Northern Ghana elephant survey

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Abstract

Northern Ghana shelters an important protected areas network. However, the current elephant range is restricted to a few protected areas. An aerial total count was carried out in Mole National Park and partially in Gbele Resource Reserve. The eastern and western corridors were surveyed by direct and indirect distance sampling counts. A minimum of 401 elephants were observed in Mole National Park while 15 elephants (coefficient of variation: 87%) were estimated by dung count in the extreme north of the western corridor. No elephant sign was observed in the other areas surveyed. Human activities were widely spread in all areas except Mole National Park, where permanent human activities, fields and villages were outside the boundaries. Because of high human impact in the corridors, elephant migration is now essentially non-existent in both corridors. The recent records of elephant in Gbele Resource Reserve plead for a third corridor between Mole National Park and Bontioli in Burkina Faso through Gbele Resource Reserve.

Additional key words: northern Ghana corridors, elephant trends, Mole National Park, human impact

Résumé

Le Nord Ghana abrite un réseau important d'aires protégées. Cependant l'aire de distribution des éléphants est actuellement réduite à quelques aires protégées. Un comptage aérien total a été mené au Parc National de Mole et partiellement sur la Réserve de Gbele. Les corridors Est et Ouest ont été recensés par comptage pédestre direct et indirect en utilisant la méthode du transect en ligne. Un minimum de 401 éléphants ont été observés dans le Parc National de Mole alors que 15 éléphants (coefficient de variation: 87 %) ont été estimés par le comptage de crotte dans l'extrême nord du Corridor Ouest. Aucun signe de présence d'éléphant n'a été enregistré dans les autres aires protégées couvertes par cet inventaire. Les activités humaines étaient largement répandues sur toute la zone d'étude à l'exception du Parc National de Mole pour lequel les activités humaines permanentes, champs et villages, sont contenues hors des limites du parc. L'impact humain élevé dans les corridors a rendu la migration des éléphants inexistante dans les deux corridors. Les récentes observations d'éléphant dans la Réserve de Gbele plaide pour l'existence d'un troisième corridor entre le Parc National de Mole et Bontioli au Burkina Faso via la Réserve de Gbele. Cependant ceci reste à être confirmé.

Mots clé supplémentaires : corridors du Nord Ghana, tendences des elephants, Parc National de Mole, impact humain

Introduction

Despite the protected areas network in northern Ghana (fig. 1), current elephant range is restricted to a few protected areas or corridors (Wildlife Division 2000; Blanc et al. 2003). During the first half of the 20th century, elephants were widely distributed across Ghana (Roth and Douglas-Hamilton 1991). After 1950, elephant distribution decreased and became restricted to a few protected areas. Even after the 1950s it was long known that some elephant populations used to migrate between protected areas of West Africa (Bouché and Lungren 2004), mainly along the scattered relict of the former Sudanian savanna that spread from Senegal to the Nile River. The original habitats of the region were progressively transformed into agropastoral areas. West Africa has had the larger human population of the continent, with a high birth rate (PNUE 2002**[not in reference list]**). Human population pressure induced the fragmented habitat.

Recently, Ghana created corridors in its national parks using the relicts of the savanna between the current protected areas. Corridors play a key role in conserving migrating species and are a priority of the Wildlife Division (2000) and IUCN (2003). Corridors may play a more important role in West Africa than in other regions of the continent because most protected areas are very small and often surrounded by agricultural and pastoral areas. They are often the last link and chance to ensure genetic mixing of West African elephants (Bouché 2004; Bouché and Lungren 2004).

This paper summarizes the main results of the northern Ghana elephant survey carried out in 2006 by the World Conservation Union (IUCN) and the Northern Savannah Biodiversity Conservation Programme, funded by the Global Environment Facility and the World Bank. This survey was the first attempt to establish a baseline status of northern Ghanaian elephant in protected areas in Ghana and those of

