

Bird Surveys in the Gamba Complex of Protected Areas, Gabon

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1 Introduction

Approximately 2,100 species of birds are known from Africa south of the Sahara. Gabon is fairly well known ornithologically, the first collections having been made by du Chaillu as early as the 1850s. To date, 678 species have been recorded in the country (Christy 2001), or about 30% of the total known for sub-Saharan Africa. Gabon's bird diversity is relatively limited compared to some other Afrotropical countries, such as Cameroon, which has more than 900 species. The main factors involved include its relatively small size and lack of habitat and topographic diversity. The natural vegetation of most of Gabon is lowland evergreen and semi-evergreen forest, with only limited areas of savanna in the east and south, and its maximum elevation is 1,575 m, compared to 4,095 m for Cameroon. Because of this Gabon has relatively few species native to savanna or montane environments.

In economic terms, in recent decades petroleum has been Gabon's most important natural resource. Many of Gabon's deposits are in tropical forest areas, and their development for production necessarily involves removal of some forest and its conversion to other habitats such as grass, scrub, and bare ground. Road building and construction can block or change drainage patterns, altering the flow of streams and creating ponds, swamps, and marshes. Roads and pipeline clearings can fragment forests, and allow colonization by potential competitors, predators and parasites (Kroodsma 1982, 1984). Gas flares, by attracting and killing nocturnal insects, could potentially affect resources for some species.

The Gamba region has been a very important area for oil development by Shell Gabon for more than 40 years. It is also a very significant area for the conservation of Gabon's birds. Eight protected reserves under various levels of protection (see following section), collectively known as the Gamba Complex of Protected Areas, were previously set up. In 2002, the

status of protected areas within the complex was revised, and two areas, Loango and Moukalaba-Doudou, were upgraded to National Parks. An analysis by BirdLife International (Christy 2001) found the Gamba Complex to qualify as one of Gabon's six Important Bird Areas (IBAs). Important Bird Areas are areas that have been determined to be most important for the conservation of birds at the global level, based on the distribution of endangered, endemic, habitat-restricted, and congregatory species.

Despite its importance, there has been relatively little published ornithological work on the Gamba Complex. Sargeant (1993) was resident at Gamba for five years and compiled a bird list for the immediate area, and as well as lists for other localities within the Complex, including Rabi, the Rembo (River) Ndogo, and the east side of the Moukalaba Faunal Reserve, based on much briefer visits. Schepers and Marteiijn (1993) included some incidental observations of land birds from the area in their report on surveys of waterbirds along Gabon's coast. Christy (2001) provided a list of species of conservation interest for the Complex, but without details on individual sites within it. No detailed ornithological surveys have been undertaken in most of the Complex.

In order to rectify this lack of information, the Smithsonian Institution's Monitoring and

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Assessment of Biodiversity Program (MAB), in consultation with local stakeholders, and with the support of Shell Foundation and Shell Gabon, undertook more intensive bird surveys in the Gamba Complex. The principal objectives of this work were (1) to obtain more detailed bird species lists and other information on bird communities at sites in the Gamba Complex, including areas subject to oil development and more remote areas; (2) evaluate differences between these areas that might be attributed to oil and other development; (3) obtain baseline information that could be used to develop monitoring programs or research projects on the effect of development in the area.

2 Study Areas

The Gamba Complex totals approximately 1,130,000 ha centered on the coast around the town of Gamba. The Complex originally consisted of eight protected areas: the faunal reserves of Petit Loango, Ouanga Plain and Moukalaba-Dougoua; the hunting domains of Setté Cama, Iguéla, Ngové-Ndongo and Moukalaba; and the sensible-use faunal zone of Monts Doudou. In 2002 the status of the protected areas was revised, and Loango and Moukalaba-Doudou National Parks were established.

The coast consists mainly of sandy beach and sand dunes, with coastal scrub immediately inland. Wave action intermittently blocks lagoon and river mouths with sand, producing small brackish or freshwater lagoons that periodically empty into the sea during the rainy season when rains cause the rivers to rise and breach these barriers. Mangroves occur in lagoons and river mouths and other areas sheltered from the surf. The Ndogo Lagoon is the largest freshwater lagoon system in Africa. Beyond the coastal zone lowland tropical forest covers most of the area, including permanently and seasonally flooded swamp forest and upland forest. Immediately inland from the coast these forests are broken by small areas of savanna, and there is more extensive savanna on the eastern side of Moukalaba-Doudou National Park. The area mostly consists of lowlands, with the exception of the Monts Doudou area to the northwest, which reaches about 800 m.

Average annual rainfall at Rabi was 2,301.8 mm for the period 1989-2001. The rainy season extends from October to May, and there is a short but intense dry season from June to September. During the rainy

season there are two peaks in precipitation, the larger in November (mean of 394.9 mm) and the smaller in April (301.5 mm); the rainy season month with the lowest precipitation is February (226.3 mm). Very little rain falls during the peak months of the dry season, July (2.2 mm) and August (7.2 mm). All data is from Rabi 1989-2001 and provided by Shell Gabon.

Oil development in the area of Gamba began in 1967. In 1987 development began at the Rabi oil field about 80 km to the north, and a road and a pipeline were constructed to connect the field to Gamba. More recently, oil has been discovered in the Toucan-Calao area just to the north of the Rabi field, and roads and well sites were constructed in 2001 and 2002.

We worked at four main sites within the Gamba Complex, two of them in areas of oil development and two at more remote and relatively pristine sites: (1) the Gamba area; (2) the Rabi and Toucan oil fields; (3) Loango National Park; and (4) Moukalaba-Doudou National Park (see map page xxxii). These sites are described in more detail in the following sections.

2.1 Gamba

The natural habitats of the Gamba area include sandy beaches, coastal scrub, and mangroves along the coast, and swamp and upland forests interspersed with small strips of savanna inland. There are also a number of small lakes, including Yenzi and Totou, and the Ndogo Lagoon is directly to the north. Development in the area has included an extensive complex of oil and gas wells in the Gamba and Ivinga fields, pipelines, the Gamba oil terminal, the towns of Gamba, Yenzi, and Vembo, an airport, and an extensive connecting network of roads. There are also several traditional villages in the area that practice subsistence agriculture and hunting, principally with snares. Because of this, much of the forest in the immediate area of Gamba has been fragmented and disturbed, but less-disturbed habitat occurs only a few kilometers away.

We established four mist-netting sites in the Gamba area (see the Methods section for description of mist-netting protocols). These sites were selected to compare bird communities in areas adjacent to the oil fields (Gamba-30 and Gamba-26) to those farther away (Mayonami Road and Totou). The sites were: (1) **Gamba-30** (02°45'24"S, 10°00'29"E). This well

site is located in a block of relatively dry upland forest completely surrounded by roads and about 1.8 x 2.0 km in size. (2) **Gamba-26** (02°45'31"S, 10°01'30"E). This well site is located in a block of forest, including both upland forest and seasonally-flooded forest with areas dominated by raffia palms, completely surrounded by roads and about 1.8 x 2.0 km in size. (3) **Mayonami Road** (02°49'44"S, 10°05'38"E). This site, in continuous unfragmented seasonally-flooded forest, is located approximately 8 km out on the road to Mayonami south of Yenzi, and 4 km east of the nearest oil well, Ivinga-4. (4) **Totou** (02°42'03"S, 10°00'01"E). This site, in continuous unfragmented upland forest, is located between Ndogo Lagoon and Totou Lake, approximately 1 km northeast of the active Totou-7 oil well, and about 500 m from the inactive Totou-4. The sites ranked from driest to wettest were Totou, Gamba-30, Gamba-26, and Mayonami Road.

2.2 Rabi-Toucan

These sites are discussed together because of their proximity. The original natural vegetation of the area included seasonally-flooded and upland forest. The Rembo Rabi, a forested river, flows through the center of the Rabi field. At the time of study, the Rabi area included production and other wells, a ring road and branches connecting the wells, a pipeline system, a central and five subsidiary gathering stations, an air strip, housing, office and shop areas, quarries, and other facilities. The ring road isolates a central block of forest from the surrounding continuous forest, which is further subdivided by transverse roads and pipeline corridors. Road and well construction has altered the flow of surface water in some areas, drowning trees and creating areas of open water. At the central station and the gathering stations six large flares are used to burn off unutilized natural gas from the wells.

More recently, the discovery of oil to the north of Rabi prompted the construction of a new road, 12 km in length, following the course of a former logging road, from the north end of the Rabi field to the Toucan well site, in 2001. In 2002, the road was in the process of being extended an additional 6 km to the planned Calao well site during our surveys in the area. The road, excluding shoulders, is 15 m in width.

Selective logging took place in the Rabi area up until oil development began about 15 years ago, and logged forest is evident in several areas especially in

the northeast around M'Bari. Selective logging was conducted in the Toucan-Calao area more recently. On the new road between Rabi and Toucan, approximately the first 6 km were heavily affected by recent logging, while the forest along the rest of the road was relatively intact. Likewise the first 4 km of the road between Toucan and Calao was mostly intact, while the final 2 km were heavily impacted by logging, especially around the Calao well site itself. These relatively intact zones were logged in 2003. Extensive forestry concessions and logged areas are located immediately around the Toucan-Calao area.

Shell Gabon employees and contractors in the Rabi area are prohibited from hunting or purchasing bush meat. Because of Shell's control of road access and the distance from Rabi to villages, little if any hunting by outsiders probably takes place within the Rabi field. There are several villages to the north of Calao, however, and the frequency of snares, spent shells, and other evidence indicates substantial hunting pressure in the Toucan-Calao area (Laurance *et al.* in press; Croes *et al.* submitted).

We established five main mist-netting sites in the Rabi area and four along the Toucan road. These sites were selected to compare primary forest, both seasonally flooded and upland (Rabi-12, Rabi-59, Rabi-33, PK-2, and Marianga River) with sites that had suffered disturbance, including selectively logged sites (M'Bari and Marianga Road) and those that had been completely deforested and now were regenerating to scrub (Ossengue Camp and Quarry). Of the primary forest sites, Rabi-12 and PK-2 were in drier upland forest and Rabi-33 and Marianga River in swamp forest, while Rabi-59 included both. All of the disturbed sites were on drier terrain.

