

Review of the protected area network in Guinea, West Africa, and recommendations for new sites for biodiversity conservation

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Abstract With only five protected areas dedicated to the conservation of biodiversity (two national parks, one strict nature reserve and two faunal reserves), Guinea has one of the smallest protected area networks in West Africa. As a result, two of the five ecoregions of the country and six of the 14 globally threatened large and medium-sized mammals occurring in Guinea are not found in the national protected area network. To identify areas with high biodiversity that could be included in the national protected area network, we used the Key Biodiversity Areas (KBA) methodology. We devised a scoring system to rank the identified KBAs according to their relative conservation significance. We identified a total of 16 KBAs throughout the country. Their proclamation as protected areas would result in the protection of all ecoregions and all but one of Guinea's globally threatened large and medium-sized mammals. Twelve of the 16 KBAs have the legal status of classified forest, a status that should facilitate the change into formal biodiversity protected areas (IUCN category I–IV). Our analysis indicates that even if only the two areas with the highest conservation significance score, the Zياما and Diécké forests, become formal protected areas, this would provide protection to both the western Guinean lowland forests, one of the most threatened ecoregions in Africa, and to 11 of the 14 threatened large and medium-sized mammals occurring in Guinea.

Keywords Biodiversity · Guinea · Key biodiversity area · Protected areas · Systematic planning

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Introduction

With only five protected areas dedicated to the conservation of biodiversity (IUCN categories I–IV), the Republic of Guinea has one of the smallest protected area networks in West Africa, both in terms of number of protected areas and the percent of the country protected (2.9% of the country land surface). As a result, many nation's ecosystems and species are not represented in the country's protected areas. This situation is partly explained by the fact that, until recently, conservation of biodiversity was given a very low priority in the Republic of Guinea (IUCN 1991) and that data on biological diversity are scarce, even for higher taxa (Barnett and Prangley 1997). Despite significant achievements in recent years, the country's biodiversity remains today one of the least well-studied in West Africa (MTPE-DNE 1997). This represents a real challenge in establishing a protected area network based on systematic planning (Margules and Pressey 2000).

As a party of the Convention of Biological Diversity, the Republic of Guinea (hereafter Guinea) regards the development of a national protected area network as a key priority (MMGE 2001). However, very little has been done to identify key areas with high biodiversity. As a result, the creation of a national protected area network based on systematic planning principles remains largely unachieved. Preliminary recommendations to develop a protected area network in Guinea were formulated by MacKinnon and MacKinnon (1986) and IUCN (1987). The identification of Important Bird Areas (IBA) throughout the country (Robertson 2001) provided the most recent significant advance in identifying individual sites with high biodiversity in Guinea. However, it is unclear how in the Guinean context the IBA network accounts for the conservation of other taxa, in particular the large and medium-sized mammals, a group that includes the largest number of threatened species in Guinea (IUCN 2007).

In this paper we review the history of protected areas in Guinea and analyse the existing protected area network focussing on areas dedicated to the conservation of biodiversity (IUCN categories I–IV, hereafter biodiversity protected areas). We provide a preliminary list of key biodiversity areas and discuss their contribution to the conservation of the country's biodiversity.

Historical background

Colonial and post-colonial period

Guinea was colonized by the French from the 1860s and during the colonial period, forestry resources were given a high priority. The first protected areas created in the Guinean colony were "Classified Forests"; they were created mainly to ensure the sustainable management of the forestry resources and the protection of water catchments. From 1885 to 1958 (date of Guinean independency) 147 Classified Forests covering 11,550 km² (mean size: 78.6 km²) were created throughout the Guinean colony (MTPE-DNE 1997). Animal species benefited from the creation of Classified Forests since no hunting was allowed in these forests. Further to the Convention for the Preservation of Animal, Birds and Fish in Africa established in London in 1900, the French government drafted the first legislation on protected areas in Africa in the 1910s (Guyon 1911). The definitive legislation providing for the creation of national parks in French African colonies was proclaimed in 1925 (JO-RF 1925) and this led to the creation of the first three national parks in Guinea in 1926 (Kankan, Dinguiraye and Boké National Parks; JO-AOF 1926)