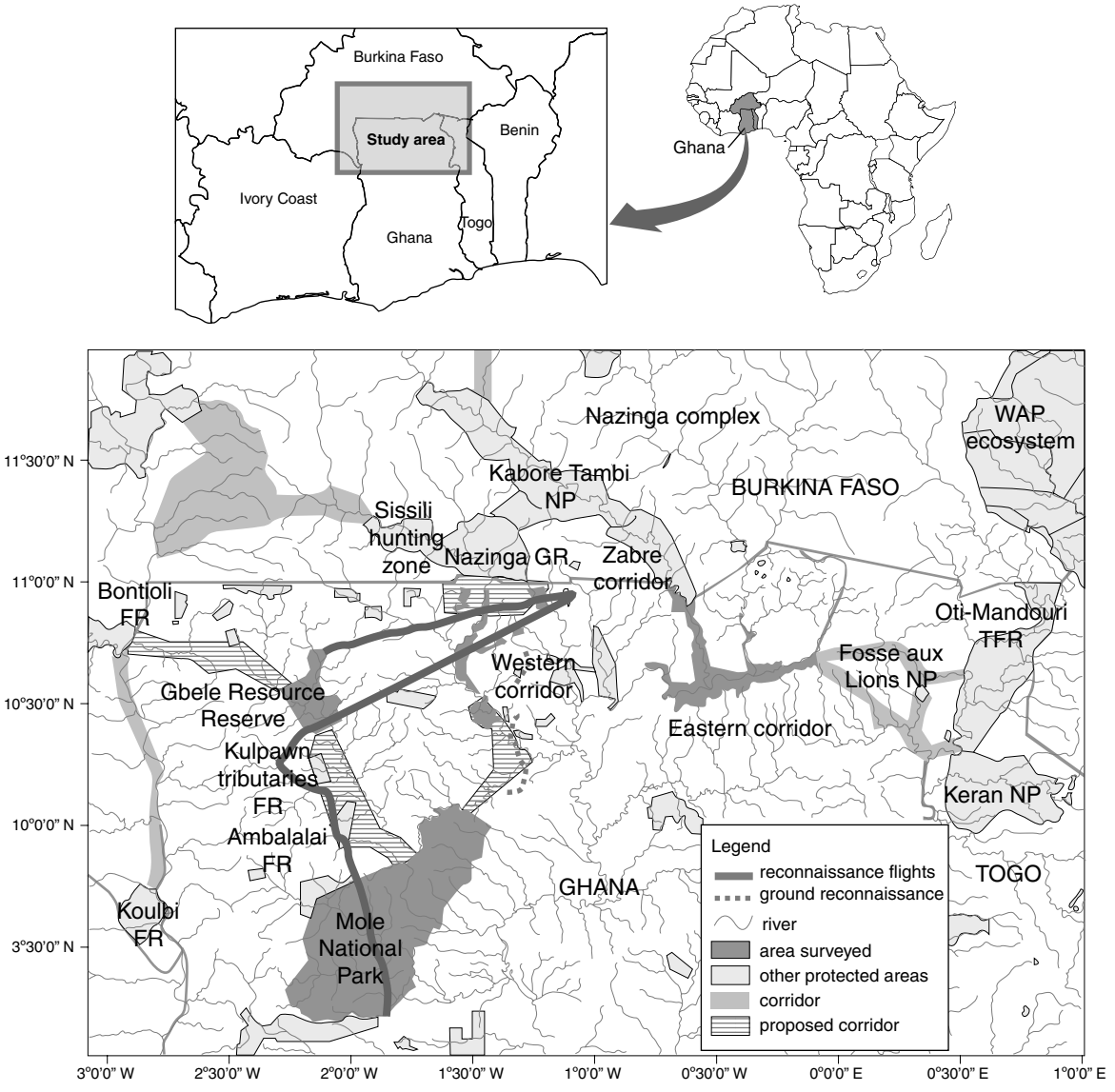

Figure 1. The protected areas network in northern Ghana and neigbouring countries (FR — forest reserve, GR — game reserve, NP — national park).

Burkina Faso, notably the Nazinga Game Ranch and Kabore Tambi National Park. This network extends into Burkina Faso and currently constitutes a hub for elephant migration in West Africa (Bouché and Lungren 2004).

Survey area

At first, the survey of Gbele Resource Reserve was not planned, but Tumu Wildlife officers advised us on the potential of Gbele Resource Reserve and that elephants had been observed there in the last few years. We took their advice. The survey was carried out on the current elephant range of northern Ghana, except the Nadom range in the extreme north-west of Ghana (Wildlife Division 2000; Blanc et al. 2003). It covered the 4504 km^2 of Mole National Park (Bouché 2006), the 968 km^2 eastern corridor (commonly called Red Volta), the 510 km^2 of the western corridor (Ghana Geographical Survey n.d.) and the 549 km^2 of Gbele Resource Reserve (fig. 1). The corridors are a series of contiguous forest reserves (fig. 1). The study area elevation ranges from 120 m to 490 m.

The climate has three seasons: a dry cold season from October or November to February, a dry hot season in March and April, and a rainy season from April or May to October or November. During the cold dry season the harmattan wind blows from the north-east, drying out the vegetation. In the rainy season a monsoon wind blows from the south-west. Annual rainfall ranges from 900 mm in Bolgatanga to 1100 mm in Mole National Park (Wilson 1993). The mean annual temperature is 27.8 °C, with extremes of 10 °C and 40 °C (Wilson 1993).

Habitat is mainly bushy to woodland savanna with *Vitellaria paradoxa, Combretum* spp., *Acacia* spp., *Anogeissus leiocarpa*, *Afzelia africana, Burkea africana, Isoberlinia doka,* and *Terminalia* spp. Forest galleries along main rivers contain *Danielia oliveri, Terminalia* spp., *Anogeissus leiocarpa* and *Khaya senegalensis*.

Method

Mole National Park and Gbele Resource Reserve survey

The aerial total count method (Douglas-Hamilton 1996; Craig 2004) was used to survey elephants (*Loxodonta africana*). A four-seater Cessna 175 aircraft with a pilot, front-seat recorder and two rear-seat observers was used. The altitude was adapted according to the terrain, visibility and vegetation. The average height was around 100 m or less. The flight speed was between 130 km and 150 km per hour, but could reach 175 km to 195 km per hour with a back wind. An average of six to seven flight hours each day was necessary to cover the daily flight plan. The flights began in the morning between 0545 and 0600 and continued until the entire daily flight plan was completed. In addition several reconnaissance flights were done between Mole National Park and Gbele Resource Reserve and across the western corridor.

