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Research Paper

**AVIFAUNAL DIVERSITY OF THE BIODIVERSITY CONSERVATION AREA
OF THE SOUBRE HYDROELECTRIC DAM (SOUTH-WEST, CÔTE
D'IVOIRE)**

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Abstract

The ornithological inventory of the Biodiversity Conservation Area (BCA) of the Soubre hydroelectric dam was carried out in January and May 2018, in order to know the avifaunal diversity for a better conservation of the site. Based on the methods of listening points from fixed points, call-playback technic, catches with Japanese nets and time-limited counts on line transects. This study made it possible to inventory 190 species of birds belonging to 57 families of 19 orders. Resident birds species are best represented with 84.74 % of bird specific richness. Among families, the Cisticolidae are the best represented with 06.32 % of whole BCA's bird species richness. Of these bird species, five are listed as species of global interest for protection, four are identified as restricted-range species, eight are qualified as endemic to West Africa and 17 are recognized as migratory species. A relatively significant sample of Côte d'Ivoire's forest bird species is present, with 71 of the 185 species in the Guinea-Congolese forest biome recorded in the study area. The results obtained indicate that this BCA is in a good state of conservation. Further studies will certainly be necessary and will provide much more evidence regarding the importance of this site for biodiversity conservation.

Key words: Avifauna, biodiversity conservation area, hydroelectric dam, Soubre.

INTRODUCTION

In Côte d'Ivoire, the creation of hydroelectric dams dates back to the mid-1960s [1]. It responds, on the one hand, to the country's quest for energy independence, with an option in favour of hydropower, and on the other hand, to a political will to reduce inter-regional disparities [1]. The positive consequences of major hydropower projects are numerous and diverse. Indeed, these works contribute to economic development and human advancement [2]. However, the construction of these superstructures is the source of many problems, including massive and forced displacement of populations [3,4] and the consequent destruction of the natural environment with the associated wildlife. Aware of these facts and with a view to reconciling the environment and sustainable development, the Ivorian State has included in its development program, the conduct of an environmental and social impact assessment (ESIA) prior to the implementation of any project likely to have an impact on the environment [5]. Thus, an Environmental and Social Management Plan (ESMP) was drawn up following the ESIA of the Soubre dam hydroelectric development project. In order to compensate for habitat loss, the ESMP proposed a restoration and rehabilitation area immediately downstream of the dam called "Biodiversity Conservation Area (BCA)". This area would be a sanctuary or refuge for wildlife in general and for avian fauna in particular. Indeed, birds occupy an important place within this biodiversity. They actively contribute to the functioning of ecosystems (pollination, seed dissemination, etc.). Because of their visibility, the extent and diversity of their habitats and their ecological role, birds are important indicators of ecosystem health [6].

The objective of this study was to evaluate and characterize the initial state of the avifauna of the Soubre hydroelectric dam BCA before considering any other conservation program (monitoring of rare or bio-indicator species, population dynamics, reproduction of threatened species, etc.). This would provide the managers of this site with reliable baseline data for decision making for long-term management of the ACA's natural resources for present and future generations.

MATERIALS AND METHODS

Materials

The equipment used consists of a pair of binoculars (Bushnell, 10 x 50 mm), a telescope (Ojoticron ES 80 GA SD) for direct observation of birds and a large torch

(Garrity ®) to illuminate tracks and trails during night surveys ; a digital camera (Panasonic Lumix DMC TZ61) and a dictaphone (SONY ®; Cassette-Corder; TCM-150) connected to a micro-directional respectively for taking pictures for recording vocalizations ; a Bird Identification Guide [7] was used for bird identification; a Global Positioning System (GPS) device (Garmin 60 CSx) to record geographical coordinates, altitude, plot routes and mark the various observation points; two mist nets (10 m long, 3.5 m high, 25 mm mesh size) for the capture and recapture of birds.

Methods

Description of the study site

The BCA is located immediately downstream of the Soubre hydroelectric dam. It constitutes an ecological continuum of 200 ha extending on the left and right banks of the Sassandra River (Figure 1).