The sites at Rabi included: (1) **Rabi-12** (01°58'18"S, 09°01'55"E). The area of this well site, near the southern end of the Rabi field, included drier upland primary forest (although two nets were placed on a small marshy stream). (2) **Rabi-59** (01°56' 51"S, 09°51'08"E). The area of this well site, on the southwest side of the field, included both primary swamp forest and drier upland forest. (3) **Rabi-33** (01°56'43"S, 09°52'00"E). This well site, in the middle of the southern part of the field within the ring road, included primary swamp forest. (4) **M'Bari** (01°52'17"S, 09°51'57"E). This area, near the northeast corner of the field, was selectively logged approximately 15 years ago. Nets were placed along the edges of a broad logging road that

was open to the sky and within selectively logged forest along overgrown logging roads. (5) **Ossengue Camp** (01°56'11"S, 09°52'51"E). This area was north of the airstrip and immediately to the west of Ossengue Camp on the southeast side of the oil field, and included young secondary growth and scrub in the airstrip approach area.

The sites at Toucan included: (1) **Quarry** (01°51'24"S, 09°51'08"E). This site was near the beginning of the Toucan Road, at the large inactive Moambatsango quarry to the east of the road near the Rabi-165 well, and included tall secondary growth growing on piles of rubble between the quarry and the road. (2) **PK-2** (01°50' 53" S, 09° 51' 35" E). This site was approximately 2 km from the start of the Toucan Road, and included upland primary forest to the east of the road. (3) **Marianga Road** (01°49'30"S, 09°52'50"E). This site was located along an old logging road west of the Toucan Road, on a ridge just south of the Marianga River, and included selectively logged upland forest. (4) **Marianga River** (01°56'11"S, 09°52' 51"E). This site was on the north side of the Marianga River to the west of the Toucan Road, and included primary swamp forest.

Besides the mist-netting sites, we made observations throughout the Rabi road system and on the road east from the oil field, the Toucan-Calao Road, and on other trails that had been set up for the project in the Rabi and Toucan areas. Angehr, Schmidt, and Christy also visited Lake Divangui, about 15 km east of Rabi, on 9 March 2002.

2.3 Loango National Park

Our base camp was located near the coast approximately 12 km north of the outlet of the Ndogo Lagoon. The littoral zone in this area consists of a sandy beach with often heavy surf. Streams become temporarily dammed by sand where they enter the sea, producing lagoons of brackish water. Rain periodically causes lagoon waters to rise and burst through these sand dams, suddenly draining the lagoons. The vegetation immediately along the coast includes grassy prairies, windswept scrub, mangroves, and open palm groves. In a few places tall forest extends to the edge of the beach itself. Just inland from this coastal zone a series of small narrow savannas run parallel to the coastline. Primary lowland forest, swampy in places, extends inland from these savannas. Although some selective logging and construction of seismic lines

took place in the area in the past, the area at the time of study was relatively undisturbed. Because of its distance from human habitation, hunting pressure is probably very light.

We established three mist-netting sites in the area, which were selected to sample the three main natural habitats. The sites were: (1) **Primary forest** (02°20'25"S, 09°35'52"E). This site included drier open primary forest. Nets were placed near undergrowth if possible and in vine tangles near dry stream beds. (2) **Coastal vegetation** (02°20'36"S, 09°35'30"E). The site included low dense coastal scrub and dry mangrove forest. Two nets were placed in a nearby stream bottom with pools of water. (3) **Savanna/gallery forest** (02°20' 34"S, 09°35' 46"E). Nets were placed in the savanna/forest transition zone (i.e., 1040 m inside the forest from its border with savanna), and in small copses ("gallery forest") within the savanna.

Besides the areas of the mist-netting sites, our surveys covered the coastal area from the mouth of the Ndogo Lagoon north for approximately 20 km, to the mouth of a large river just south of Petit Loango itself. From the base camp, we walked trails inland to a distance of about three km.

2.4 Moukalaba-Doudou National Park

Our base camp was located near the northwest corner of the Ndogo Lagoon, at 02°35'13"S, 10°14'03"E. It was in primary upland forest, approximately 1.3 km from the shore of the lagoon and about 700 m from permanently flooded forest fringing the lagoon. Low hills to the north of the camp rose to about 200 m. The site is remote from human habitation, and hunting pressure is probably slight.

We mist-netted at four sites selected to sample upland and swamp forests, the only major habitats present at the site. (Precise locations for the sites are not given because of the difficulty of obtaining GPS readings within dense closed-canopy forest.) The sites were: (1) **Camp-1**. This site was in upland primary forest just west of the base camp. (2) **Camp-2**. This site was in upland primary forest just north of the base camp, on rocky slopes that were drier than at Camp-1. (3) **Swamp-1**. This site was located in and at the edge of seasonally flooded forest about 700 m east the base camp. (4) **Swamp-2**. This site was located in and at the edge of seasonally flooded forest about 1 km northeast of the base camp.

In addition to the mist-netting sites, we walked other trails in the area to a distance of about 3 km from the base camp. We visited the lower part of the Rembo Ndogo on 21 and 22 April 2003. This river is mostly lined with permanently flooded swamp forest, and has areas of papyrus and swamp near its mouth. We also include observations from the Ndogo Lagoon between our base camp and the river.

3 Methods

The dates of our field surveys were: Gamba, 3 July-2 August 2001 (Angehr) and 14-22 November 2002 (Njie); Rabi, 18 February-15 March 2002 (Angehr, Christy, and Schmidt); Toucan-Calao, 27 May-20 June 2002 (Angehr, Schmidt, and Gebhard); Loango National Park, 23 September-16 October (Schmidt) and 23 October-13 November 2002 (Angehr and Njie); and Moukalaba-Doudou National Park, 25 March-22 April 2003 (Angehr, Schmidt, and Njie). Landry Tchignoumba, Martin A. Erere Ombenotori, Raoul Niangadouma, and Olivier Uchendu Moussavou assisted with field work during various parts of the study.

To obtain species lists for each site, we used a combination of auditory/visual surveys and mist-netting. On auditory/visual surveys, we attempted to visit all major habitats at each site. We walked trails, roads, coastal areas, or through savanna from dawn to about mid-day, and usually again from 1600 to near dusk. We also surveyed for owls, nightjars, and other nocturnal species at night, by spot-lighting along roads and trails, and by playing calls and listening for response.

We documented species occurrence by collection of voucher specimens (principally by mist-netting), by photographs, and by recording vocalizations with a Sony TCM-5000 portable tape recorder with a Sennheiser short shotgun microphone. For species identifications we primarily used Borrow and Demey (2001) and Mackworth-Praed and Grant (1970, 1973), supplemented by Rand *et al.* (1959), Serle *et al.* (1977), Christy and Clarke (1994), and Kemp and Kemp (1998), and for vocalizations Chappuis (2000).

We carried out a pilot study using standardized mist-netting samples in order to obtain information on capture rates for development of a long-term monitoring program in the future. MacArthur and MacArthur (1974), and Karr (1981) provide discussion of mist-

netting as a survey technique. Mist-netting samples mostly the portion of the bird community using the lower strata of the forest (ground level to 3 m), and those that are highly mobile (MacArthur and MacArthur 1974, Karr 1981, Remsen and Good 1996). Although mist-netting is biased toward understory species, this group includes many of the species that are most vulnerable to local extinction due to habitat change (e.g. Willis 1974, Karr 1982). We also used mist-netting to obtain information on breeding condition and molt, to document the presence of furtive and non-vocal species, and to obtain voucher specimens.

We used "ATX" type nets, 12 m long by 2.6 m high, with a 36-mm mesh. For standard samples, at each site we placed 15-25 nets, set at least 10 m apart, usually in a loop pattern. We opened nets as soon as possible after first light (as soon as it was possible to see well within the forest), usually starting between 0615-0630, and usually closed them in the late afternoon, between 1615-1745. We operated nets until we obtained a minimum of 400 net-hours, with the exception of coastal vegetation at Petit Loango, where we obtained 383 net-hours. (Net-hours are calculated by multiplying the number of nets by the number of hours that they are open.)

Data taken on captured birds included sex, weight, wing chord, tail length, culmen, and tarsus. We checked birds for molt and for presence of a brood patch or other evidence of breeding. Birds with refeathering brood patches were scored as "non-breeding," and juveniles were not included in the totals for breeding status. We marked captured birds that were released by clipping a tail feather, in order to avoid taking data on the same bird more than once. Selected species were also photographed.

We obtained voucher specimens from standard mist-netting samples, from additional mist-netting besides the standard samples, and by hand by spot-lighting at night. A few birds were also obtained fortuitously in nets set for bats by mammalogists. All specimens have been deposited at either the Biodiversity Centre at Vembo, near Gamba, or in the National Museum of Natural History, Smithsonian Institution, Washington D.C., USA.

In order to obtain the greatest amount of scientific value from each specimen we used a variety of techniques (Remsen 1995, Winker 2000). We took blood smears from as many individuals as possible for study of haematoparasites, by pricking the live bird with a small lance near the base of the ulna and

collecting a drop of blood on a glass microscope slide. This drop was then smeared across the slide to obtain a single-cell-thick layer of blood. The slide was allowed to air dry, then fixed in ETOH overnight. After fixing, the slides were allowed to dry again, and stored in this state until study.

We also obtained tissue samples, especially for genetic analysis, from as many specimens as possible. After the bird was humanely sacrificed, about 1 cubic cm (less on birds <15 g) of muscle tissue was cut from one side of the breast, finely diced with a single edged razor blade, then put into a 4 ml tissue tube of Seutin buffer solution (Seutin *et al.* 1991). The tube was shaken to thoroughly mix with the buffer. (We did not take tissue from some fluid-preserved specimens in order to preserve the integrity of the entire specimen for later use.)

After taking blood smears and tissue samples, the voucher specimen was then preserved as a study skin, as a skeleton, and/or preserved in fluid. From all the study skin specimens, the trunk was also preserved in formalin for anatomical study and to preserve stomach contents for dietary analysis. In addition, detached spread wings were also prepared from some skin and skeleton specimens. Spread wings are useful for studies of flight mechanics, molt, and for identification purposes. At the Moukalaba-Doudou site, feather samples were also obtained from the skeleton preparations. These feathers will be used for identification purposes, biochemical analysis, and/or other studies.