Mole National Park was divided into several blocks. Gbele Resource Reserve was considered a single block. Each block was scanned by a series of east-to-west 1-km flight lines. Each flight line went beyond the block limit, overlapping the neighbouring block by 2 km. Each block was supposed to be covered in one day. The low elephant density and the large block size minimized the risk of elephants moving from one block to another, especially during the survey in early March, when water is mostly in the main streams. In March, scarcity of water points causes the large herbivores to group mostly in large herds near water. On the other hand earlier surveys (Wilson 1993; Bouché 2002; Mackie 2004) showed elephants mainly concentrated in the core of the southern, wider part of Mole National Park. This did not hamper application of the total count because the whole area was scanned.

Elephants were counted accurately; the number of adults, subadults, young and babies in herds were recorded. This had the advantage of comparing elephant group distribution and eliminating double counts. Elephant carcasses were recorded, as proposed by Douglas-Hamilton (1996). For large elephant herds of more than 15 individuals, pictures were taken with a Nikon Coolpix 3.2 M pixels digital camera. Animal counts from digital images followed the procedure described in Blake et al. (2003).

The survey of Mole National Park was carried out from 2 to 9 March 2006. It took almost 31.5 hours to cover the 4504 km^2 of the park at 138.65 km^2/h. The Gbele Resource Reserve survey was carried out from 4 to 5 July 2006. Limited fuel did not allow completely surveying Gbele Resource Reserve, 356.3 km^2 of 548.9 km^2 (65%) were covered at 125 km^2/hour.

Corridor surveys

A ground count method was selected for corridors because it was assumed that animal densities were low (Adjewodah 2004). The teams would have a better chance to see elephants or their sign from the ground than they would from the air. A ground count of live wild animals and their dung or scat was planned using the distance sampling method (Buckland et al. 1993, 2001 **[not in ref list]**; Jachmann 1996; Barnes 2006 **[2002 in ref list]**,). Data treatment was run under DISTANCE 4.1 software (Thomas et al. 2003a, 2003b). The results in this paper concern only elephants. To estimate elephant numbers from dung count, the dung decay rate and the dry-season defecation rate observed in Nazinga Game Ranch, Burkina Faso, were used (Jachmann 1991).

The choice of what forest reserves in the western corridor to survey was guided by the elephant corridor the Wildlife Division (2000) recognized. Some Wildlife Division officers found elephants might not have used the whole corridor and asked to target areas most likely to have been used in migration.

A reconnaissance visit in February 2006 showed the habitat of forest reserves in some places was degraded by cultivation, villages and wood cutting, while other areas remained untouched. Because some animals were observed only in remote areas and poached animals were observed in some villages, it was assumed that wildlife existed in lower density near areas degraded and occupied by humans than in areas where habitat seemed intact. In addition, discussion with traditional hunters provided information about recent elephant migration routes and patterns. A ground survey between the western corridor and Mole National Park was also done.

To compare areas with intact habitat with those with degraded habitat, greenness was assessed using Google Earth™ (2006) satellite images. To avoid a complete vegetation map treatment, which would have required a completely separate mission, Adobe Photoshop Elements 2.0™ software was used. Habitats were selected by the software by coloured patches. A patch was considered untouched if it had a green colour index between 0 and 95. All patches that did not meet the criteria were considered degraded habitat. It was unlikely this greenness index corresponded to intensive agriculture, which was not in the study area. The satellite images showed some areas, the Chiana and Sissili south corridors, were outside the forest reserves but had intact habitat. It was decided to survey them to check their potentialities.

The transects were perpendicular to the main rivers inside the forest reserves. A series of 2-km transects were used to cover the corridors where the habitat was intact and a 4-km transect where the habitat was degraded (Bouché 2006). Twelve teams of three people each carried out the survey. Each team had a transect to walk each day. One team member recorded the observations and manipulated the GPS, compass and tape measure, while the other two spotted animals.

The survey of the eastern corridor was carried out from 14 to 19 June 2006; 363.43 km of transect were walked by 11 teams. The survey of the western corridor was carried out from 21 to 23 June 2006; 219.76 km of transect were walked by 11 teams.

Results

Mole National Park

Elephant

A total 401 elephants were observed. Each herd was counted accurately, resulting in a density of 0.08 elephants/km^2, a minimum estimate. Several herds may have been missed in the large forest galleries along the major rivers. Mean group size was 9.11 ± 14.66 (SD); herds ranged up to 80 individuals.