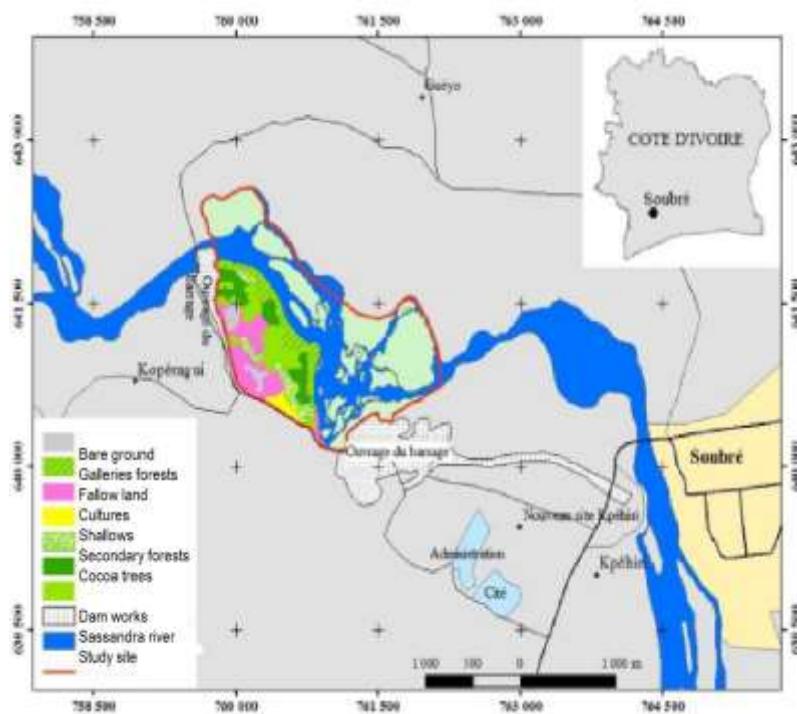


Figure 1: Map of the Biodiversity Conservation Area (BCA) of the Soubre hydroelectric dam and its location in Côte d'Ivoire

It is located in the sub-prefecture of Soubre, capital of the Nawa region in southwest Côte d'Ivoire. The town of Soubre is itself located at 5°47' north and 6°37' west, at an altitude of 134 m and about 130 km from the Gulf of Guinea [8]. The climate of the BCA is that of the town of Soubré, it is of the transitional equatorial type. The flora of the Soubre region (chief town of the Nawa region) has a particular character, due to

the existence of endemism, which is essentially at the specific level, with the exception of a few genera such as *Triphyo phylum* for example [9]. In the northern part of Soubre, the primary dense forests are of the *Eremospatha macrocarpa* and *Diospyros mannii* type. On the schistous soils of the southern region, forests with *Diospyros spp* and *Mapania spp* develop, and the fauna of this region is nowadays characterised at the level of mammalian fauna by harnessed guib, antelopes, deer and small rodents such as aulacodes, squirrels, etc, [9]. The Soubre region is adjacent to the Taï National Park [10].

Methodology

The study took place from January to May 2018. In order to take into account the heterogeneity of the environment, the Soubre hydroelectric dam BCA was subdivided into three sectors according to habitat types. These are :

- Forest Areas (FA) (05°47'53.5" N / 06°38'52.5" W and 05°47'53.1" N / 06°38'56.2" W) are composed of secondary forests, gallery forests and mosaics of semi-deciduous forests. Some trees such as the *Ceiba pentandra*, the *Triplochydion scleroxylon*, etc. can be found there;
- Fallow Land (FL) (05°47'46.8" N / 06°39'02.0" W and 05°47'33.9" N / 06°39'06.6" W) which contains the old *Theobroma cacao* plantations with some pineapple plants (*Ananas comosus*) in places and grass thickets of *Chromolaena odorata* ;
- Wetlands (WE) (05°48'07.6" N / 06°39'17.2" W and 05°47'19.9" N / 06°38'15.4" W) composed of the Sassandra River, swamps and water bodies with a strongly herbaceous vegetation.