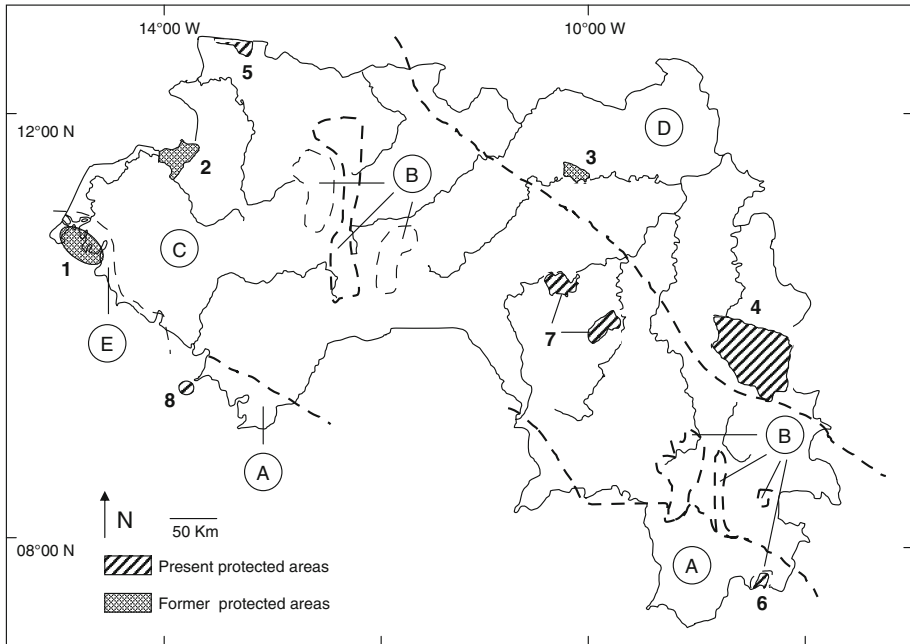


Fig. 1 Ecoregions (circled letter) and former and present biodiversity protected areas (number) in Guinea. A: Western Lowland Guinean Forest, B: Guinean Montane Forests, C: Guinean Forest-savanna Mosaic, D: West Sudanian Savanna, E: Guinean Mangroves. 1: Boké National Park, 2: Koumbia National Park, 3: Dinguiraye National Park, 4: Kankan Faunal Reserve, 5: Badiar National Park, 6: Mont Nimba Strict Nature Reserve, 7: Haut Niger National Park, 8: Blanche Island Faunal Reserve

(Fig. 1). An additional park (Koumbia) was created in Guinea in 1933. The creation of these parks was mainly motivated by the protection of large game species.

In June 1944 the Mount Nimba Strict Nature Reserve, straddling the border between the Ivory Coast and Guinea colonies (JO-RF 1944), was officially proclaimed to protect an unusual level of unknown species and a spectacular landscape. Unlike the four national parks of Guinea (which were managed by the local forestry administration), this protected area was placed under the scientific management of the *Museum National d'Histoire Naturelle* (based in Paris, France). As a result, a significant number of scientific studies were conducted in the reserve until the Guinean independency (see a review in Lamotte et al. 2003).

Guinea gained independency from France in 1958. The independent government turned into a state-run economy with major emphasize on agriculture. Protected areas were given very low priority. Farmers progressively invaded national parks and most classified forests established under the colonial period. No updated legislation on protected areas and fauna was drawn up and no new parks were created for 25 years after independency (only eight small classified forests were created during that period—MTPE-DNE 1997). The situation changed with the onset of a new political regime in 1984, which opened up the country to international cooperation. The Badiar National Park was created in 1985 (JO-RG 1985) along the border with Senegal partly in response to the request of Senegalese authorities to better control transboundary poaching in the contiguous Niokolo Koba National Park.

In 1990 a new legislation addressing protected areas and hunting regulations, locally known as “*Code de protection de la faune sauvage et reglementation de la chasse*”, was

Table 1 Category of protected areas in Guinea

Category	Aim	Equivalent IUCN management category ^a
National park	Protection and conservation of natural sites, landscape, geological formations and wildlife for scientific, education and recreation purposes	II
Strict nature reserve	Guarantee free evolution of natural processes	I
Managed nature reserve	Conservation and management of fauna	IV
Special reserve (also named Wildlife sanctuary)	Protection of threatened species of fauna or flora	IV
Sport hunting reserve	Sustainable exploitation of game species	VI

^a Reference: IUCN (1994)

adopted: it recognises five categories of protected areas including four dedicated to the conservation of biodiversity and one for hunting (Table 1). Article 33 of the Code mentions that state-owned parts of the territory should receive priority for increased protected area status. Despite new legislation for protected areas, no attempt has since been made to rehabilitate the national parks created under the colonial era. These colonial parks are regarded now by the central administration as non-existent (although, as far as we know, they have not been officially degazetted) with the notable exception of the Kankan park, now referred to as the “Kankan Faunal reserve”.

With the opening up of Guinea to international cooperation, international donor-funded missions and projects started in the late 1980s. A mission carried out by the Wetlands Programme of the International Union for the Conservation of Nature identified in 1992 six sites of major biological importance along the Guinean coast (Scharz 1992). The recommendations of the missions led to the proclamation of the first six Ramsar sites (wetlands of international importance) in Guinea and to the creation of the Blanche Island Faunal Reserve (proclaimed to protect marine birds and turtles). In 1993 the World Heritage Committee accepted to degazette 15.5 km² of the Mount Nimba World Heritage Site (proclaimed in 1980) to allow mining prospection. However, this decision was never retranscribed into the national legislation and, as a result, the size of the Mount Nimba Strict Nature Reserve remains unchanged (Debonnet and Collin 2007). In the framework of the European Union funded “*Programme Regional d’Aménagement des Bassins Versants du Niger et de la Gambie, PRABV*” which started in the mid 1990s, the Mafou and Kouya Classified Forests were proclaimed as a national park (JO-RG 1997a, b); these two forests presently form the Haut Niger National Park. The PRABV ended in 1999 and its successor, the AGIR program, started in 2000 with the aim to strengthen transboundary cooperation in natural resources management. The project proposed the creation of two trans-boundary protected areas; one on the border with Guinea Bissau and one on the border with Mali. Field surveys carried out during the project improved the knowledge on the biodiversity of remote transboundary areas in Guinea and resulted in the discovery of remnant populations of threatened species such as elephant (*Loxodonta africana*) and giant eland (*Tragelaphus derbianus*) (Darroze 2004; Brugière et al. 2005, 2006). At the end of the AGIR program in 2005, the two proposed transboundary protected areas had still not been officially proclaimed. At last, following a nation-wide survey conducted in 2005 on the status of African vultures in Guinea which showed that the Fouta Djallon range harbours several regionally important

breeding colonies of vultures (ANI 2006), a ministerial order was issued in September 2006 to create the Fouta-Djallon Vulture Sanctuary (JO-RG 2006). The proclamation process is not yet complete as the borders, size and management structure of the sanctuary remain to be determined by subsequent legal documents.