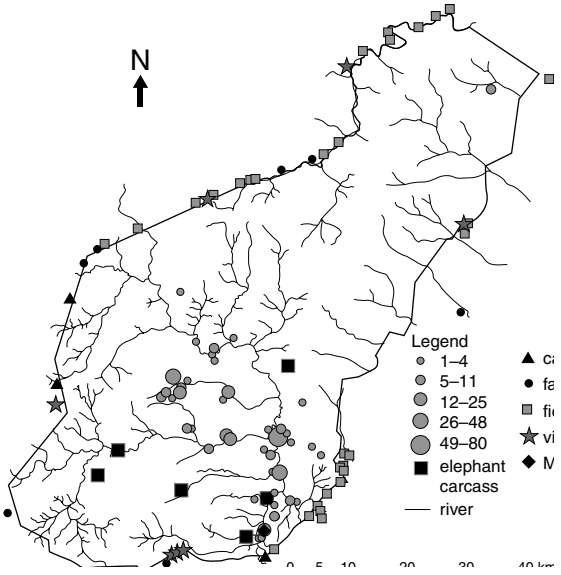

Figure 2. Elephant distribution and human activity in Mole National Park.

Six elephant carcasses, all old, were observed in the south of the park. Elephants were mainly in the central area and near the headquarters in the south-west of the park (fig. 2). For the first time elephants were observed in the north of the park. The other areas had no elephants.

Human activity

Human activity was recorded outside the park, but several were very close to park limits. Very often the fields were just beyond the perimeter road that marks the park boundary. The pressure from fields, farms and villages varied. Farm fields and villages seemed to continuously increase along the north-west, south-east and southern boundaries. Pressure along the western and north-eastern boundaries seemed quite low (fig. 2).

Gbele Resource Reserve

Elephant

No elephant was recorded during this survey.

Human activity

Gbele Resource Reserve is surrounded by fields. Several fields and two villages were observed inside the north-west part of the reserve. All other Gbele habitat covered by this survey seemed untouched (fig. 3). During the reconnaissance flight made between Mole and Gbele, half of the land between the two protected areas, which included the Kulpawn tributaries and the Ambalalai Forest Reserve was absolutely free of fields. Only old fields were observed. However, the rest of the distance was extensively cultivated, mainly along a tributary of the Kulpawn River (fig. 1).

Eastern corridor

Elephant

The survey revealed no elephant sign in the eastern corridor. According to traditional hunters in the region, no elephants had been observed for two years, although they had still been 'numerous' four years ago. In the recent past elephants did not reside in the eastern corridor but visited the area between September and November or December, when crops were harvested. Elephants used to follow the Red Volta River from Burkina Faso to go into Ghana.

Human activity

There was plenty of human activity inside the corridor. There were several permanent villages, camps and fields, and cattle herds and sign were numerous (fig. 4). It was obvious the eastern corridor was used to move cattle from the Sahel to the coast of West Africa. The presence of villages and fields confirms that law enforcement in the corridor has been weak for several years.

Western corridor

Elephant

Figure 5 shows large species distribution in the western corridor. Elephant signs were observed in the

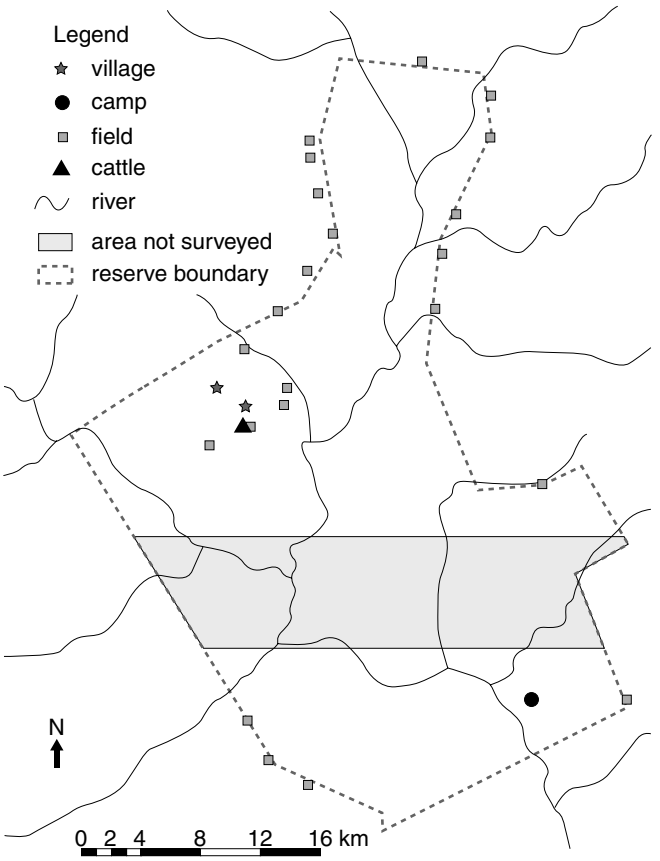

Figure 3. Main human activity in Gbele Resource Reserve.

conserved northern part of the corridor. The number elephant dung contacts in the northern part of the corridor was quite low—only 29. To reach reasonable precision for statistical treatment, 60 to 80 observations are recommended. However, we decided to treat the number we found (table 1).

The data treatment provides a result of 412.62 dung count/km^2. According to the results, a mean estimate of 15 elephants visited the corridor in Pudo Hills and Sissili North (77.74 km^2). No live elephant was observed. The coefficient of variation and therefore the variance and the confidence interval are very important because most of the dung (87.8%) was concentrated in a few transects along the Sissili River. It was possible that elephants roamed between Pudo Hills and Sissili.