The methods used are respectively those of listening points [11, 12, 13, 14, 15], capture and recapture with mist nets [16] and time-limited surveys along line transects [17, 18, 19] with five-minute stopping points at listening stations [15]. Indeed, the fixed listening point method was carried out during a whole day between 07:00 am and 18:30 pm. Capture and recapture with mist nets (excluding transects) was carried out at the same times as the listening stations, but in two of the three study sectors, i.e. forests (05°47'53.1" N / 06°38'56.2" W) and fallow land (05°47'46.8" N / 06°39'02.0" W).

Diurnal observations on line transects took place in the morning from 07h00 mn to 10h00 mn and in the afternoon from 15h00 mn to 18h00 mn. The surveys

were based on a systematic count of all bird species identified, seen or heard along the three 1 km transects during a slow (0.5 to 1 km/h) and silent walk.

For night observations, the surveys were carried out on the transects used for sampling of diurnal species. The call-playback technic was the main methodology. The songs of all nocturnal bird species likely to be encountered at the site were reviewed (10 in total). The vocalisation of a given species was listened to for 1 minute, followed by a 1-minute wait before moving on to another species. Observations were made during the full moon, from 19:00 to 23:00 on the outward journey and from 04:00 to 06:00 in the morning for the return journey. For each species surveyed, the conservation status [20], restricted-range species (RR), endemism in West Africa (AO) and biogeographic status according to [7], were indicated. Guidance on biomes is from [21] and [22]. The data collected also allowed the calculation of : the specific richness (S) of each habitat ($S=\sum \text{espèces}$), the relative frequency defined by Thiollay (1986) ($Fr = (Ci / C') * 100$) ; with Ci , the number of individuals per species and C , the total number of individuals of the stand counted in a habitat), the Shannon diversity index H' ($H' = -\sum (ni/N) \log_2 (ni/N)$), the equitability index (E) with $E = H'/H'\max$ ($H'\max = \ln S$) and the similarity coefficient (Cs) between habitats ($Cs = (2c/(a+b)) * 100$), with a : number of species in habitat X, b : number of species in habitat Y and c : number of species common to habitats X and Y. For the drafting of this manuscript, reference was made to the nomenclature, taxonomy and order according to [23].

RESULTS

A total of 190 species belonging to 57 families of 19 orders were recorded (Table 1). Resident birds species are best represented with 84.74 % of bird specific richness. The family Cisticolidae appears to be the most represented with 12 species (Table 1). Figure 2 shows some specimens of birds encountered in the BAC. The site has a good species diversity index (H') of 4.72 and a best birds distribution with 0.9 us equitability index (E) (Table 1). Concerning the different biotopes, fallow land has the highest species richness with 127 species (66.84% of the number of species inventoried in the BCA), the highest diversity index ($H' = 4.41$) and the most evenly distributed birds ($E = 0.9$). The lowest species richness (53 species, 27.89% of that of the entire study area) and the lowest diversity and equitability indices are observed in the wetlands with H' of 2.85 and E of 0.72 respectively.

Table 1: List and status of bird species observed in the Soubre hydroelectric dam Biodiversity Conservation Area