The National Direction of Water and Forests was in charge of the management of protected areas until 2003. In 2004 this responsibility was transferred to the newly created CENAGAP (“*Centre National de Gestion des Aires Protégées*”), an institutional body placed under the supervision of the Ministry Agriculture, Livestock Breeding, Environment, Water and Forest. The Mount Nimba Strict Nature Reserve is managed by the CEGENS (“*Centre National de Gestion de l’Environnement des Monts Nimba et Simandou*”), an institutional body placed under the supervision of the Ministry of Education and Research.

Current protected area coverage

The Guinea network of nationally designated biodiversity protected areas is made up of two national parks (Badiar and Haut Niger), one strict nature reserve (Mount Nimba) and two faunal reserves including one (Kankan) with unclear legal status (Fig. 1, Table 2). These protected areas cover 7,050 km², that is 2.9% of the country land surface. Sites designated under international conventions include one world heritage site, four biosphere reserves and 16 Ramsar sites (Table 2).

Five ecoregions are represented in Guinea (Burgess et al. 2004; Fig. 1). Three ecoregions are currently covered by the four nationally designated biodiversity protected areas whereas two ecoregions (the Western Guinean Lowland Forests and Guinean Mangroves) are not covered by any existing biodiversity protected areas (Fig. 1). A total of 14 globally threatened large and medium-sized mammals occur in Guinea (IUCN 2007); six of them are not found in Guinea’s present national protected area network (Table 3).

Methods to identify key biodiversity areas

In order to identify sites of high biodiversity significance, we used the criteria for Key Biodiversity Areas (KBAs) following Eken et al. (2004). A site can be regarded as a KBA if it meets at least one out of four criteria that define a KBA. We focussed on the first criteria (which refer to the occurrence of at least one globally threatened species) as the three other criteria are difficult to use in Guinea given the scarcity of data on species distribution and abundance (see Eken et al. 2004 for a discussion on the implementation of the four criteria).

We used data on occurrence of globally threatened species of five groups of large and medium-sized mammals (Artiodactyla, Proboscidae, Sirenia, Carnivora, Primates). The rationale to select threatened mammal species as surrogates of biodiversity in this study is based on three facts: (1) this is the group for which the largest amount of data is available; (2) this group includes the largest number of globally threatened species in Guinea; (3) threatened mammals perform well as indicator of terrestrial vertebrate species diversity: Moore et al. (2003) showed that this group captured 83–96% of species (mean = 89% ± 6.4 SD) in four vertebrate groups (mammals, birds, snakes and amphibians) at the Africa continental scale.

Table 2 List of protected areas in Guinea (as of December 2007)

	IUCN category	Year gazetted	Area (km ²)	Ecoregion	Note
<i>Protected areas proclaimed under national legislation^a</i>					
Monts Nimba Strict Nature Reserve	Ia	1944	125.40	Guinean Montane Forests	Contiguous with the Monts Nimba Strict Nature Reserve in Ivory Coast
Badiar National Park	II	1985	382.00	Guinean Forest-savanna Mosaic	Contiguous with the Niokolo-Koba National Park in Senegal
Haut Niger National Park	II	1997	1,228.00	Guinean Forest-savanna Mosaic	Includes two separate areas: Mafou sector (554.0 km ²) and Kouya sector (674.0 km ²). There is a buffer zone (IUCN category V) around the Mafou sector (proclaimed in 2002 over 5,916 km ²)
Blanche Island Faunal Reserve	IV	1992	0.13	Guinean Forest-savanna Mosaic	Covers three islands: Blanche island (0.08 km ²), Corail island (0.03) and Cabri island (0.006 km ²) plus three islets
Kankan "Faunal Reserve"	IV	1926	5,314.48	West Sudanian Savanna	Proclaimed in 1925 as National Park; no updated legal status but regarded by central administration as a "Faunal reserve"
Total			7,050.01		
<i>Protected areas proclaimed under international conventions^b</i>					
Monts Nimba World Heritage Site	NA	1981	105.80	Guinean Montane Forests	Initially the World Heritage site covered the same area as the strict nature reserve. In 1993, the World Heritage Committee degazetted 1.5 km ² to allow mining prospecting
Monts Nimba Biosphere Reserve	NA	1980	1,452.00	Guinean Montane Forests	Core areas: 217.8 km ² (Mont Nimba SNR: 125.4 km ² ; Dere CF: 89.2 km ² ; Bossou CF: 3.2 km ²); buffer zone: 351.4 km ² ; transition area: 882.8 km ²
Ziama Biosphere Reserve	NA	1980	1,161.70	Western Guinean Lowland Forests	Core area: 425.4 km ² , buffer zone: 272.3 km ² , transition area: 463.9 km ²
Badiar Biosphere Reserve	NA	2002	2,843.00	Guinean Forest-savanna Mosaic	Core areas: 1,138.0 km ² (Badiar NP: 382.0 km ² , Badiar Sud CF: 86.0 km ² , Ndama CF: 670.0 km ²); buffer zone: 328.0 km ² ; transition area: 1,377.0 km ²
Haut Niger Biosphere Reserve	NA	2002	6,470.00	Guinean Forest-savanna Mosaic	Core area: 554.0 km ² (Mafou sector of Haut Niger NP); buffer zone: 3,641.0 km ² ; transition area: 2,275.0 km ²
Alcatraz Island Ramsar Site	NA	1992	0.01	Guinean Mangroves	
Tristao Islands Ramsar Site	NA	1992	850.00	Guinean Mangroves	