Human activity

Several permanent villages, camps and fields were installed in the corridor, and cattle herds and sign were numerous. Figure 5 shows human activity was spread throughout the corridor, but an untouched patch of habitat was observed from the satellite image. This area is under the protection of local gods and has cultural value. Evidence of a migration corridor was discussed with some traditional hunters and members of several communities. According to them, the last elephant migration was in 1986. The western corridor has not been active for two decades.

Discussion

Mole National Park

Several surveys have been conducted in Mole National Park (Wilson 1993; EBM&WD 2001, 2003 **[not in reference list]**; Barnes 2002; Bouché 2002; Mackie 2004). However, only aerial surveys provided animal estimates (Wilson 1993; Bouché 2002; Mackie 2004).

Elephant

Figure 6 shows the estimates provided by the aerial surveys of 1993, 2002, 2004 and 2006 (Wilson 1993;

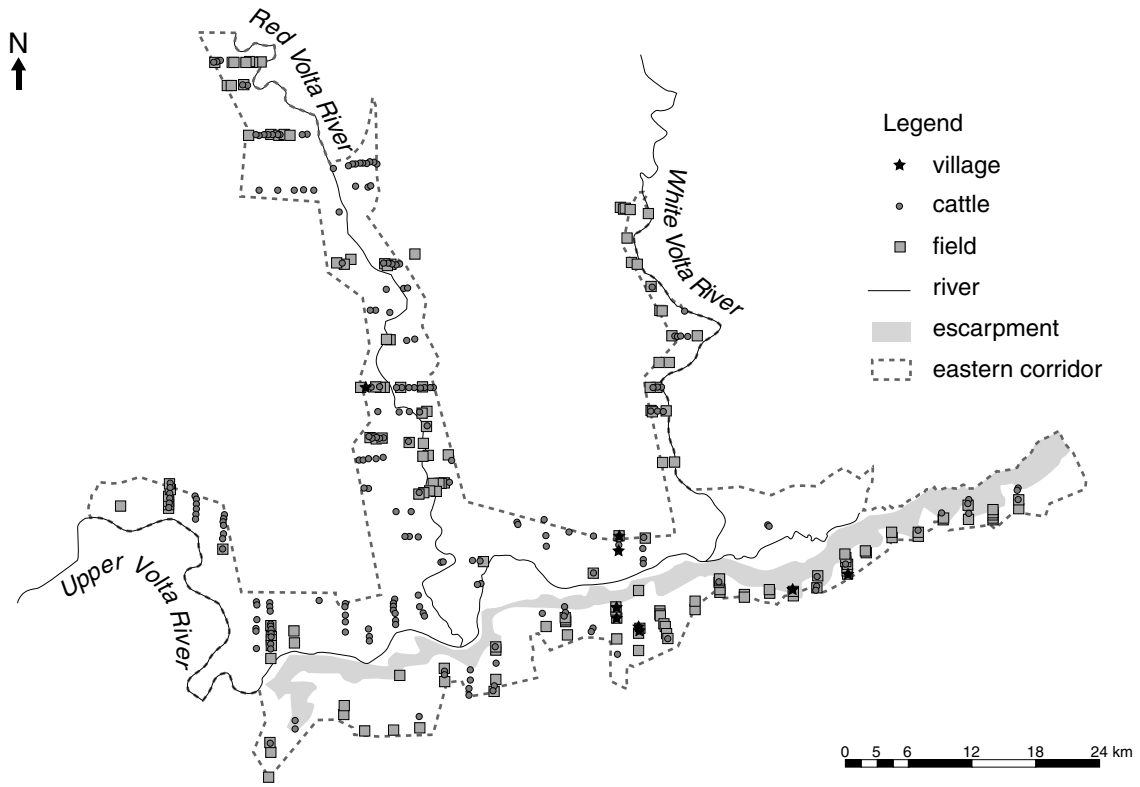

Figure 4. Main human activity in the eastern corridor.