Scientific name	Common name	FA	FL	WE	Eff.	Fr (%)	CS	BS	BIO	RR	END.
GALLIFORMES											
NUMIDIDAE (2)											
<i>Numida meleagris</i> (Linnaeus, 1758)	Helmeted guineafowl			2		20	0,37	LC	R		
<i>Guttera pucherani</i> (Hartlaub, 1861)	Crested guineafowl	3	6			9	0,17				
PHASIANIDAE (2)											
<i>Pternistis ahantensis</i> (Temminck, 1854)	Ahanta francolin	4	1			14	0,26	LC	R	GC	
<i>Pternistis bicalcaratus</i> (Linnaeus, 1766)	Double spurred francolin	6	12			18	0,33	LC	R		
ANSERIFORMES											
ANATIDAE (2)											
<i>Dendrocygna viduata</i> (Linnaeus, 1766)	White-faced whistling duck			5	500	9,27	LC	R/M			
<i>Nettapus auritus</i> (Boddaert, 1783)	African pygmy goose			59	59	1,09	LC	R			
PODICIPEDIFORMES											
PODICIPEDIDAE (1)											
<i>Tachybaptus ruficollis</i> (Pallas, 1764)	Little grebe			15	15	0,29	LC	R			
COLUMBIFORMES											
COLUMBIDAE (7)											
<i>Treron calvus</i> (Temminck, 1811)	African green pigeon	47	2			67	1,24	LC	R		
<i>Turtur brehmeri</i> (Hartlaub, 1865)	Blue-headed wood dove	4				4	0,07	LC	R	GC	
<i>Turtur tympanistria</i> (Temminck, 1809)	Tambourine dove	7				7	0,13	LC	R		
<i>Turtur afer</i> (Linnaeus, 1766)	Blue-spotted wood dove	9	48			57	1,06	LC	R		
<i>Columba iriditorques</i> (Cassin, 1856)	Western bronze-naped	1				10	0,18	LC	R	GC	
<i>Streptopelia semitorquata</i> (Rüppell, 1837)	Red-eyed dove		63	11	74		1,37	LC	R		
<i>Spilopelia senegalensis</i> (Linné, 1766)	Laughing dove		86	23	109		2,02	LC	R		
CAPRIMULGIFORMES											
APODIDAE (6)											
<i>Rhaphidura sabini</i> (Gray, 1829)	Sabine's spinetail	6	21			81	1,5	LC	R	GC	
<i>Telacanthura melanopygia</i> (Chapin, 1915)	Black spinetail	75	22			97	1,8	LC	R	GC	
<i>Telacanthura ussheri</i> (Sharpe, 1870)	Mottled spinetail		38			38	0,7	LC	R		
<i>Cypsiurus parvus</i> (Lichtenstein, 1823)	African palm swift		15			105	1,95	LC	R		
<i>Apus apus</i> (Linnaeus, 1758)	Common swift		54	18	54		1	LC	P		
<i>Apus affinis</i> (Gray, 1830)	Little swift		41	7	48		0,89	LC	R		
CUCULIFORMES											
CUCULIDAE (10)											
<i>Clamator levaillantii</i> (Swainson, 1829)	Levaillant's cuckoo	1	5			6	0,11	LC	M		
<i>Cuculus solitarius</i> (Stephens, 1815)	Red-chested cuckoo	5				5	0,09	LC	M		
<i>Cuculus clamosus</i> (Latham, 1802)	Black cuckoo	8				8	0,15	LC	M		
<i>Cercococcyx olivinus</i> (Sassi, 1912)	Olive long-tailed cuckoo	11				11	0,2	LC	R	GC	
<i>Chrysococcyx cupreus</i> (Shaw, 1792)	African emerald cuckoo		25			25	0,46	LC	R		
<i>Chrysococcyx klaas</i> (Stephens, 1815)	Klaas's cuckoo	4	8			12	0,22	LC	R/M		
<i>Chrysococcyx caprius</i> (Boddaert, 1783)	Didric cuckoo		32			32	0,59	LC	R/M		