Table 2 continued

	IUCN category	Year gazetted	Area (km ²)	Ecoregion	Note
Konkoure Ramsar Site	NA	1992	900.00	Guinean Mangroves	
Rio Kapatchez Ramsar Site	NA	1992	200.00	Guinean Mangroves	
Rio Pongo Ramsar Site	NA	1992	300.00	Guinean Mangroves	
Blanche Island Ramsar Site	NA	1993	0.10	Guinean Forest-savanna Mosaic	
Niger-Mafou Ramsar Site	NA	2002	10,154.50	Guinean Forest-savanna Mosaic	Include part of the Haut Niger NP (Mafou sector)
Niger-Niandani-Milo Ramsar Site	NA	2002	10,464.00	Guinean Forest-savanna Mosaic and West Sudanian Savanna	Include part of the Haut Niger NP (Kouya sector)
Niger Source Ramsar Site	NA	2002	1,804.00	Guinean Forest-savanna Mosaic	
Niger-Tinkisso Ramsar Site	NA	2002	4,006.00	West Sudanian Savanna	
Sankarani-Fie Ramsar Site	NA	2002	10,152.00	West Sudanian Savanna	
Tinkisso Ramsar Site	NA	2002	8,960.00	Guinean Forest-savanna Mosaic and West Sudanian Savanna	
Gambie-Koulountou Ramsar Site	NA	2005	2,814.00	Guinean Forest-savanna Mosaic	
Gambie-Ouintou-Liti Ramsar Site	NA	2005	5,274.00	Guinean Montane Forests Ecoregion	
Bafing Falémé Ramsar Site	NA	2007	5,173.00	Guinean Forest-savanna Mosaic and West Sudanian Savanna	
Bafing source Ramsar Site	NA	2007	3,172.00	Guinean Forest-savanna Mosaic	
Total					

^a Include only protected areas corresponding to IUCN categories I-IV; Classified Forests (IUCN category VI) not mentioned

^b Biosphere Reserve refers to the Man and Biosphere Program (managed by UNESCO); World Heritage site refers to the World Heritage Convention and Ramsar sites refer to the Convention on Wetlands; NA: Not applicable

Table 3 Occurrence of the globally threatened large and medium-sized mammals in the Guinean national biodiversity protected area network

Species ^a	2007 IUCN Red List Status	Occurrence in the existing protected area network ^b
Artiodactyla		
<i>Hexaprotodon liberiensis</i>	Endangered	
<i>Hippopotamus amphibius</i>	Vulnerable	HNNP, BNP, KFR
<i>Tragelaphus derbianus</i>	Endangered	
<i>Cephalophus jentinki</i>	Vulnerable	MNSNR
<i>Cephalophus zebra</i>	Vulnerable	
Proboscidae		
<i>Loxodonta africana</i>	Vulnerable	
<i>Loxodonta cyclotis</i>	Vulnerable	
Sirenia		
<i>Trichechus senegalensis</i>	Vulnerable	HNNP
Carnivora		
<i>Panthera leo</i>	Vulnerable	HNNP, KFR
<i>Profelis aurata</i>	Vulnerable	HNNP, MNSNR
<i>Lycaon pictus</i>	Endangered	
Primates		
<i>Cercopithecus diana</i>	Endangered	MNSNR
<i>Procolobus badius</i>	Endangered	MNSNR, BNP
<i>Pan troglodytes</i>	Endangered	HNNP, MNSNR
Reference	IUCN (2007)	Galat-Luong and Galat (1990), Adie et al. (1997), Sillero-Zuberi et al. (1997), Lamotte and Roy (1998), Ziegler et al. (2002), Brugière and Magassouba (2003), and Butzler (1998)

^a Taxonomy follows Duff and Lawson (2004); ^b MNSNR, Mont Nimba Strict Nature Reserve; HNNP, Haut Niger National park; BNP, Badiar National Park; KFR, Kankan Faunal Reserve

Data on occurrence of mammal species was collected in two different ways: (1) field visit by authors resulting in direct or indirect (e.g., tracks) observations; (2) review of published papers and unpublished reports.