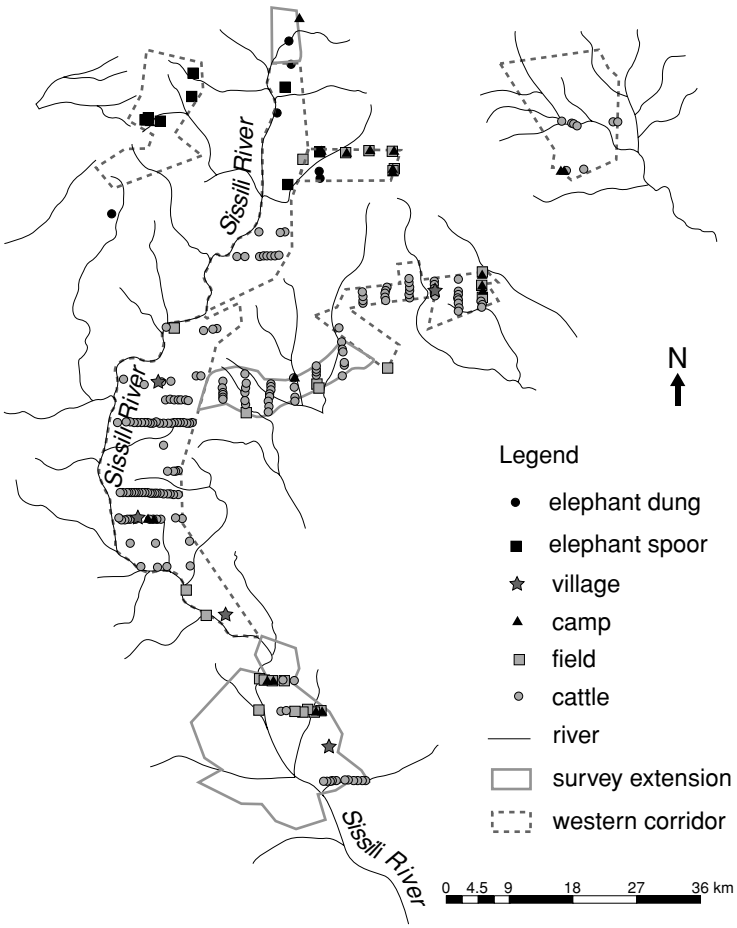

Figure 5. Elephant sign and human activity in the western corridor.

Bouché 2002; Mackie 2004). All were carried out in March. Results show that an aerial sampling count provides estimates with a large confidence interval and, therefore, poor precision. The aerial total count in 2006 provided a minimum estimate higher than the mean estimates provided by the aerial sampling count in 2002 and 2004 and higher than the lower confidence limit of 1993. It is difficult to confirm elephant decline since 1993, like that affirmed by Mackie (2004), because the size of the confidence interval provided by earlier surveys is large and the estimate of 2006 is a minimum one. Statistically, there is no significant difference between the three former surveys (d test$_{1993\ vs\ 2002}$ = 0.124 NS and d test$_{2002\ vs\ 2004}$ = 0.133 NS). The heat could have influenced the results because animals take refuge in the deep shade and may not have been spotted by the observers. It is almost sure that several herds or individuals escaped observation in the deep forest galleries.

This survey showed the presence of elephants in the north of Mole National Park (fig. 2), the first time a survey showed elephant presence in this remote area. Elephants used to migrate between the park and Nazinga Game Ranch up to the mid-1980s. However, it seems that since then the migration stopped (Bouché 2006). We have no information about the links that could have existed between Mole National Park and Côte d'Ivoire, notably Comoé National Park.

Comparison with other protected areas in West Africa

Table 2 shows the mean densities of elephants in several protected areas in the region that have recently been surveyed. Considering that Mole National Park aerial surveys provide a minimum estimate for elephant, density in the park is the lowest when compared with other protected areas in West Africa surveyed using the same methods (Bouché et al. 2004a, 2004b).

Table 1. Elephant density (no./km^2), coefficient of variation (CV%), degree of freedom (df) and limits of the 95% confidence interval

	Estimate (no./km^2)	CV%	df	95% confidence interval	
Dung density	412.62	81.19	40.06	97.953	1738.1
Elephant density	0.187	85.54	37.47	0.042	0.84
Elephant number	15	85.54	37.47	3	65

The current situation is contradictory. First, the protected areas in the park benefit from high annual rainfall and a short dry season. Secondly, the park is covered by an extensive network of rivers and streams that have water even in the driest month, March. All the other areas cited have chronic problems with water availability that oblige managers to spend large amounts of money and effort in water structures and water management (Lungren et al. 2004, 2005; Bouché and Lungren 2005).

The higher rainfall and shorter dry season should be advantageous for Mole National Park. It should harbour larger elephant densities. It certainly has high potential for biodiversity and could enhance wildlife densities to some of the highest in the region.

Gbele Resource Reserve

In 2005, three elephants visited Gbele Resource Reserve (pers. comm. Tumu wildlife officers 2006). Tumu wildlife officers assumed they came from Mole National Park. The elephants could also have come from Bontioli in Burkina Faso, close to Nandom in Ghana (fig. 1), known to be an elephant range (Wildlife Division 2000; Blanc et al. 2003). Gbele Resource Reserve is at equal distance between Mole National Park and the Black Volta. Black Volta, between Bontioli and Gaoua in Burkina Faso, is also known to be an episodic elephant corridor (Bouché and Lungren 2004). Despite the low animal densities (Bouché 2006) and human activity (fig. 7), Gbele Resource Reserve could be important for a third corridor between Mole National Park and Bontioli in Burkina Faso, mainly along the Kulpawn River. From the air, this corridor seems, in some areas, not much affected by human activity. However, a thorough ground reconnaissance should be undertaken to check free areas. The area between Gbele Resource Reserve and Bontioli should be included in the survey.

Eastern corridor

Despite more transects walked than in previous surveys (Sam et al. 2002; Adjewodah 2004) no elephant sign was recorded in the eastern corridor. According to several testimonies, the elephant migration seems have stopped two years ago. Traditional hunters did not complain about elephants raiding crops the last two years. The last community record was two or three years ago. Adjewodah (2004) recorded very little elephant dung in the Red Volta Forest Reserve in 2003 and 2004. The literature provides some estimated elephant numbers for the eastern corridor (Sam 1994, 1998; Wildlife Division 2000; Blanc et al. 2003; Adjewodah 2004). Figure 7 shows that in 12 years the elephant population in the eastern corridor collapsed.

