah et al. 2009b).

However, the principal threat in Goaso, which could have led the transition of elephants from highly abundant animals to their generally threatened and vulnerable status, is loss of range and habitat as a result of rapidly increasing human populations. The beginning of 1990 witnessed a massive acceleration of migrants, mainly farmers from other regions in Ghana to the high forest zone in western Ghana (Sam 2000). The boom in Ghana's timber and cocoa industry in the 1990s exacerbated the situation and contributed to severe encroachment on elephant habitat with major recorded decreases in effective elephant range and numbers. For this period, forest cover decreased by 4.53%. The rate of forest loss was estimated to be 326.23 ha per annum. The size of the degraded or open area increased by 18.95%. Current satellite images combined with ground investigations indicate few forests remaining outside the reserves as much of the original vegetation has been converted to agriculture and urban expansion. Currently, many villages and hamlets are scattered throughout the whole area.

From this discussion, it is possible to identify three broad objectives for elephant conservation in the high forest zone of western Ghana. First, it is clearly necessary to establish a long-term programme for monitoring elephant abundance and trends on a large scale. Second, the conservation and restoration of degraded forests should be a priority for stabilizing and maintaining existing healthy elephant populations. Finally, despite the lack of extensive experimental evidence, management activities aimed at decreasing poaching activity and increasing the quantity and quality of both refuge and food should continue to be implemented.

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