We took the following data from as many specimens as possible: internal reproductive data (size of gonads, state of gonads, condition of oviduct, presence of seminal vesicles), internal aging characteristics (skull pneumatization and/or bursa condition), soft-part colors (iris, legs, feet, bill, and mouth lining), stomach contents, molt, and fat condition.

4 Results

4.1 Species list

A list of species recorded in the Gamba Complex is shown in Table 1. We recorded a total of 317 species for all sites combined. We found 158 species at Gamba, 204 at Rabi-Toucan, 203 at Loango National Park, and 177 at Moukalaba-Doudou National Park. Details of the more significant records appear in Angehr *et al.* (submitted).

Table 1 also includes species listed by Sargeant (1993; not including those records listed as “requiring confirmation”), Schepers and Martejn (1993), and by Christy (2001) as occurring in the Gamba Complex. Sargeant was resident at Gamba for five years. His list for Gamba includes a much wider area than we surveyed, extending along the coast north to Setté Cama and south to the Nyanga River, and inland to Vera and Bouda. Sargeant also provides a brief list of birds observed on the Rembo Ndogo, now in Moukalaba-Doudou National Park. In 1992, Sargeant visited Rabi for a total of six days, and the eastern side of the Moukalaba Faunal Reserve for five days. The eastern part of Moukalaba-Doudou contains savanna, scrub, and cultivation, habitats not present in the area we surveyed. Schepers and Martejn (1993) visited the Gamba area, the Rembo Ndogo, and the Rabi area. Christy (2001) made observations in several parts of the Gamba Complex not included in our study, from Setté Cama to the savannas of the Moukalaba. Including these published records brings the total to 455 species recorded from the Gamba Complex to date. These additional records bring the total for Gamba to 392, Rabi to 216, and Moukalaba-Doudou National Park to 282. Christy (2001) cites a total of 470 species for the Gamba Complex as a whole, including additional unpublished records.

4.2 Capture rates in mist-net samples

Data on mist-net samples are presented in Tables 2, 3, 4, and 5. We captured 1,551 individuals (not counting recaptures), representing 72 species, in a total of 10,869 net-hours during standard samples. (Another six species were captured during 930 net-hours of non-standard netting.) Because of limited time at each site, and because we visited different sites at different seasons (which can affect capture rates and species composition), it was not possible to obtain enough samples under comparable conditions for meaningful statistical comparisons. However, the data we obtained do suggest some directions for more detailed studies in the future.

Capture rates for standard samples are shown in Table 2. Capture rates in primary forest ranged from 5.4/100 net-hours at Moukalaba-Doudou Camp-2 to 26.6/100 net-hours at Moukalaba-Doudou Swamp-2. In the limited sample available, no clear differences in capture rates are evident between upland and

Table 1. Birds recorded in the Gamba Complex. Species recorded in this study indicated by “X.” Additional species listed by Sargeant (1993) for each area indicated by “s.” Species not listed by Sargeant but listed by Schepers and Mateijn (1993) indicated by “sm,” and by Christy (2001) indicated by “c.” Common and scientific names follow Borrow and Demey (2001).

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Podicipedidae						
Little Grebe	<i>Tachybaptus ruficollis</i>	s	X			
Phalacrocoracidae						
Long-tailed Cormorant	<i>Phalacrocorax africanus</i>	s	X		X	
Anhingidae						
African Darter	<i>Anhinga rufa</i>	X	X	X	X	
Pelicanidae						
Great White Pelican	<i>Pelecanus onocrotalus</i>	s				s
Pink-backed Pelican	<i>Pelecanus rufescens</i>	s		X		s
Ardeidae						
Little Bittern	<i>Ixobrychus minutus</i>	s				
Dwarf Bittern	<i>Ixobrychus sturmii</i>		X			s
White-crested Tiger-Heron	<i>Tigriornis leucolophus</i>	X				X
White-backed Night Heron	<i>Gorsachius leuconotus</i>	s	X			X
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	s	X			
Squacco Heron	<i>Ardeola ralloides</i>	s	X			
Cattle Egret	<i>Bubulcus ibis</i>	X	s	X		s
Green-backed Heron	<i>Butorides striatus</i>	s	X	X		X
Black Heron	<i>Egretta ardesiaca</i>	s				
Western Reef Egret	<i>Egretta gularis</i>	s				
Little Egret	<i>Egretta garzetta</i>	X		X		
Intermediate Egret	<i>Egretta intermedia</i>	X				
Great Egret	<i>Egretta alba</i>	X	X	X		X
Purple Heron	<i>Ardea purpurea</i>	X				
Gray Heron	<i>Ardea cinerea</i>	X		X		
Black-headed Heron	<i>Ardea melanocephala</i>	s		X		
Goliath Heron	<i>Ardea goliath</i>	s		X		X
Scopidae						
Hamerkop	<i>Scopus umbretta</i>		X	X		X
Ciconiidae						
Yellow-billed Stork	<i>Mycteria ibis</i>	s		X		
Abdim's Stork	<i>Ciconia abdimii</i>	s	X			
Woolly-necked Stork	<i>Ciconia episcopus</i>	X	X	X		
White Stork	<i>Ciconia ciconia</i>	s		X		
Marabou Stork	<i>Leptotilos crumeniferus</i>	s				
Threskiornithidae						
Hadada Ibis	<i>Bostrychia hagedash</i>	X	X	X		X
Olive Ibis	<i>Bostrychia olivacea</i>	s	X			X
Spot-breasted Ibis	<i>Bostrychia rara</i>	s	X			X
Phoenicopteridae						
Lesser Flamingo	<i>Phoeniconaias minor</i>	s				
Anatidae						
White-faced Whistling Duck	<i>Dendrocygna viduata</i>	s				X
Spur-winged Goose	<i>Plectropterus gambensis</i>	s				
Hartlaub's Duck	<i>Pteronetta hartlaubii</i>	s	X	X		X
Knob-billed Duck	<i>Sarkidiornis melanotos</i>	s				
African Pygmy Goose	<i>Nettapus auritus</i>	s	X			
Pandionidae						
Osprey	<i>Pandion haliaetus</i>	X		X		X

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Accipitridae						
African Cuckoo Hawk	<i>Aviceda cuculoides</i>	s	X		X	
European Honey-Buzzard	<i>Pernis apivorus</i>	X		X		
Bat Hawk	<i>Macheiramphus alcinus</i>	X	X	X	X	
Black-shouldered Kite	<i>Elanus caeruleus</i>	s				
Black Kite	<i>Milvus migrans</i>	s		X		
African Fish Eagle	<i>Haliaeetus vocifer</i>	X	X	X	X	
Palm-nut Vulture	<i>Gypohierax angolensis</i>	X	X	X	X	
Congo Serpent Eagle	<i>Dryotriorchis spectabilis</i>	s	X	X	X	
African Harrier Hawk	<i>Polyboroides typus</i>	X	X	X	X	
Eurasian Marsh Harrier	<i>Circus aeruginosus</i>	X				
African Goshawk	<i>Accipiter tachiro</i>	X	X	X	X	
Chestnut-flanked Sparrowhawk	<i>Accipiter castanius</i>	X		X	X	
Red-thighed Sparrowhawk	<i>Accipiter erythropus</i>	X	X			X
Black Sparrowhawk	<i>Accipiter melanoleucus</i>	X	X	X		s
Long-tailed Hawk	<i>Urotriorchis macrourus</i>	s		X	X	
Lizard Buzzard	<i>Kaupifalco monogrammicus</i>			X		
Common Buzzard	<i>Buteo buteo</i>	X		X		
Red-necked Buzzard	<i>Buteo auguralis</i>	X		X	X	
Ayres' Hawk Eagle	<i>Hieraaetus ayersii</i>	s				
Long-crested Eagle	<i>Lophaetus occipitalis</i>	s				
Cassin's Hawk Eagle	<i>Spizaetus africanus</i>	s	X			X
Crowned Eagle	<i>Stephanoaetus coronatus</i>	s	X	X	X	
Falconidae						
Common Kestrel	<i>Falco tinnunculus</i>	s				
Red-footed Falcon	<i>Falco vespertinus</i>	s				
Lanner Falcon	<i>Falco biarmicus</i>	s				
Peregrine Falcon	<i>Falco peregrinus</i>	s				
Phasianidae						
Harlequin Quail	<i>Coturnix delegorguei</i>	s				
Latham's Forest Francolin	<i>Francolinus lathamii</i>	s		X	X	
Scaly Francolin	<i>Francolinus squamatus</i>	s	X			s
Red-necked Francolin	<i>Francolinus afer</i>					s
Numididae						
Black Guineafowl	<i>Agelastes niger</i>	s	X	X	X	
Plumed Guineafowl	<i>Guttera plumifera</i>	s	X			
Turnicidae						
Black-rumped Buttonquail	<i>Turnix hottentata</i>	s				
Rallidae						
Nkulengu Rail	<i>Himantornis haematopus</i>	s			X	
Gray-throated Rail	<i>Canirallus oculus</i>	s	X			
White-spotted Flufftail	<i>Sarothrura pulchra</i>	s	X		X	
African Crake	<i>Crex egregia</i>	s				s
Black Crake	<i>Amauornis flavirostris</i>	s	X			
Allen's Gallinule	<i>Porphyrio alleni</i>	s				
Lesser Moorhen	<i>Gallinula angulata</i>	s				
Helionithidae						
African Finfoot	<i>Podica senegalensis</i>	s	X	X	X	
Otididae						
Black-bellied Bustard	<i>Eupodotis melanogaster</i>	s				