The eastern corridor seems to have been threatened by human activity for several years (Sam and Barnes 1998; Sam et al. 2002; Adjewodah 2004). According to traditional hunters, elephants apparently have not been resident in the corridor these last decades. They used to roam in the area, mainly at the end of the rainy season when crops reached maturity (Adjewodah 2004; Adjewodah et al. 2005), then moved back to Burkina Faso.

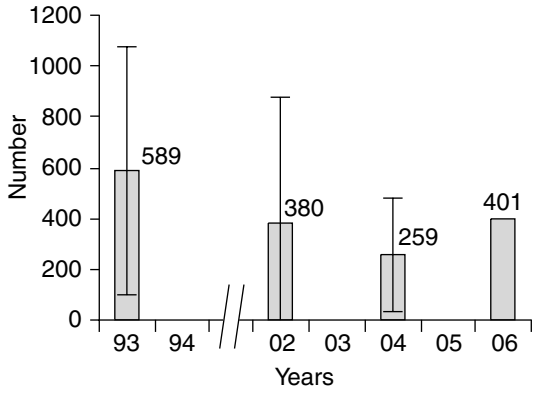

Figure 6. Elephant estimates and the 95% confidence interval of the 1993, 2002, 2004 and 2006 surveys.

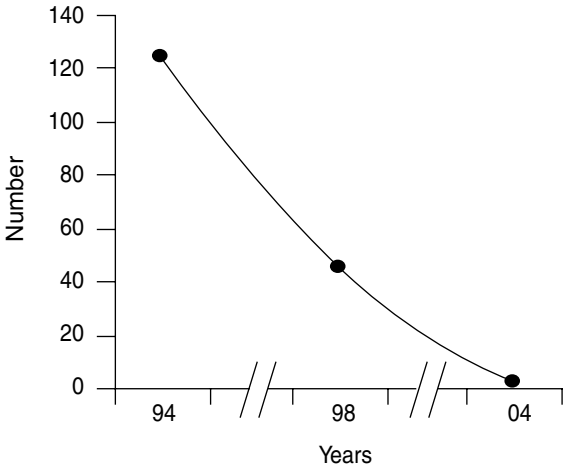

Figure 7. Evolution of mean elephant numbers in the eastern corridor from 1994 to 2006.

Table 2. Elephant densities (no./km²) in several protected areas of West Africa

Protected area	Area (km²)	Rainfall (mm)	Country	Elephant density	Source
Mole National Park	4,540	1100	Ghana	0.08	This study
W Regional Park	14,360	700–1000	BE–BF–NG	0.08	Bouché et al. 2004a
Pendjari National Park	2,660	1000	Benin	0.29	Bouché et al. 2004a
Nazinga Game Ranch	940	900	Burkina	0.66	Bouché et al. 2004b
Konkombouri Hunting Zone	650	900	Burkina	1.16	Bouché et al. 2005

BE – Benin ; BF – Burkina Faso ; NG – Niger

The current situation in the eastern corridor is critical. This corridor has not been active since 2004. Illegal activities are numerous and widespread, posing questions on the effectiveness of law enforcement. The consequence is that with the local population growth and the immigration of people, and thus the need for land, communities have invaded the last unoccupied lands. Before its gazetting in the 1950s, traditional authorities owned the land (Wheelan 1950).

The eastern corridor seems to be an important halting place in cattle transhumance from the Sahel to the subhumid zones of coastal countries in the dry season and back in the rainy season.

Figures 1 and 4 show that the larger rivers, thus the larger water resources, are landlocked in the corridor. In the absence of effective law enforcement and official and managed cattle routes, for years cattle herders have used the corridor to take their cattle to drink. Sam et al. (2002) believed that elephants avoid cattle-grazed areas. During the day the same phenomenon, extended to fields and villages, was observed in several places in West Africa (Bouché et al. 2004a, 2004b; Bouché 2005). However, the proposal of Sam et al. (2002) to convince cattle herdsman to keep their cattle between the farmland and the reserve to reduce crop raiding would be difficult to implement because cattle compete with elephants for the same water. The herdsmen do not receive any advantage by protecting elephants that compete for the same resources as the cattle. This competition has increased over the years in the region because of the demand for meat. With agriculture expanding up to the limits of the protected areas, herdsmen sometimes have no other choice than to use the forest reserve to avoid conflicts with farmers.

The corridor does not provide significant revenue or advantage for communities. If it did, the communities could have the feeling that the reserve land was theirs. Currently, those who take the land illegally considered that the land was a wasted resource because only a limited number of people benefited. Up to now the corridor acts more as an obstacle for traditional activities, such as cultivation, pastoralism and hunting.