To assess the relative conservation significance of the KBAs, we applied a scoring system using species and ecoregion conservation status at the national and global context. Ecoregions of Africa have been categorised into five classes of decreasing priority for conservation (class I being the most important) according to biological distinctiveness and conservation status criteria (Burgess et al. 2004). We attributed a decreasing score from 5 to 1 to KBAs identified in class I to class V ecoregions, respectively. To address the principles of systematic conservation planning, in particular the principle of complementarity (Margules and Pressey 2000), the ecoregion conservation score of KBAs located in an ecoregion with no existing biodiversity protected areas in Guinea was elevated by one point. Similarly a score ranging from 3 to 1 was attributed to threatened mammals species found in KBAs according to their Red List status from 3 for the most threatened species (Critically Endangered category in the 2007 IUCN Red List of Threatened Species) to 1 for the least threatened species (Vulnerable category). The score of threatened mammal

species not represented in the existing Guinean biodiversity protected areas was elevated by one point and an additional point was attributed when a species was recorded in only one site (see Table 5 for details on the scoring system). The species conservation score of a KBA was calculated as the average of the score of each species recorded in the KBA. The conservation significance score of a KBA is the sum of its ecoregion and species conservation scores.

Results

We identified a total of 16 KBAs across the country including five in the two forest ecoregions (lowland and mountain), nine in the two savanna ecoregions (West Sudanian and Forest-Savanna Mosaic) and two in the mangrove ecoregion (Fig. 2). The three KBAs with the highest conservation significance scores are located in the same ecoregion, the Western Guinean Lowland Ecoregion (Table 4; see Tables 5, 6, 7, 8, 9, 10 for details). This is explained by three facts: (1) it is the most threatened ecoregion found in Guinea; (2) this ecoregion is not covered by any existing biodiversity protected areas and (3) two of the three KBAs located in this ecoregion (Ziama and Diécké) have the greatest number of threatened mammals of all Guinean KBAs and, in addition, the species recorded have a high score. This includes three of the seven Endangered mammal species found in Guinea: the chimpanzee (*Pan troglodytes*), the Diana monkey (*Cercopithecus diana*) and the pygmy hippopotamus (*Hexaprotodon liberiensis*). The threatened mammal with the highest species score in Guinea, the Lord Derby's eland, is found only in Bakoy KBA and significantly contributed to high conservation significance score of that site. Sites located in

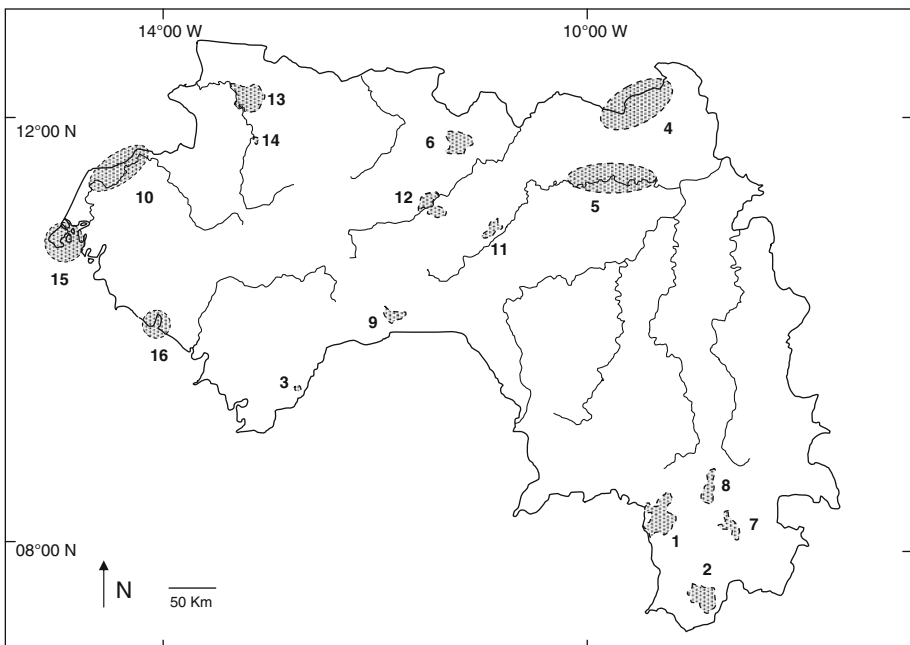


Fig. 2 Key biodiversity areas in Guinea. Site number refers to Table 4

Table 4 Key biodiversity areas (KBA) in Guinea (ranked in order of conservation significance; numbers refer to Fig. 2)