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Jacaniidae						
African Jacana	<i>Actophilornis africana</i>	X	X		X	
Burhinidae						
Water Thick-knee	<i>Burhinus vermiculatus</i>	X	X	X		
Glareolidae						
Temminck's Courser	<i>Cursorius temminckii</i>	s				
Bronze-winged Courser	<i>Rhinoptilus chalcopterus</i>	s				
Black-winged Pratincole	<i>Glareola nordmanni</i>	s				
Rock Pratincole	<i>Glareola nuchalis</i>	s				
Gray Pratincole	<i>Glareola cinerea</i>	s		X		
Charadriidae						
Common Ringed Plover	<i>Charadrius hiaticula</i>	s		X		
Kittlitz's Plover	<i>Charadrius pecuarius</i>	X				
Forbes's Plover	<i>Charadrius forbesi</i>	X	X			
Kentish Plover	<i>Charadrius alexandrinus</i>	s				
White-fronted Plover	<i>Charadrius marginatus</i>	s		X		
Pacific Golden Plover	<i>Pluvialis fulva</i>	s				
Gray Plover	<i>Pluvialis squatarola</i>	s		X		
White-headed Lapwing	<i>Vanellus albiceps</i>	s		X	sm	
Spur-winged Lapwing	<i>Vanellus spinosus</i>	s				
Lesser Black-winged Lapwing	<i>Vanellus lugubris</i>	X				
Scolopaciidae						
Red Knot	<i>Calidris canutus</i>	s				
Sanderling	<i>Calidris alba</i>	s		X		
Little Stint	<i>Calidris minuta</i>	s		X		
Curlew Sandpiper	<i>Calidris ferruginea</i>	s				
Ruff	<i>Philomachus pugnax</i>	s				
Great Snipe	<i>Gallinago media</i>	s				
Bar-tailed Godwit	<i>Limosa lapponica</i>	s		X		
Whimbrel	<i>Numenius phaeopus</i>	s				
Eurasian Curlew	<i>Numenius arquata</i>	s				
Marsh Sandpiper	<i>Tringa stagnatilis</i>	s				
Common Greenshank	<i>Tringa nebularia</i>	s		X		
Green Sandpiper	<i>Tringa ochropus</i>	s				
Wood Sandpiper	<i>Tringa glareola</i>	s		X		
Common Sandpiper	<i>Actitis hypoleucos</i>	X		X		
Ruddy Turnstone	<i>Arenaria interpres</i>	s		X		
Stercorariidae						
Arctic Skua	<i>Stercorarius parasiticus</i>	s				
Laridae						
Lesser Black-backed Gull	<i>Larus fuscus</i>	s		X		
Sternidae						
Caspian Tern	<i>Sterna caspia</i>	s		X		
Royal Tern	<i>Sterna maxima</i>	s		X		
Sandwich Tern	<i>Sterna sandvicensis</i>	s		X		
Common Tern	<i>Sterna hirundo</i>	s		X		
Arctic Tern	<i>Sterna paradisaea</i>	s		X		
Damara Tern	<i>Sterna balaenarum</i>	s		X		
Little Tern	<i>Sterna albifrons</i>	s				
Black Tern	<i>Chlidonias niger</i>	s		X	sm	

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
White-winged Tern	<i>Chlidonias leucopterus</i>	s				
Black Noddy	<i>Anous minutus</i>	s				
Brown Noddy	<i>Anous stolidus</i>	sm				
Rynchopidae						
African Skimmer	<i>Rynchops flavirostris</i>	s		X		
Columbidae						
African Green Pigeon	<i>Treron calva</i>	X	X	X	X	
Blue-headed Wood Dove	<i>Turtur brehmeri</i>	X	X	X	X	
Tambourine Dove	<i>Turtur tympanistria</i>	X	X	X	X	
Blue-spotted Wood Dove	<i>Turtur afer</i>	X	X	X		
Emerald-spotted Wood Dove	<i>Turtur chalcospilos</i>	X		X		
Namaqua Dove	<i>Oena capensis</i>	s				
Western Bronze-naped Pigeon	<i>Columba iriditorques</i>	s	X			
Afep Pigeon	<i>Columba unicincta</i>	s	X	X	X	
Rock Dove	<i>Columba livia</i>	X				
Lemon Dove	<i>Aplopelia larvata</i>	s				s
Red-eyed Dove	<i>Streptopelia semitorquata</i>	X		X		s
Laughing Dove	<i>Streptopelia senegalensis</i>	s				
Psittacidae						
Gray Parrot	<i>Psittacus erithacus</i>	X	X	X	X	
Red-fronted Parrot	<i>Poicephalus gularis</i>	s	X		X	
Red-headed Lovebird	<i>Agapornis pullarius</i>					s
Fischer's Lovebird	<i>Agapornis fischeri</i>	s				
Musophagidae						
Great Blue Turaco	<i>Corythaeola cristata</i>	X	X	X	X	
Green Turaco	<i>Tauraco persa</i>	X				
Yellow-billed Turaco	<i>Tauraco macrorhynchus</i>	X	X	X	X	
Cuculidae						
Jacobin Cuckoo	<i>Oxylophus jacobinus</i>	s		X		
Levaillant's Cuckoo	<i>Oxylophus levillantii</i>	s				
Great Spotted Cuckoo	<i>Clamator glandarius</i>	s				
Thick-billed Cuckoo	<i>Pachycoccyx audeberti</i>		s			
Red-chested Cuckoo	<i>Cuculus solitarius</i>	X	X	X		
Black Cuckoo	<i>Cuculus clamosus</i>	X	X	X	X	
African Emerald Cuckoo	<i>Chrysococcyx cupreus</i>	X	X	X	X	
Yellow-throated Cuckoo	<i>Chrysococcyx flavigularis</i>		X			X
Klaas's Cuckoo	<i>Chrysococcyx klaas</i>	s	X	X	X	
Didric Cuckoo	<i>Chrysococcyx caprius</i>	X		X		
Yellowbill	<i>Ceuthmochares aereus</i>	X	X	X	X	
Black-throated Coucal	<i>Centropus leucogaster</i>		sm			
Gabon Coucal	<i>Centropus anelli</i>	X	X	X	X	
Black Coucal	<i>Centropus grillii</i>	s				s
Senegal Coucal	<i>Centropus senegalensis</i>	s	X			s
Blue-headed Coucal	<i>Centropus monachus</i>	s	X			
Tytonidae						
Barn Owl	<i>Tyto alba</i>	s				s
Strigidae						
Sandy Scops Owl	<i>Otus icterorhynchus</i>	s				X
Maned Owl	<i>Jubula lettii</i>	s				
Fraser's Eagle Owl	<i>Bubo poensis</i>					X

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Akun Eagle Owl	<i>Bubo leucostictus</i>	s	X			
Pel's Fishing Owl	<i>Scotopelia peli</i>				X	
Vermiculated Fishing Owl	<i>Scotopelia bouvieri</i>	s			s	
Red-chested Owlet	<i>Glaucidium tephronotum</i>		X		X	
Chestnut-backed Owlet	<i>Glaucidium sjostedti</i>	s	X		X	
African Wood Owl	<i>Strix woodfordii</i>	s	X		X	
Marsh Owl	<i>Asio capensis</i>	X				
Caprimulgidae						
Bates's Nightjar	<i>Caprimulgus batesi</i>	s	X	X		
Swamp Nightjar	<i>Caprimulgus natalensis</i>	s		X	s	
Long-tailed Nightjar	<i>Caprimulgus climacurus</i>	X		X		
Square-tailed Nightjar	<i>Caprimulgus fossii</i>	X		X		
European Nightjar	<i>Caprimulgus europaeus</i>		X			
Pennant-winged Nightjar	<i>Macrodipteryx vexillarius</i>	s				
Apodidae						
Sabine's Spinetail	<i>Rhaphidura sabini</i>	s	X		X	
Black Spinetail	<i>Telacanthura melanopygia</i>	s	X	X		
Cassin's Spinetail	<i>Neafrapus cassini</i>	X	X	X	X	
African Palm Swift	<i>Cypsiurus parvus</i>	X		X	s	
Common Swift	<i>Apus apus</i>	X	X	X	X	
Bates's Swift	<i>Apus batesi</i>					c
White-rumped Swift	<i>Apus caffer</i>	s				
Little Swift	<i>Apus affinis</i>	X	X		s	
Coliidae						
Speckled Mousebird	<i>Colius striatus</i>				s	
Trogonidae						
Narina's Trogon	<i>Apaloderma narina</i>		s		X	
Bare-cheeked Trogon	<i>Apaloderma aequatoriale</i>		X		X	
Alcedinidae						
Chocolate-backed Kingfisher	<i>Halcyon badia</i>	X	X	X	X	
Blue-breasted Kingfisher	<i>Halcyon malimbica</i>	X	X	X	X	
Woodland Kingfisher	<i>Halcyon senegalensis</i>	X	X	X		
African Dwarf Kingfisher	<i>Ceyx lecontei</i>	X	X		X	
African Pygmy Kingfisher	<i>Ceyx picta</i>	X	X	X	s	
White-bellied Kingfisher	<i>Alcedo leucogaster</i>	X	X	X	X	
Malachite Kingfisher	<i>Alcedo cristata</i>	X	X	X	X	
Shining-blue Kingfisher	<i>Alcedo quadribrachys</i>	X	X	X	X	
Giant Kingfisher	<i>Megaceryle maxima</i>	X	X	X	X	
Pied Kingfisher	<i>Ceryle rudis</i>	X		X	X	
Meropidae						
Black-headed Bee-eater	<i>Merops breweri</i>	X	s	X	s	
Blue-headed Bee-eater	<i>Merops muelleri</i>					c
Black Bee-eater	<i>Merops gularis</i>	s	X		X	
Little Bee-eater	<i>Merops pusillus</i>				s	
Blue-breasted Bee-eater	<i>Merops variegatus</i>	X	s	X	s	
White-fronted Bee-eater	<i>Merops bullockoides</i>				s	
White-throated Bee-eater	<i>Merops albicollis</i>	s	X		s	
Rosy Bee-eater	<i>Merops malimbicus</i>	X	X	X	s	
Coraciidae						
European Roller	<i>Coracias garrulus</i>	s				
Blue-throated Roller	<i>Eurystomus gularis</i>	X	X		X	