Scientific name	Common name	FA	FL	WE	Eff.	Fr (%)	CS	BS	BIO	RR	END.
<i>Ceuthmochares aereus</i> (Vieillot, 1817)	Yellowbill	9	4		13	0,24	LC	R			
<i>Centropus leucogaster</i> (Leach, 1814)	Black-throated coucal		12			12	0,22	LC	R	GC	
<i>Centropus senegalensis</i> (Linnaeus, 1766)	Senegal coucal			28		28	0,51	LC	R		
GRUIFORMES											
HELIORNITHIDAE (1)											
<i>Podica senegalensis</i> (Vieillot, 1817)	African finfoot			2	2	0,04	LC	R			
RALLIDAE (5)											
<i>Himantornis haematopus</i> (Hartlaub, 1855)	Nkulengu rail	2	1	3	0,06	LC	R	GC			
<i>Sarothrura pulchra</i> (Gray, 1829)	White-spotted flufftail	6		6	0,11	LC	R	GC			
<i>Zapornia flavirostra</i> (Swainson, 1837)	Black crake			11	11	0,2	LC	R			
<i>Porphyrio porphyrio</i> (Linnaeus, 1758)	Purple swamphen			11	11	0,2	LC	R/M			
<i>Gallinula chloropus</i> (Linnaeus, 1758)	Common moorhen			7	7	0,13	LC	R			
MUSOPHAGIFORMES											
MUSOPHAGIDAE (3)											
<i>Tauraco persa</i> (Linnaeus, 1758)	Green turaco	2		20	0,37	LC	R	GC			
<i>Tauraco macrorhynchus</i> (Fraser, 1839)	Yellow-bill turaco	2		20	0,37	LC	R	GC			
<i>Crinifer piscator</i> (Boddaert, 1783)	Western grey plantain-eater	39		39	0,72	LC	R				
PELECANIFORMES											
ARDEIDAE (10)											
<i>Calherodius leuconotus</i> (Wagler, 1827)	White-backed night heron	3	3	0,06	LC	R					
<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	Black-crowned night heron	8	8	0,15	LC	R					
<i>Ardeola ralloides</i> (Scopoli, 1769)	Squacco heron	8	8	0,15	LC	R/P					
<i>Bubulcus ibis</i> (Linnaeus, 1758)	Cattle egret	44	44	0,82	LC	R/M					
<i>Butorides striata</i> (Linnaeus, 1758)	Green-backed heron	19	19	0,35	LC	R					
<i>Egretta gularis</i> (Bosc, 1792)	Western reef egret	7	7	0,13	LC	R					
<i>Egretta garzetta</i> (Linnaeus, 1766)	Little egret	76	76	1,41	LC	R					
<i>Egretta intermedia</i> (Wagler, 1829)	Intermediate egret	11	11	0,2	LC	R					
<i>Egretta alba</i> (Linnaeus, 1758)	Great egret	16	16	0,3	LC	R					
<i>Ardea cinerea</i> (Linnaeus, 1758)	Grey heron	4	4	0,07	LC	R/P					
SULIFORMES											
PHALACROCORACIDAE (2)											
<i>Microcarbo africanus</i> (Gmelin, 1789)	Long tailed cormorant	35	35	0,65	LC	R					
<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	Great cormorant	7	7	0,13	LC	R					
CHARADRIIFORMES											
BURHNINIDAE (2)											
<i>Burhinus senegalensis</i> (Swainson, 1837)	Senegal thick-knee	17	17	0,31	LC	R					
<i>Burhinus vermiculatus</i> (Cabanis, 1868)	Water thick-knee	22	22	0,41	LC	R					
CHARADRIIDAE (2)											
<i>Vanellus senegallus</i> (Linnaeus, 1766) *	African wattled lapwing	18	18	0,33	LC	R					
<i>Vanellus spinosus</i> (Linnaeus, 1758) *	Spur-wing lapwing	49	49	0,91	LC	M					
JACANIDAE (2)											
<i>Actophilornis africanus</i> (Gmelin, 1789)	African jacana	76	76	1,41	LC	R					