KBA Number	Name	Size (km ²)	Current legal status	Ecoregion	Number of threatened mammals species ^a	Ecoregion conservation score	Species conservation score	Conservation significance score
1	Ziama	420	Classified Forest	Western Guinean Lowland Forests	8	6	2.1	8.1
2	Diéké	150	Classified Forest	Western Guinean Lowland Forests	6	6	1.8	7.8
3	Kounoukan	50	Classified Forest	Western Guinean Lowland Forests	3	6	1.7	7.7
4	Bakoy	1,000	None	West Sudanian Savanna	4	5	2.0	7.0
5	Tinkisso	500	None	West Sudanian Savanna	4	5	1.5	6.5
6	Bakoun	280	Classified Forest	West Sudanian Savanna	2	5	1.5	6.5
7	Mt Bero	236	Classified Forest	Guinean Montane Forests	4	4	2.0	6.0
8	Pic de Fon	256	Classified Forest	Guinean Montane Forests	2	4	2.0	6.0
9	Pinselli-Soyah	214	Classified Forest	Guinean Forest-savanna Mosaic	1	4	2.0	6.0
10	Kogon	500	None	Guinean Forest-savanna Mosaic	6	4	1.7	5.7
11	Balayan Souroumba	250	Classified Forest	Guinean Forest-savanna Mosaic	2	4	1.5	5.5
12	Bani-Dar-es-Salam	350	Classified Forest	Guinean Forest-savanna Mosaic	2	4	1.5	5.5
13	Ndama	670	Classified Forest	Guinean Forest-savanna Mosaic	4	4	1.5	5.5
14	Fello Digué	30	Classified Forest	Guinean Forest-savanna Mosaic	3	4	1.3	5.3
15	Tristao Islands	300	None	Guinean Mangroves	1	3	1.0	4.0
16	Rio Pongo	300	None	Guinean Mangroves	1	3	1.0	4.0
Total		5,506						

^a From the taxonomic groups: Artiodactyla, Proboscidea, Sirenia, Carnivora, Primates

the Guinean Mangrove Ecoregion have the lowest conservation significance score due both to low level of threat of the mangrove ecoregion and the small number of threatened mammals recorded. Overall, the KBAs identified in this study cover an area of 5,506 km² and, if gazetted, this would bring the total biodiversity protected area coverage in Guinea from 2.9% to 5.1% of the country's land surface. This would provide protection to all ecoregions and all but one globally threatened large and medium-sized mammals species recorded in the country.

Discussion

Limitations

In this study, the identification of specific KBAs within each ecoregion and the assessment of their relative conservation significance are based on the availability of data on mammal occurrence. This method has several limitations and therefore the result should be interpreted with caution. First, sites with available data are not distributed equally across the country and some ecoregions are better covered than others. It is certain therefore that more KBAs remain to be identified across the country. Second, all sites with available data have not been surveyed with the same methods and same intensity, ranging from intensive multi-taxa surveys conducted by scientists over years (e.g., Ziama and Diecké) to short surveys based on interviews with local hunters (e.g., Tinkisso). As a result, additional species of mammals are likely to be found in low effort sampled sites that, in turn, may increase their conservation significance. Finally, and most importantly, the ultimate goal of a protected area network is to maintain biodiversity over the long term and the occurrence of species does not necessarily mean persistence. As abundance is commonly used to estimate probability of persistence (e.g., Araujo and Williams 2000), local population density of species should be a key criterion in identifying sites. However data on species abundance is lacking in Guinea. Based on simulations using field data, Gaston and Rodrigues (2003) showed that reserve networks selected on the basis of occurrence data obtained by low sampling effort tended to include sites within species ranges where they were locally more abundant (because the species detection rate is partly a function of local abundance). This suggests that KBAs identified in this study could include sites where some species reach their peak of abundance and thus are less vulnerable to extinction over time.

Agreement with the IBA network

Three of the 18 IBAs identified in Guinea correspond to existing biodiversity protected areas (Badiar and Haut Niger National Parks, Mount Nimba Strict Nature Reserve) (Robertson 2001). Of the remaining 15 IBAs, six match KBAs identified in this study (Ziama, Diécké, Konounkan, Nialama, Tristao and Pongo). Interestingly this includes the three KBAs with the highest global conservation scores. Of the remaining nine IBAs that do not match KBAs, four fall within the Guinean mangrove ecoregion and four within the Guinea forest savanna-mosaic ecoregion. Overall, nine IBAs out of 18 corresponds to the existing or proposed biodiversity protected areas, suggesting a moderate rate of congruence between protected area network selected on the occurrence of bird species and threatened mammal species in Guinea.

KBA conservation status

The fact that 12 of the 16 KBAs identified in this study already have the legal status of Classified Forest underlines the role that forest reserves could play in completing the biodiversity protected area network. Burgess et al. (2007) recently shown that almost all of the protected areas gaps identified in Africa have significant coverage by forest reserves and recommended to pay more attention to these areas when identifying new protected areas to close the gap in national or regional protected area networks. In Guinea, this recommendation has a legal basis, as the national legislation on protected area mentions that state-owned parts of the territory (Classified Forests in particular) should receive priority for increased protected area status. Classified forests in Guinea are supposed to be managed by the State for sustainable natural resource management. However the control of the State has been weak over the last 20 years and most classified forests in Guinea are now severely degraded (mainly due to farming activities) (MMGE 2001). Isolation has been the best protection and so far only remote classified forests remain relatively undisturbed.