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Broad-billed Roller	<i>Eurystomus glaucurus</i>	s	X		X	
Upupidae						
Hoopoe	<i>Upupa epops</i>	s				
Bucerotidae						
White-crested Hornbill	<i>Tropicranus albocristatus</i>	X	X	X	X	
Black Dwarf Hornbill	<i>Tockus hartlaubi</i>	s	X		s	
Red-billed Dwarf Hornbill	<i>Tockus camurus</i>	X	X	X	X	
African Pied Hornbill	<i>Tockus fasciatus</i>	X	X	X	X	
Piping Hornbill	<i>Bycanistes fistulator</i>	X	X	X	X	
White-thighed Hornbill	<i>Bycanistes albotibialis</i>	s	X	X		
Black-casqued Hornbill	<i>Ceratogymna atrata</i>	X	X	X	X	
Capitonidae						
Gray-throated Barbet	<i>Gymnobucco bonapartei</i>				X	
Bristle-nosed Barbet	<i>Gymnobucco peli</i>	s	X	X	X	
Naked-faced Barbet	<i>Gymnobucco calvus</i>	X	X	X	X	
Speckled Tinkerbird	<i>Pogoniulus scolopaceus</i>	X	X	X	X	
Red-rumped Tinkerbird	<i>Pogoniulus atroflavus</i>	X	X	X	X	
Yellow-throated Tinkerbird	<i>Pogoniulus subsulphureus</i>	X	X	X	X	
Yellow-rumped Tinkerbird	<i>Pogoniulus bilineatus</i>	sm				
Yellow-spotted Barbet	<i>Buccanodon duchailui</i>	X	X	X	X	
Hairy-breasted Barbet	<i>Tricholaema hirsuta</i>	X	X	X	X	
Black-backed Barbet	<i>Lybius minor</i>					s
Yellow-billed Barbet	<i>Trachyphonus purpuratus</i>	s		X	X	
Indicatoridae						
Cassin's Honeybird	<i>Prodotiscus insignis</i>	s	X	X	X	
Lyre-tailed Honeyguide	<i>Melichneutes robustus</i>	s	s		X	
Spotted Honeyguide	<i>Indicator maculatus</i>	X	X	X	X	
Thick-billed Honeyguide	<i>Indicator conirostris</i>	s	X		s	
Least Honeyguide	<i>Indicator exilis</i>	X	X	X	X	
Picidae						
Red-throated Wryneck	<i>Jynx ruficollis</i>					s
Green-backed Woodpecker	<i>Campethera cailliautii</i>	X	X	X	X	
Buff-spotted Woodpecker	<i>Campethera nivosa</i>	X	X		X	
Brown-eared Woodpecker	<i>Campethera caroli</i>	s	X	X	X	
Gabon Woodpecker	<i>Dendropicos gabonensis</i>	s	X		X	
Golden-crowned Woodpecker	<i>Dendropicos xantholophus</i>	s	X		X	
Eurylaimidae						
Rufous-sided Broadbill	<i>Smithornis rufolateralis</i>	s	X		X	
African Broadbill	<i>Smithornis capensis</i>				X	
Alaudidae						
Flappet Lark	<i>Mirafra rufocinnamomea</i>				s	
Red-capped Lark	<i>Calandrella cinerea</i>	s				
Hirundinidae						
African River Martin	<i>Pseudochelidon eurystomina</i>	X	s	X	s	
Square-tailed Sawwing	<i>Psaldiprocne nitens</i>	s			X	
Black Sawwing	<i>Psaldiprocne pristoptera</i>				s	
Banded Martin	<i>Riparia cincta</i>	X		X	s	
Gray-rumped Swallow	<i>Pseudhirundo griseopyga</i>	X		X	s	
Rufous-chested Swallow	<i>Hirundo semirufa</i>	X	X		s	
Mosque Swallow	<i>Hirundo senegalensis</i>	sm				

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Lesser Striped Swallow	<i>Hirundo abyssinica</i>	X		X	s	
Forest Swallow	<i>Hirundo fuliginosa</i>					c
Red-throated Cliff Swallow	<i>Hirundo rufigula</i>	s			s	
White-throated Blue Swallow	<i>Hirundo nigrita</i>	X			X	
Angola Swallow	<i>Hirundo angolensis</i>	s				
Barn Swallow	<i>Hirundo rustica</i>	X	X	X	s	
Motacillidae						
Yellow Wagtail	<i>Motacilla flava</i>	s				
Mountain Wagtail	<i>Motacilla clara</i>	s				
African Pied Wagtail	<i>Motacilla aguimp</i>	s			sm	
Long-legged Pipit	<i>Anthus pallidiventris</i>	X	X	X	s	
Yellow-throated Longclaw	<i>Macronyx croceus</i>	s			s	
Campephagidae						
Purple-throated Cuckoo-shrike	<i>Campephaga quiscalina</i>	X				
Blue Cuckoo-shrike	<i>Coracina azurea</i>	X	X		X	
Pycnonotidae						
Little Greenbul	<i>Andropadus virens</i>	X	X	X	X	
Little Gray Greenbul	<i>Andropadus gracilis</i>	X	X	X	X	
Ansorge's Greenbul	<i>Andropadus ansorgei</i>	X	X	X	X	
Cameroon Sombre Greenbul	<i>Andropadus curvirostris</i>	X	X		X	
Slender-billed Greenbul	<i>Andropadus gracilirostris</i>	X	X	X	X	
Yellow-whiskered Greenbul	<i>Andropadus latirostris</i>	X	X	X	X	
Golden Greenbul	<i>Calyptocichla serina</i>	X	X	X	X	
Honeyguide Greenbul	<i>Baeopogon indicator</i>	X	X	X	s	
Sjöstedt's Honeyguide Greenbul	<i>Baeopogon clamans</i>	X	X		X	
Spotted Greenbul	<i>Ixonotus guttatus</i>	X	X	X	X	
Simple Leaflove	<i>Chlorocichla simplex</i>	s		X	s	
Yellow-throated Leaflove	<i>Chlorocichla flavicollis</i>	s			s	
Swamp Palm Greenbul	<i>Thescelocichla leucopleura</i>	X			X	
Leaflove	<i>Phyllastrephus scandens</i>	s	s		s	
Pale Olive Greenbul	<i>Phyllastrephus fulviventris</i>	s				
Icterine Greenbul	<i>Phyllastrephus icterinus</i>	X	X	X	X	
Xavier's Greenbul	<i>Phyllastrephus xavieri</i>					c
White-throated Greenbul	<i>Phyllastrephus albigularis</i>					c
Red-tailed Bristlebill	<i>Bleda syndactyla</i>	X	X	X	X	
Lesser Bristlebill	<i>Bleda notata</i>	X	X	X	X	
Eastern Bearded Greenbul	<i>Criniger chloronotus</i>	X	X	X	X	
Red-tailed Greenbul	<i>Criniger calurus</i>	X	X	X	X	
White-bearded Greenbul	<i>Criniger ndussumensis</i>	s	X			
Common Bulbul	<i>Pycnonotus barbatus</i>	X	X	X		
Western Nicator	<i>Nicator chloris</i>	X	X	X	X	
Yellow-throated Nicator	<i>Nicator vireo</i>					c
Turdidae						
Forest Robin	<i>Stiphornis erythrothorax</i>	X	X	X	X	
Lowland Akalat	<i>Sheppardia cyornithopsis</i>					c
Red-capped Robin Chat	<i>Cossypha natalensis</i>	s		X		
Snowy-crowned Robin Chat	<i>Cossypha niveicapilla</i>	s		X	s	
Fire-crested Alethe	<i>Alethe diademata</i>	X	X	X	X	

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Brown-chested Alethe	<i>Alethe poliocephala</i>	X	X	X	X	
Red-tailed Ant Thrush	<i>Neocossyphus rufus</i>	X	X	X	X	
White-tailed Ant Thrush	<i>Neocossyphus poensis</i>	s	X	X	X	
Rufous Flycatcher Thrush	<i>Stizorhina fraseri</i>	X	X	X	X	
Rufous-tailed Palm Thrush	<i>Cichladusa ruficauda</i>	X		X		
White-browed Scrub Robin	<i>Cercotrichas leucophrys</i>				s	
Common Stonechat	<i>Saxicola torquata</i>	s			s	
Northern Wheatear	<i>Oenanthe oenanthe</i>	s				
Sooty Chat	<i>Myrmecocichla nigra</i>				s	
Black-eared Ground Thrush	<i>Zoothera camaronensis</i>				X	
African Thrush	<i>Turdus pelios</i>	X			s	
Sylviidae						
Black-faced Rufous Warbler	<i>Bathmocercus rufus</i>				X	
African Moustached Warbler	<i>Melocichla mentalis</i>				s	
Broad-tailed Warbler	<i>Schoenicola platyura</i>				s	
Sedge Warbler	<i>Acrocephalus schoenobaenus</i>	s				
European Reed Warbler	<i>Acrocephalus scirpaceus</i>	s				
Great Reed Warbler	<i>Acrocephalus arundinaceus</i>	s			sm	
Icterine Warbler	<i>Hippolais icterina</i>	s				
Red-faced Cisticola	<i>Cisticola erythrops</i>				s	
Whistling Cisticola	<i>Cisticola lateralis</i>				s	
Chattering Cisticola	<i>Cisticola anonymus</i>	s	X		s	
Winding Cisticola	<i>Cisticola galactotes</i>	s			X	
Croaking Cisticola	<i>Cisticola natalensis</i>				s	
Zitting Cisticola	<i>Cisticola juncidis</i>	s				
Pectoral-patch Cisticola	<i>Cisticola brunnescens</i>	X			s	
Ayre's Cisticola	<i>Cisticola ayresii</i>				s	
Tawny-flanked Prinia	<i>Prinia subflava</i>				s	
Banded Prinia	<i>Prinia bairdii</i>	s	X			
White-chinned Prinia	<i>Schistolais leucopogon</i>				s	
Yellow-breasted Apalis	<i>Apalis flavida</i>	s		X		
Buff-throated Apalis	<i>Apalis rufogularis</i>	s	X		X	
Gray-backed Camaroptera	<i>Camaroptera brachyura</i>	s	X	X	s	
Yellow-browed Camaroptera	<i>Camaroptera superciliaris</i>	s	X	X	s	
Olive-green Camaroptera	<i>Camaroptera chloronota</i>	s	s		s	
Yellow Longbill	<i>Macrosphenus flavicans</i>	s	X	X	X	
Gray Longbill	<i>Macrosphenus concolor</i>	X	X	X	X	
Rufous-crowned Eremomela	<i>Eremomela badiceps</i>	s	X		X	
Green Crombec	<i>Sylvietta virens</i>	X	X	X	X	
Lemon-bellied Crombec	<i>Sylvietta denti</i>	s	X		X	
Willow Warbler	<i>Phylloscopus trochilus</i>	s		X		
Wood Warbler	<i>Phylloscopus sibilatrix</i>	s		X		
Garden Warbler	<i>Sylvia borin</i>	s		X		
Greater Whitethroat	<i>Sylvia communis</i>	s				
Violet-backed Hyliota	<i>Hyliota violacea</i>	s	X		X	
Green Hylia	<i>Hylia prasina</i>	X	X	X	X	
Muscicapidae						
Fraser's Forest Flycatcher	<i>Fraseria ocreata</i>	s	X	X	X	
White-browed Forest Flycatcher	<i>Fraseria cinerascens</i>	s	X	X	X	
Pale Flycatcher	<i>Melaenornis pallidus</i>	s				