A corridor is supposed to link protected areas. In the past, the eastern corridor linked the Burkina Faso Nazinga complex to Togolese protected areas (Okoumassou and Barnes 1998) that were the last step before reaching the W–Arly–Pendjari (WAP) ecosystem (Bouché and Lungren 2004) (fig. 1). However, the protected areas on the Togo side were completely invaded by many fields and other human activity not compatible with elephant survival. No elephants were observed there in 2003 (Bouché et al. 2004a). In the 1990s during the Togolese civil trouble, 300 elephants left Togo for the WAP ecosystem and never came back (Bouché et al. 2000; Bouché et al. 2002).

Until recently, the administrations in charge of the environment did very little to conserve wildlife in the eastern corridor. In the Togo areas it seems recent efforts were made to rehabilitate some protected areas, but the efforts may be too late and insufficient to have a significant impact. At the same time, huge efforts were made in Burkina Faso to link Kaboré Tambi National Park of the Nazinga complex to the eastern corridor by the Zabre corridor, with the agreement of the communities (pers. comm. Drabo A. 2006) (fig. 1).

Western corridor

The situation in the western corridor is markedly different. The northern part shelters a wildlife population coming mostly from Nazinga Game Ranch in Burkina Faso (fig. 1). Intense poaching makes it highly unlikely that wildlife would be resident in that part of northern Ghana. Human activities increase in the corridor southward. The western corridor seems more visited by cattle

herds in the south of Sissili North, Sissili Central and Bopono Forest Reserves. Farming pressure seems less important than in the eastern corridor.

The Sissili River is still used by elephants. However, it seems that elephants did not migrate beyond the northern part of Sissili North once human activity became more intense. According to several testimonies, elephants have not migrated between Mole National Park and the western corridor since 1986. The northern part, along the Burkina Faso border and the Nazinga Game Reserve, was free from cattle and fields, as predicted by satellite images, even if poaching is still active there. Efforts should be made to agree with local communities to give to that area an official conservation status. Two particular points must be mentioned concerning this area:

- The area was cultivated in the past (Bouché 2006). Ground survey and aerial reconnaissance in 2003 (Bouché et al. 2004b) and in 2006 confirm that this area became free of fields.
- During the ground survey a team member met some local people who were not in favour of letting the team have access to part of the forest protected by local gods.

The context seems favourable to rapidly gazette that area (fig. 1), with agreement of the communities, and with a concrete financial mechanism to generate socio-economic revenues, at least in the northern part. This is a run against time. Such a favourable situation may not recur in the next 10 years.

Wildlife densities are still very small. Concrete and appropriate conservation efforts must be done to favour a wildlife population increase. The proximity of Nazinga Game Ranch could help enhance wildlife density, if appropriate management is taken. The ground survey between the western corridor and Mole National Park showed that most of the land is covered by cattle grazing during the dry season. In the rainy season, however, the land is empty of cattle herds. The area is little populated. Few villages exist and the impact of their fields is low. There are opportunities to create wildlife community areas. Some villages are in favour of that because large game has completely disappeared from the area and the negative impact of wildlife is nil.

How to reactivate the corridors

Most parts of the corridors have been invaded by human activity. They could be reactivated through a long process that would include several stakeholders. First, the government should define a clear vision of how it intends to use its wildlife patrimony and provide a strong commitment to realizing it.

A corridor is a purely ecological view. Legally the protected areas in the corridors are forest reserves managed by foresters for wood production and not by wildlife officers. The legal status of these forest reserves should be revised to include ecological aspects linked to the corridor goals. However, the protected areas are often small and narrow and many of them are scattered. First, the corridors must be enlarged to provide sufficient space to let elephants roam and gaps between corridors should be reduced. Land between protected areas should be surveyed to check for human activity density and to see how communities could provide some land to help to build up the corridor. Communities could create protected areas that could be leased to private partners to run ecological and cultural tourism. Appropriate management that pays for itself from professional tourism revenue could finance long-term conservation in the corridor and create substantial revenue for local communities. This way, Mole National Park could be a hub for an elephant corridor in northern Ghana, with elephants coming from Nazinga Game Ranch in the north and possibly from Gbele from the north-west and the link between Comoé National Park and Côte d'Ivoire to the west.

Conclusion

In Mole National Park the trends are difficult to define, since the 1993 to 2004 estimates are imprecise. Compared with other protected areas of West Africa, Mole National Park elephant density is the same as in W Regional Park, but far less than in Pendjari National Park in Benin, Nazinga Game Ranch or Konkombouri Hunting Zone in Burkina Faso. Sound management should be implemented to enhance the elephant population in Mole National Park.

The current situation shows the corridors are no longer active, mainly from human pressure on what was untouched habitat a few years ago. Increasing population, cattle pressure, lack of revenue from wildlife activities for communities and the absence of effective law enforcement have all converted the wildlife corridors into agricultural and pastoral areas, despite a lot of money spent in the last eight years for a natural resource management programme (World Bank 1998). Large conservation measures, in agree-

ment with socio-economic interest of people living in and around the corridors, must be implemented. If no appropriate measures are taken, the corridors may disappear completely. The loss of corridors and the associated wildlife would represent not only the loss of a natural and cultural richness, but also the loss of an economic opportunity for local people. If the corridors were properly managed, tourism, starting with game viewing organized by local people, could be a source of revenue for communities.

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