Although Classified Forests have generally received little attention from the government, Zياما and Diécké Classified Forests are the exception as they have been subject to intense management over the last 15 years (funded by international assistance). They are presently managed according to forest management plans that include conservation core areas with no human activity allowed. Closed canopy lowland forests in Guinea have been largely cleared for agriculture purposes over the last 20 years (Wilson 1992; FAO 2005) and Zياما and Diécké today represents the two last largest unfragmented closed-canopy forest blocks in Guinea. Given that these forests (1) have the highest conservation significance scores of all KBAs in Guinea, (2) that they harbour four of the seven threatened large and medium-sized mammal species presently not represented in the existing biodiversity protected areas and (3) that Zياما holds the sole viable populations of several threatened species in Guinea (in particular the pygmy hippo and the forest elephant, Butzler 1994; Barnes and Awo 2005, respectively) we recommend that the conservation core areas established under the forest management plans receive the highest level of formal protection, that is the national park status. The proclamation of Zياما and Diécké as biodiversity protected areas would increase the number of globally threatened mammals included in the national protected area network from 8 to 11.

Conclusion

The KBAs identified in this study could form the basis of the future national protected areas network in Guinea. However because of the limitations of the method used more work is needed to establish a fully comprehensive protected area network that conserve the country's biodiversity over the long term. There is not yet a standard method for designing a protected area network and the procedure proposed here should be regarded as preliminary. It is important to include all appropriate stakeholders in Guinea to design the best method to complete the existing protected areas. In particular, the consensual definition of the objectives of such protected area network is essential in determining the subsequent pragmatic procedure to be followed in site selection (IUCN 1998).

Designing a protected area network at the national level is costly and time-consuming. In Uganda, where the national biodiversity is much better studied than in Guinea, such a conservation planning exercise involved more than 100 person-years of work and cost in excess of US\$ 1 million (Howard et al. 2000). Guinea might not have the financial or technical resources to conduct such a program. We therefore strongly recommend that international donor agencies provide appropriate support to help Guinea build its national protected area network for the conservation of the country's biodiversity over the long term.

We recognized that it is also necessary to secure the funding and technical capacity for the sound management of Guinea's existing areas. However, we do not feel that developing Guinea's protected area network should be delayed pending further resources for existing protected areas. Studies suggest that even "paper parks" can yield significant biodiversity conservation benefits (Bruner et al. 2001). In addition, donors might actually be more likely to fund protected areas in Guinea if they see a strong political commitment to creating a protected areas network. Finally, a vision of what a complete protected area network entails, can greatly aid a country in determining its management needs and thus conservation planning in the long term.

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Appendix 1

See Table 5.

Table 5 Scoring system for species recorded in the Guinean Key Biodiversity Areas according to their conservation status (IUCN Red List) and their occurrence in the existing Guinean biodiversity protected area network

IUCN Red List category	Recorded in the existing protected area network (and or not in any KBA)	Not recorded in the existing protected area network and found in at least two KBAs	Not recorded in the existing protected area network and found in only one KBA
Critically Endangered	3	4	5
Endangered	2	3	4
Vulnerable	1	2	3

Appendix 2

See Tables 6, 7, 8, 9, 10.

Table 6 Conservation significance score of KBAs located in Western Guinean Lowland Forests Ecoregion

Species ^a	2007 IUCN Red List Status	Score of species ^b	Species occurring in KBA		
			Ziama	Diécké	Kounounkan
Artiodactyla					
<i>Hexaprotodon liberiensis</i>	EN	3	3	3	
<i>Hippopotamus amphibius</i>	VU	1			
<i>Tragelaphus derbianus</i>	EN	4			
<i>Cephalophus jentinki</i>	VU	1	1	1	
<i>Cephalophus zebra</i>	VU	3	3		
Proboscidae					
<i>Loxodonta africana</i>	VU	3			
<i>Loxodonta cyclotis</i>	VU	3	3		
Sirenia					
<i>Trichechus senegalensis</i>	VU	1			
Carnivora					
<i>Panthera leo</i>	VU	1			
<i>Profelis aurata</i>	VU	1	1	1	1
<i>Lycyon pictus</i>	EN	NA			
Primates					
<i>Cercopithecus diana</i>	EN	2	2	2	2
<i>Procolobus badius</i>	EN	2	2	2	2
<i>Pan troglodytes</i>	EN	2	2	2	2
KBA Species score ^c			2.12	1.83	1.66
KBA Ecoregion score ^d			6	6	6
KBA Conservation significance score ^e			8.12	7.83	7.66
Reference	IUCN (2007)		Butzler (1994), Wright et al. (2007a)	Butzler (1994)	Barnett et al. (1994, 1996)

^a Taxonomy follows Duff and Lawson (2004); ^b See text ("Method" section) and Table 5 for details; ^c Mean of score of each species; ^d See text ("Method" section) for details; ^e Sum of Species score and Ecoregion score; NA, not applicable; species not recorded in the existing protected area network or in any KBA

Table 7 Conservation significance score of KBAs located in Guinean Montane Forests Ecoregion

Species	2007 UICN Red List Status	Score of species	Species occurring in KBA		Fello Digué
			Ptc de Fon	Mt Bero	
Artiodactyla					
<i>Hexaprotodon liberiensis</i>	EN	3		3	
<i>Hippopotamus amphibius</i>	VU	1			1
<i>Tragelaphus derbianus</i>	EN	4			
<i>Cephalophus jentinki</i>	VU	1			
<i>Cephalophus zebra</i>	VU	3			
Proboscidae					
<i>Loxodonta africana</i>	VU	3			
<i>Loxodonta cyclotis</i>	VU	3			
Sirenia					
<i>Trichechus senegalensis</i>	VU	1			
Carnivora					
<i>Panthera leo</i>	VU	1			
<i>Profelis aurata</i>	VU	1		1	1
<i>Lycyon pictus</i>	EN	NA			
Primates					
<i>Cercopithecus diana</i>	EN	2	2	2	
<i>Procolobus badius</i>	EN	2			
<i>Pan troglodytes</i>	EN	2	2	2	2
KBA Species score			2.0	2.0	1.33
KBA Ecoregion score			4	4	4
KBA Conservation significance score			6.0	6.0	5.33
Reference	IUCN (2007)		McCullough (2004)	Butzler (1999), Wright et al. (2007b)	Ham (1998)