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Spotted Flycatcher	<i>Muscicapa striata</i>	X		X		
Cassin's Flycatcher	<i>Muscicapa cassini</i>	s	X		X	
Olivaceous Flycatcher	<i>Muscicapa olivascens</i>	s	s		X	
Yellow-footed Flycatcher	<i>Muscicapa sethsmithi</i>	s	X		X	
Sooty Flycatcher	<i>Muscicapa infuscata</i>	s	X	X	X	
Gray-throated Flycatcher	<i>Myioparus griseigularis</i>	s	X		X	
Lead-colored Flycatcher	<i>Myioparus plumbeus</i>	s	X	X		
Monarchidae						
Chestnut-capped Flycatcher	<i>Erythrocerus mcallii</i>	s	X		X	
Dusky Crested Flycatcher	<i>Elminia nigromitrata</i>	s	X		X	
Blue-headed Crested Flycatcher	<i>Trochocercus nitens</i>	s	X	X	X	
African Paradise Flycatcher	<i>Terpsiphone viridis</i>	s	X	X	s	
Rufous-vented Paradise-Flycatcher	<i>Terpsiphone rufocinerea</i>					c
Red-bellied Paradise Flycatcher	<i>Terpsiphone rufiventer</i>	X	X	X	X	
Platysteiridae						
Shrike Flycatcher	<i>Megabyas flammulatus</i>	s	X		X	
Black-and-white Flycatcher	<i>Bias musicus</i>	s				
Chestnut Wattle-eye	<i>Dyaphorophya castanea</i>	X	X	X	X	
White-spotted Wattle-eye	<i>Dyaphorophya tonsa</i>	X	X	X	X	
Yellow-bellied Wattle-eye	<i>Dyaphorophya concreta</i>	s	X	X		
Common Wattle-eye	<i>Platysteira cyanea</i>	s		X	s	
Black-headed Batis	<i>Batis minor</i>				s	
Angola Batis	<i>Batis minulla</i>					c
Verreaux's Batis	<i>Batis minima</i>		X		X	
Picathartidae						
Red-headed Picathartes	<i>Picathartes oreas</i>				c	
Timaliidae						
Pale-breasted Illadopsis	<i>Illadopsis rufipennis</i>	X	X		X	
Brown Illadopsis	<i>Illadopsis fulvescens</i>	X	X	X	X	
Blackcap Illadopsis	<i>Illadopsis cleaveri</i>	X	X		X	
Arrow-marked Babbler	<i>Turdoides jardineii</i>				s	
Remizidae						
Forest Penduline Tit	<i>Anthoscopus flavifrons</i>	s	X		X	
Tit-hylia	<i>Pholidornis rushiae</i>	s				
Nectariniidae						
Violet-tailed Sunbird	<i>Anthreptes aurantium</i>	s		X	X	
Brown Sunbird	<i>Anthreptes gabonicus</i>	s				
Green Sunbird	<i>Anthreptes rectirostris</i>	X	X		X	
Little Green Sunbird	<i>Anthreptes seimundi</i>	s	X		X	
Fraser's Sunbird	<i>Deleornis fraseri</i>	X	X	X	X	
Reichenbach's Sunbird	<i>Anabathmis reichenbachii</i>	X	X	X		
Green-headed Sunbird	<i>Cyanomitra verticalis</i>	X		X		
Blue-throated Brown Sunbird	<i>Cyanomitra cyanolaema</i>	X	X	X	X	
Western Olive Sunbird	<i>Cyanomitra obscura</i>	X	X	X	X	
Green-throated Sunbird	<i>Chalcomitra rubescens</i>	s	X		X	
Carmelite Sunbird	<i>Chalcomitra fuliginosa</i>	X		X		
Collared Sunbird	<i>Hedydipna collaris</i>	X	X	X	X	
Olive-bellied Sunbird	<i>Cinnyris chloropygius</i>	X	X	X	s	

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Tiny Sunbird	<i>Cinnyris minullus</i>	s	X			
Johanna's Sunbird	<i>Cinnyris johannae</i>	X	X	X	X	
Superb Sunbird	<i>Cinnyris superbus</i>	X		X	s	
Bates's Sunbird	<i>Cinnyris batesi</i>	s				
Copper Sunbird	<i>Cinnyris cupreus</i>	X			s	
Laniidae						
Common Fiscal	<i>Lanius collaris</i>				s	
Lesser Gray Shrike	<i>Lanius minor</i>	s		X		
Red-backed Shrike	<i>Lanius collurio</i>	s		X		
Woodchat Shrike	<i>Lanius senator</i>	s				
Malaconotidae						
Fiery-breasted Bushshrike	<i>Malaconotus cruentus</i>				s	
Marsh Tchagra	<i>Antichromus minutus</i>				s	
Black-crowned Tchagra	<i>Tchagra senegala</i>				s	
Sabine's Puffback	<i>Dryoscopus sabinii</i>	X	X	X	X	
Black-shouldered Puffback	<i>Dryoscopus senegalensis</i>	s			s	
Sooty Boubou	<i>Laniarius leucorhynchus</i>	X	X		X	
Swamp Boubou	<i>Laniarius bicolor</i>	s		X		
Prionopidae						
Chestnut-bellied Helmetshrike	<i>Prionops rufiventris</i>	X	X	X	X	
Oriolidae						
Black-winged Oriole	<i>Oriolus nigripennis</i>		X			
Western Black-headed Oriole	<i>Oriolus brachyrhynchus</i>	X	X	X	X	
Eurasian Golden Oriole	<i>Oriolus oriolus</i>	X		X		
Dicruridae						
Square-tailed Drongo	<i>Dicrurus ludwigii</i>	s	s		s	
Shining Drongo	<i>Dicrurus atripennis</i>	X	X	X	X	
Velvet-mantled Drongo	<i>Dicrurus modestus</i>	s	X	X	X	
Corvidae						
Pied Crow	<i>Corvus albus</i>	X				
Sturnidae						
Narrow-tailed Starling	<i>Poeoptera lugubris</i>	s	X			
Forest Chestnut-winged Starling	<i>Onychognathus fulgidus</i>	sm	X		s	
Purple-headed Glossy Starling	<i>Lamprotornis purpureiceps</i>	X	X	X	X	
Splendid Glossy Starling	<i>Lamprotornis splendidus</i>	X	X	X	s	
Wattled Starling	<i>Creatophora cinerea</i>	s				
Buphagidae						
Yellow-billed Oxpecker	<i>Buphagus africanus</i>	s		X	s	
Passeridae						
Northern Gray-headed Sparrow	<i>Passer griseus</i>	s				
Ploceidae						
Slender-billed Weaver	<i>Ploceus pelzelni</i>			X		
Loango Weaver	<i>Ploceus subpersonatus</i>	s				
Black-necked Weaver	<i>Ploceus nigricollis</i>	s		X	s	
Spectacled Weaver	<i>Ploceus ocularis</i>				s	
Orange Weaver	<i>Ploceus aurantius</i>	s				
Vieillot's Black Weaver	<i>Ploceus nigerrimus</i>	s		X	s	
Village Weaver	<i>Ploceus cucullatus</i>	X		X	X	

Table 1. *Continued.*

English Name	Scientific Name	Gamba	Rabi-Toucan	Loango NP	Moukalaba-Doudou NP	Locality Not Specified
Yellow-mantled Weaver	<i>Ploceus tricolor</i>	s	X	X	X	
Maxwell's Black Weaver	<i>Ploceus albinucha</i>	s	X			
Compact Weaver	<i>Ploceus superciliosus</i>					s
Blue-billed Malimbe	<i>Malimbus nitens</i>	s	X	X	X	
Crested Malimbe	<i>Malimbus malimbicus</i>	s				s
Cassin's Malimbe	<i>Malimbus cassini</i>	s	X		X	
Red-headed Malimbe	<i>Malimbus rubricollis</i>	s	X	X	X	
Red-bellied Malimbe	<i>Malimbus erythrogaster</i>	s	X		X	
Red-headed Quelea	<i>Quelea erythrops</i>	s				s
Red-billed Quelea	<i>Quelea quelea</i>	s				
Black-winged Bishop	<i>Euplectes hordaceus</i>					s
Yellow-mantled Widowbird	<i>Euplectes macrourus</i>					s
Red-collared Widowbird	<i>Euplectes ardens</i>					s
Estrilidae						
Red-headed Antpecker	<i>Parmoptila woodhousei</i>	s				X
Gray-crowned Negrofinch	<i>Nigrita canicapilla</i>	X	X	X	X	
Pale-fronted Negrofinch	<i>Nigrita luteifrons</i>	X	X		X	
Chestnut-breasted Negrofinch	<i>Nigrita bicolor</i>	s	X		X	
White-breasted Negrofinch	<i>Nigrita fusconota</i>	s	X		X	
Black-bellied Seedcracker	<i>Pyrenestes ostrinus</i>	X	X			s
Western Bluebill	<i>Spermophaga haematina</i>	X	X	X	X	
Brown Twinspot	<i>Clytospiza monteiri</i>					s
Blue-billed Firefinch	<i>Lagonosticta rubricata</i>					s
Orange-cheeked Waxbill	<i>Estrilda melpoda</i>	X				s
Common Waxbill	<i>Estrilda astrild</i>	s		X		s
Zebra Waxbill	<i>Amandava subflava</i>	s				s
Black-chinned Quailfinch	<i>Ortygospiza gabonensis</i>	X				
Bronze Mannikin	<i>Lonchura cucullata</i>	X	X	X		s
Black-and-white Mannikin	<i>Lonchura bicolor</i>	s	X			s
Magpie Mannikin	<i>Lonchura fringilloides</i>	s				s
Viduidae						
Pin-tailed Whydah	<i>Vidua macroura</i>	X		X		s
Emberizidae						
Yellow-fronted Canary	<i>Serinus mozambicus</i>					s
Cinnamon-breasted Rock Bunting	<i>Emberiza tahapisi</i>	s		X		s
Totals		392	216	203	282	
Total Species = 455						

swamp forest, dry season or rainy season, or fragmented and unfragmented forest samples.

However, capture rates at individual localities in the late rainy season and dry season, together with our qualitative observations of bird activity, suggest there may be a movement of birds from drier areas to wetter ones at this time of year. At Gamba in the dry season, the two drier sites, Totou (6.0) and Gamba-30 (10.2) had lower capture rates than the wetter sites, Mayonami Road (14.1) and Gamba-26 (16.6). At Moukalaba-Doudou in the late rainy season, the driest site (and the one farthest from the swamp), Camp-2, had the lowest capture rate (5.4) of any site in the study, while the two swamp sites, Swamp-1 (25.9) and Swamp-2 (26.6) had the highest rates of any forest sites. Although the capture rate at Camp-1 (25.9), an upland site, was just as high as the swamp sites, it was much closer to the swamp than Camp-2, and bird activity there may have reflected this proximity.

The highest capture rates of any sites were found in the two natural edge/scrub habitats, coastal vegetation (37.6 individuals/100 net-hours) and savanna/gallery forest edge (27.0 individuals/100 net-hours) at Loango. This may have been due in part to birds tending to move along the interface between habitat types. However, capture rates at Loango may have also been inflated somewhat at these sites because nets were closed earlier in the day than at other sites, so that samples include a greater proportion of the more productive morning hours. Also, at the coastal vegetation site, capture rates were inflated because many birds, especially flocks of Purple-headed Glossy Starlings, were caught as they came into drink and bathe at the pools near which we had placed nets. Birds may have been especially attracted to these pools because of limited water availability in the late dry season.

Table 2. Summary of mist-netting data from standard samples.

Locality	Site	Habitat	Season	Total individuals	Net-hours	Individuals/100 net-hours	Species
Primary forest							
Gamba	Totou	upland	dry	31	516	6	10
Gamba	Gamba-30	upland (fragmented)	dry	53	520	10.2	10
Toucan	PK-2	upland	rainy-dry transition	90	772	11.6	19
Rabi	Rabi-12	upland	mid rainy	41	525	7.8	10
Moukalaba	Camp-1	upland	late rainy	82	523	25.9	24
Moukalaba	Camp-2	upland	late rainy	23	525	5.4	11
Loango	Primary forest	upland	dry-rainy transition	104	592	17.6	24
Gamba	Mayonami	swamp	dry	73	516	14.1	15
Toucan	Marianga River	swamp	rainy-dry transition	66	632	10.4	22
Moukalaba	Swamp-1	swamp	late rainy	142	549	25.9	29
Moukalaba	Swamp-2	swamp	late rainy	132	497	26.6	30
Rabi	Rabi-33	swamp (fragmented)	mid rainy	53	559	9.5	17
Rabi	Rabi-59	upland and swamp	mid rainy	42	431	9.7	9
Gamba	Gamba-26	upland and swamp (fragmented)	dry	86	519	16.6	13
Natural edge and scrub habitats							
Loango	Coastal vegetation	coastal scrub and mangrove	dry- rainy transition	144	383	37.6	26
Loango	Savanna/gallery forest	forest edge	dry- rainy transition	116	430	27	19
Human-disturbed habitats							
Rabi	Ossengue Camp	young second growth	mid rainy	58	619	9.4	13
Toucan	Quarry	tall second growth	rainy -dry transition	71	756	9.4	13
Rabi	M'Bari	logged forest and edge	mid rainy	98	470	20.8	14
Toucan	Marianga Road	logged forest	rainy -dry transition	46	635	7.2	13
				1551	10869	14.3	

Capture rates at the four sites affected by human disturbance were within the range of those at natural sites. Three sites, Ossengue (young secondary growth, 9.4 individuals/100 net-hours), Quarry (tall secondary growth, 9.4 individuals/100 net-hours), and Marianga River (logged forest, 7.2 individuals/100 net-hours), were relatively low, while M'Bari (logged forest and edge, 20.8 individuals/100 net-hours) was relatively high. The high capture rate at M'Bari was largely due to one partly frugivorous species, Yellow-whiskered Greenbul, that apparently was attracted into the area by fruiting shrubs. If this species is excluded from the sample, the capture rate falls to 8.7 captures/100 net-hours.

4.3 Species composition in mist-net samples

The most common species in mist-net samples are shown in Tables 3 and 4. We include here any species that was among the three most common species at any site. For the 17 forest sites (Table 3), this set was composed of only eight species, and these made up a total of 73.6% of all individuals captured at these sites. These species included a nectarivore/insectivore, Western Olive Sunbird; two frugivore/insectivores, Yellow-whiskered and Little Greenbuls; and four species which habitually or frequently follow driver ants to feed on insects disturbed by the ants, Lesser Bristlebill, Eastern Bearded Greenbul, and Fire-crested and Brown-chested Alethes. Insectivores, frugivores, and ant-followers all depend on resources that are highly variable in space

and time. Since they must wander widely over large areas in search of food, they are frequently among the most common species captured by mist-nets. However, the abundance of any one of these species was quite variable between sites, and no species was among the three most common species at all sites, perhaps also a consequence of dependence on variable resources. The eighth species, Icterine Greenbul, an insectivore, was among the most common core species of mixed species flocks. This species would probably have been even more common in samples except that it often foraged somewhat higher than the nets.

Species proportions at the two logged forest sites, M'Bari and Marianga Road, were generally within the range of the other sites. However, Yellow-whiskered Greenbul showed by far its highest abundance (58.2% of all individuals) at M'Bari. As mentioned in the previous section, it appeared to have been attracted to this site by an abundance of fruiting shrubs.

Among non-forest sites, differences in species composition were apparently due more to the proximity of the sites to the coast and to natural savanna rather than to physical characteristics. The two inland sites, Ossengue at Rabi and Quarry at Toucan, were fairly similar to one another and also to forest sites at the same localities, with Yellow-whiskered and Little Greenbuls being among the common species at both sites, and Western Olive Sunbird common at Ossengue. Western Nicator, common at Ossengue, was the only species that was not among the commonest species of primary forest. This species favors

Table 3. Common species in mist-net samples in forest sites. All species that were among the top three in number of individuals captured (including ties) are included. The figure given is the percentage of total individuals captured that the species represented at each site. The top three species at each site are indicated in bold. Abbreviations for sites: Gamba: G30 = Gamba-30, G26 = Gamba-26, MYR = Mayonami Road, TOT = Totou; Rabi: R12 = Rabi-12, R59 = Rabi-59, R30 = Rabi-30, MBA = M'Bari; Toucan: PK2 = PK-2, MRV = Marianga River, MRD = Marianga Road; Loango: LOA = Primary Forest; Moukalaba-Doudou: CA1 = Camp-1, CA2 = Camp-2, SW1 = Swamp-1, SW2 = Swamp-2. MBA and MRD are logged sites.

Species	G30	G26	MYR	TOT	R12	R59	R30	MBA	PK2	MRV	MRD	LOA	CA1	CA2	SW1	SW2	Total
Western Olive Sunbird	34.7	18.9	36.8	41.4	26.8	28.6	15.1	10.2	30.4	12.1	4.3	6.7	12.2	34.8	11.3	9.1	17.5
Yellow-whiskered Greenbul	6.1	12.2	13.2	3.4	26.8	19	15.1	58.2	15.2	12.1	28.3	8.7	8.5	17.4	18.3	8.3	17.4
Lesser Bristlebill	14.3		7.4	13.8	14.6		13.2	1	9.8	7.6	10.9	6.7	17.1	8.7	14.1	9.1	9.1
Little Greenbul	10.2	52.7	2.9		7.3	4.8	9.4	11.2	2.2	1.5	8.7	1	2.4	4.3	2.1	0.8	7.2
Icterine Greenbul	10.2		11.8	13.8	7.3	2.4			6.5		6.1	15.4	8.5		5.6	9.8	6.5
Fire-crested Alethe	4.1	1.4	1.5	6.9	2.4	21.4	3.8	8.2		4.5	14.3	1	15.9	4.3	5.6	7.6	6
Brown-chested Alethe												17.3	1.2	4.3	7	6.8	3.4
Eastern Bearded Greenbul												8.7			3.5	4.5	1.8
Total captures at site	49	74	68	29	41	42	53	98	92	66	46	104	82	23	142	132	1141

Table 4. Common species in mist-net samples in non-forest sites. All species that were among the top three in number of individuals captured (including ties) are included. The figure given is the percentage of total individuals captured that the species represented at each site. The top three species at each site are indicated in bold. Abbreviations for sites: Rabi: OSS = Ossengue Camp; Toucan: QUA = Quarry; Loango: COA = Coastal vegetation; SAV = Savanna/gallery forest

Species	OSS	QUA	COA	SAV	Total
Little Greenbul	32.8	16.9	4.2	0.9	9.8
Yellow-whiskered Greenbul	20.7	31			8.7
Western Olive Sunbird	3.4	28.2			5.7
Western Nicator	10.3	4.2			2.3
Carmelite Sunbird			1.4	29.3	9.3
Common Bulbul			6.9	20.7	8.7
Purple-headed Glossy Starling			21.5		8
Common Wattle-eye			11.1	11.2	7.5
Green-headed Sunbird			12.5		4.6
Total captures at site	58	71	144	116	389

dense tangled vegetation. In primary forest it seems to forage too high to be caught regularly, but in low secondary growth at Ossengue it was more easily caught.

The two sites near the coast, coastal vegetation and savanna/gallery forest at Loango, were somewhat different from one another and different from the other non-forest sites. These two sites shared no common species with any other sites, and shared only one common species between themselves, Common Wattle-eye. It should be noted that the most common species that was captured in coastal vegetation, Purple-headed Glossy Starling, is typically a species of forest canopy. As mentioned in the previous section, its abundance in samples from this habitat was due to the capture of flocks coming in to drink and bathe at pools of water near some of our nets.

4.4 Breeding and molt

Breeding and molting activity are shown in Table 5. Breeding activity, as assessed by the number of individuals in mist-net samples showing brood patches, peaked in the dry-rainy transition (13% at Loango in September-October) and the mid rainy season (18% at Rabi in February-March). Breeding activity was very low or absent at other times, including the late rainy season (3% at Moukalaba-Doudou in March-April), rainy-dry transition (0% at Toucan in May-June), and dry season (<1% at Gamba in July-August). (Note that, because only females develop brood patches in most species, the actual percentage of birds breeding in each season would have been approximately double that given.) Molt peaked in the late rainy season (78% at Moukalaba-Doudou), and was at a minimum in the late dry season (9% at Gamba).