Table 8 Conservation significance score of KBAs located in Guinean Forest-Savanna Mosaic Ecoregion

Species	2007 IUCN Red List Status	Score of species	Species occurring in KBA				
			Ndama	Bani-Dar Es Salam	Pinselli-Soyah	Kogon	Balayan- Souroumba
Artiodactyla							
<i>Hexaprotodon liberiensis</i>	EN	3					
<i>Hippopotamus amphibius</i>	VU	1	1			1	
<i>Tragelaphus derbianus</i>	EN	4					
<i>Cephalophus jentinki</i>	VU	1					
<i>Cephalophus zebra</i>	VU	3					
Proboscidae							
<i>Loxodonta africana</i>	VU	3				3	
<i>Loxodonta cyclotis</i>	VU	3					
Sirenia							
<i>Trichechus senegalensis</i>	VU	1					
Carnivora							
<i>Panthera leo</i>	VU	1	1	1		1	1
<i>Profelis aurata</i>	VU	1			1		
<i>Lycyaon pictus</i>	EN	NA					
Primates							
<i>Cercopithecus diana</i>	EN	2					
<i>Procolobus badius</i>	EN	2	2			2	
<i>Pan troglodytes</i>	EN	2	2	2	2	2	2
KBA Species score			1.50	1.50	2.0	1.66	1.5
KBA Ecoregion score			4	4	4	4	4

Table 8 continued

Species	2007 IUCN Red List Status	Score of species	Species occurring in KBA				
			Ndama	Bani-Dar Es Salam	Pinselli-Soyah	Kogon	Balayan- Souroumba
KBA Conservation significance score			5.50	5.50	6.0	5.66	5.50
Reference	IUCN (2007)	Adie et al. (1997), Pellegrini and Ghiurghi (2005)		Pelosi (2000)	Pelosi (2000)	Brugière et al. (2005, 2006), Wright et al. (2007a)	Ham (1998)

Table 9 Conservation significance score of KBAs located in the West Sudanian Savanna Ecoregion

Species	2007 UICN Red List Status	Score of species	Species occurring in KBA		
			Tinkisso	Bakoy	Bakoun
Artiodactyla					
<i>Hexaprotodon liberiensis</i>	EN	3			
<i>Hippopotamus amphibius</i>	VU	1	1		1
<i>Tragelaphus derbianus</i>	EN	4			4
<i>Cephalophus jentinki</i>	VU	1			
<i>Cephalophus zebra</i>	VU	3			
Proboscidae					
<i>Loxodonta africana</i>	VU	3			
<i>Loxodonta cyclotis</i>	VU	3			
Sirenia					
<i>Trichechus senegalensis</i>	VU	1	2		
Carnivora					
<i>Panthera leo</i>	VU	1	1		1
<i>Profelis aurata</i>	VU	1			
<i>Lycan pictus</i>	EN	NA			
Primates					
<i>Cercopithecus diana</i>	EN	2			
<i>Procolobus badius</i>	EN	2			
<i>Pan troglodytes</i>	EN	2	2		2
KBA Species score			1.5		1.5
KBA Ecoregion score			5		5
KBA Conservation significance score			6.5		6.50
Reference	IUCN (2007)	DB pers. obsv.	Darroze (2004), Granier and Martinez (2004)		Ham (1998)

Table 10 Conservation significance score of KBAs located in the Guinean Mangroves Ecoregion

Species	2007 UICN Red List Status	Score of species	Species occurring in KBA	
			Tristao Islands	Rio Pongo
Artiodactyla				
<i>Hexaprotodon liberiensis</i>	EN	3		
<i>Hippopotamus amphibius</i>	VU	1		
<i>Tragelaphus derbianus</i>	EN	4		
<i>Cephalophus jentinki</i>	VU	1		
<i>Cephalophus zebra</i>	VU	3		
Proboscidae				
<i>Loxodonta africana</i>	VU	3		
<i>Loxodonta cyclotis</i>	VU	3		
Sirenia				
<i>Trichechus senegalensis</i>	VU	1	1	1
Carnivora				
<i>Panthera leo</i>	VU	1		
<i>Profelis aurata</i>	VU	1		
<i>Lycyon pictus</i>	EN	NA		
Primates				
<i>Cercopithecus diana</i>	EN	2		
<i>Procolobus badius</i>	EN	2		
<i>Pan troglodytes</i>	EN	2		
KBA Species score			1.0	1.0
KBA Ecoregion score			3	3
KBA Conservation significance score			4.0	4.0
Reference	IUCN (2007)		D.B. pers. obsv.	D.B. pers. obsv.

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