In the seasonal tropics the greatest breeding activity usually takes place near the beginning of the rainy season, when insects and fruit are most abundant. Because molt is an energetically costly process, most birds wait until after the breeding season is finished to carry it out. Our data fit this pattern. Breeding activity was at its maximum from the dry-rainy transition into the mid rainy season, and after that was minimal. The peak of molt occurred after that of breeding, reaching its maximum in the late rainy season when most birds had terminated reproductive activity. By the mid dry season, when resources were probably at a minimum, very few birds were either breeding or molting (Schmidt and Branch 2005).

5 Discussion

5.1 Species lists

The Gamba Complex is rich in birds, with the 455 species recorded in Table 1 representing 67% of the birds known from Gabon as a whole. Additional surveys of the more remote parts of the Complex will undoubtedly increase this total.

The total number of species recorded from a site depends on the duration and intensity of surveys, the season when they were conducted, the total area covered, the habitat diversity of the site, and other factors (Remsen 1994). Therefore, these factors must be taken into account in comparing the species lists from individual sites.

We recorded the lowest number of species, 158, at Gamba. However, this was largely because our primary survey there was conducted during the dry season, when most species were not calling, and when

Table 5. Breeding condition and molt. For breeding, the figure indicates the number of individuals in mist-net samples with incipient, active, or recent brood patches or other indication of breeding. Individuals with old or re-feathering brood patches are not included. For molt, the figure indicates the number of individuals in mist-net samples showing body, wing, and/or tail molt.

Site	Months	Season	Breeding		Molt	
			number breeding/ number assessed	percent	number breeding/ number assessed	percent
Loango	Sep-Oct	dry- rainy transition	39/311	13	69/313	22
Rabi	Feb-Mar	mid rainy	41/222	18	164/253	65
Moukalaba-Doudou	Mar-Apr	late rainy	12/356	3	295/377	78
Toucan	May-Jun	rainy -dry transition	0/245	0	109/246	44
Gamba	Jul-Aug	mid dry	1/215	<1	19/215	9

northern migrants were absent. Also, because of the limited calling activity, we focused primarily on mist-netting in forest areas, rather than on wider-ranging auditory and visual surveys. Sargeant (1993) listed 380 species for the Gamba area, but this total was recorded over a much longer period (five years) and over a much larger area (approximately a 40 km radius, compared to a 10 km radius for our surveys). Although we recorded a lower number of species at Moukalaba-Doudou (177), compared to Rabi-Toucan (204) or Loango (203), this can largely be attributed to the lower habitat diversity at this site. Moukalaba-Doudou lacked the non-forest habitats present at the latter sites, human-induced in the case of Rabi and natural in the case of Loango.

5.2 Impacts of human activity

Taken as whole, the bird communities of the sites in the Gamba Complex that we surveyed appear to have been relatively little affected by development to date. Some forest habitat has been lost directly to deforestation and, at Rabi, to flooding, and some has probably been affected adversely by logging, edge effects, and fragmentation. However, the forest bird communities appear to be mostly intact, including species that may be sensitive to human disturbance or exploitation.

5.2.1 Deforestation

Direct deforestation has been most significant at Gamba, due to construction of oil facilities, towns, and other infrastructure, and also due to cultivation by local villages. Some deforestation has also taken place at Rabi and Toucan, but to a much lesser extent. The Loango and Moukalaba-Doudou sites have not been affected by recent deforestation.

Deforestation at Gamba and Rabi-Toucan has removed habitat for forest species, and conversely provided additional habitat for non-forest species. However, extensive tracts of forest together with their bird communities remain in the immediate area of Gamba. At Rabi and Toucan, deforestation has been limited relative to the concession area as a whole, and to date there has been relatively little colonization of the area by non-forest species.

5.2.2 Roads, edge effects, and fragmentation

Deforestation may, through edge effects, have an impact on bird populations over a much larger extent than just the area of forest that has been directly removed. Changes in bird diversity and/or abundance near forest edges has been documented by many studies (e.g. Lovejoy *et al.* 1986, Canaday 1996, Dale *et al.* 2000), and parasites, predators, and competitors of open areas may be able to invade the forest along edges (Kroodsma 1982, 1984; Andrews 1990; Burkey 1993; Rich *et al.* 1994; Goosem 1997). Fragmentation, that is, the division of formerly continuous forest into isolated blocks by deforestation, can have additional detrimental effects beyond edge effects. Some species disappear rapidly from fragments, and bird species richness and/or diversity has been found to be inversely correlated with fragment area in many studies (e.g. Willis 1974, Karr 1982, Bierregaard and Lovejoy 1989, Bierregaard *et al.* 1992, Warburton 1997, Stratford and Stouffer 1999, Renjifo 1999, Laurance *et al.* 2002).

Our studies were not extensive enough to document edge or fragmentation effects at Gamba, Rabi or Toucan, and more detailed research on this topic would be of considerable interest. However, the existing roads within the production area at Gamba,

Rabi and Toucan probably have relatively low impact on birds because of their width and manner of construction. Roads, excluding verges, are standardly 15 m wide. They often have tall forest on both sides that shades the road during at least part of the day, and well-vegetated margins. Such narrow, well-shaded roads probably minimize edge effects and are comparatively easy for birds to cross (Develey and Stouffer 2001). While edge effects almost certainly occur in the area, they were not obvious. Birds typical of primary forest were often observed at the edge of roads and other clearings, and no species appeared to be restricted to areas away from edges or clearings. Conversely, species typical of disturbed or open areas were not observed within closed forest. Fragmentation effects, like edge effects, also were not obvious. Forest bird communities within the ring road at Rabi, and in the smaller blocks divided by the transverse roads, appeared to be similar in composition to communities outside it.

5.2.3 Logging

Because of its effect on forest structure, selective logging is likely to have a greater effect on forest bird communities than any other factor in the area aside from direct deforestation. Bird species richness, diversity, and abundance may all be affected in selectively logged forests compared to intact forests (Thiollay 1992, Marsden 1998, Owunji and Plumtre 1998, Mason and Thiollay 2001, Zakaria and Francis 2001, Plumtre *et al.* 2001). Logging can potentially exacerbate the effects of other impacts such as edge effects. For example, Shell Gabon roads in the parts of Rabi and Toucan that have been heavily affected by selective logging are much more open and less shaded, and have more grass and shrubs lining their edges, than areas that have not been logged. This allows birds of disturbed habitats to colonize these portions of such roads, and probably makes them more of a barrier to being crossed by forest interior birds. Selective logging is a special concern in the forestry concession areas north of Rabi and Toucan. In addition, forestry roads in this area are much wider and have much less roadside vegetation than those of the oil industry, and probably have a more significant impact on bird communities.

5.2.4 Hunting

Favored game species in the Gamba Complex include guineafowl, the larger hornbills, and Great Blue Turaco. Thibault and Blaney (2003) recorded Pink-backed Pelican (2 individuals), Palm-nut Vulture (15), African Fish Eagle (2), and a *Tockus* hornbill (1) being sold in markets in Gamba during a survey of bushmeat exploitation conducted in 1997 and 1998. Some of these species, especially hornbills, are frugivores and among the most important seed-dispersers of trees and lianas (Whitney *et al.* 1998, Holbrook and Smith 2000). Loss of these species through over-hunting could have significant effects on forest regeneration.

Most of these species are present, although not particularly numerous, near Gamba, which has the largest human population and hence is likely to have the greatest impact from hunting. Several favored game species are common and conspicuous in the Rabi area, notably Black-casqued Hornbill and Great Blue Turaco. There is no indication that hunting has had an impact on game species in the Rabi area itself. Although some effect of hunting might be expected nearer to local settlements at Calao, large game species were observed there as well. Black Guineafowl and large hornbills were common at Loango, but we rarely recorded Great Blue Turaco. Conversely, although Black Guineafowl and Great Blue Turaco were common at Moukalaba-Doudou, large hornbills were notably scarce. Both sites are remote from significant human populations, so that hunting is unlikely to account for the rarity of certain game species. It is possible that the seasonal availability of fruit may cause local movements and influence the presence of some of these species at certain times. Additional study would be desirable to determine the factors that account for the apparent differences in abundance of these species between sites.

5.3 Recommendations for conservation

Within the production areas of Gamba, Rabi, and Toucan, official Shell Gabon policy calls for minimizing deforestation associated with oil development, the construction of relatively low-impact roads (narrow and with revegetated margins), and restoration and revegetation of some degraded areas. In the Rabi area, hunting has largely been controlled through limitation of road access by Shell Gabon to the concession area. Such efforts should be continued

and strengthened. Whenever possible, new roads, pipelines, and other infrastructure should be constructed in a manner that minimizes fragmentation.

Within the Gamba Complex as a whole, selective logging may be the most significant threat to the conservation of forest birds, and the area affected by logging is likely to increase in the future, at least in the periphery. Studies are needed to identify logging practices that are least detrimental to forest bird communities, together with policies that encourage such practices.

Formal designation of the Loango and Moukalaba-Doudou National Parks has been a very promising development, but effective protection of these areas will need to be promoted and enforced. As oil production declines, new sustainable economic activities will have to be developed. The Gamba Complex, with its high bird diversity and charismatic species such as hornbills that can be seen easily in several areas, has significant potential for ecotourism. Loango National Park has the highest potential in this regard, because of its scenic landscapes and the variety of habitats it presents. In the sector of Moukalaba-Doudou that we surveyed, the Rembo Ndogo, easily reached by boat from Gamba, has excellent potential for bird-oriented tourism. Hornbills and many other interesting species can easily be seen there in the course of a morning or afternoon.

Over the longer term, some oil production areas may also have potential for ecotourism development once their oil resources have been exhausted. Rabi, for example, has substantial infrastructure including an airfield, housing, and an extensive road system that is ideal for viewing wildlife. If this area can be protected and its wildlife values retained post oil production, it could be an attractive site for development of an ecotourism and research site. This could have the added advantage of concentrating such development in an area that already has been impacted by human activity, rather than risking disturbance to more pristine areas in the national parks.

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