Scientific name	Common name	FA	FL	WE	Eff.	Fr (%)	CS	BS	BIO	RR	END.
<i>Microparra capensis</i> (Smith, 1839)	Lesser jacana			21	21	0,39	LC	M			
SCOLOPACIDAE (2)											
<i>Tringa ochropus</i> (Linnaeus, 1758)	Green sandpiper		22	22	0,41	LC	P				
<i>Actitis hypoleucus</i> (Linnaeus, 1758)	Common sandpiper		36	36	0,67	LC	P				
TURNICIDAE (1)											
<i>Turnix sylvaticus</i> (Desfontaines, 1787)	Little buttonquail		1		10	0,18	LC	R			
GLAREOLIDAE (1)											
<i>Glareola nuchalis</i> (Gray, 1849)	Rock printacole			5	5	0,09	LC	R/M			
STRIGIFORMES											
TYTONIDAE (1)											
<i>Tyto alba</i> (Scopoli, 1769) *	Barn owl		1		10	0,18	LC	R			
STRIGIDAE (2)											
<i>Bubo poensis</i> (Fraser, 1853)*	Fraser's eagle owl	3			3	0,06	LC	R	GC		
<i>Strix woodfordii</i> (Smith, 1834) *	African wood owl	6	3		9	0,17	LC	R			
ACCIPITRIFORMES											
ACCIPITRIDAE (11)											
<i>Aviceda cuculoides</i> (Swainson, 1837)	African cuckoo hawk	3			3	0,05	LC	R			
<i>Elanus caeruleus</i> (Desfontaines, 1789)	Black-shouldered kite		5	2	7	0,13	LC	R			
<i>Milvus migrans</i> (Boddaert, 1783)	Black kite	3	8	13	24	0,44	LC	M			
<i>Gypohierax angolensis</i> (Gmelin, 1788)	Palm-nut vulture		5		5	0,09	LC	R			
<i>Polyboroides typus</i> (Smith, 1829)	African harrier hawk	8			8	0,15	LC	R			
<i>Circus macrourus</i> (Gmelin, 1770)	Pallid harrier		2		2	0,04	NT	P			
<i>Accipiter tachiro</i> (Daudin, 1800)	African goshawk	4			4	0,07	LC	R			
<i>Accipiter badius</i> (Gmelin, 1788)	Shikra	7	4		11	0,2	LC	R			
<i>Accipiter erythropus</i> (Hartlaub, 1855)	Red-thighed sparrowhawk	2			2	0,04	LC	R	GC		
<i>Kaupifalco monogrammicus</i> (Temminck, 1824)	Lizard buzzard	3	9		12	0,22	LC	R			
<i>Buteo auguralis</i> (Salvadori, 1865)	Red-necked buzzard		4		4	0,07	LC	R/M			
BUCEROTIFORMES											
BUCEROTIDAE (3)											
<i>Horizoceros albocristatus</i> (Cassin, 1848)	White-crested hornbill	8			8	0,15	LC	R	GC		
<i>Lophoceros semifasciatus</i> (Hartlaub, 1855)	African pied hornbill	55	46		101	1,87	LC	R	GC		
<i>Bycanistes fistulator</i> (Cassin, 1852)	Piping hornbill	28	53		81	1,05	LC	R	GC		
PHOENICULIDAE (1)											
<i>Phoeniculus bollei</i> (Hartlaub, 1858)	White-head wood-hoopoe	5	25		30	0,56	LC	R	GC		
CORACIIFORMES											
MEROPIDAE (2)											
<i>Merops pusillus</i> (Müller, 1776)	Little bee-eater		46		46	0,85	LC	R			
<i>Merops albicollis</i> (Vieillot, 1817)	White-throated bee-eater		59		59	1,09	LC	M			
CORACIIDAE (1)											
<i>Eurystomus glaucurus</i> (Müller, 1776)	Broad-billed roller		35		35	0,65	LC	R/M			
ALCEDINIDAE (3)											

Scientific name	Common name	FA	FL	WE	Eff.	Fr (%)	CS	BS	BIO	RR	END.
<i>Halcyon senegalensis</i> (Linnaeus, 1766)	Woodland kingfisher		25	12	37	0,69	LC	R			
<i>Ispidina pictus</i> (Boddaert, 1783)	African pygmy kingfisher		6	2	8	0,15	LC	R			
<i>Megaceryle maxima</i> (Pallas, 1769)	Giant kingfisher			2	2	0,04	LC	R			
PICIFORMES											
LYBIIDAE (8)											
<i>Gymnobucco peli</i> (Hartlaub, 1857)	Bristle-nosed barbet		17			17	0,15	LC	R	GC	
<i>Gymnobucco calvus</i> (Lafresnaye, 1841)	Naked-faced barbet		47			47	0,87	LC	R	GC	
<i>Pogoniulus scolopaceus</i> (Bonaparte, 1850)	Speckled tinkerbird		46	12		58	1,07	LC	R	GC	
<i>Pogoniulus atroflavus</i> (Sparmann, 1798)	Red-rumped tinkerbird		1			10	0,18	LC	R	GC	
<i>Buccanodon duchaillui</i> (Cassin, 1856)	Yellow-spotted barbet		14	2		16	0,3	LC	R	GC	
<i>Tricholaema hirsuta</i> (Swainson, 1821)	Hairy-breasted barbet		1	2		12	0,22	LC	R	GC	
<i>Lybius vieilloti</i> (Leach, 1815)	Vieillot's barbet		4	5		9	1,67	LC	R		
<i>Trachylaemus purpuratus</i> (Verreaux & Verreaux, 1851)	Yellow-billed barbet		11	6		17	0,15	LC	R	GC	
INDICATORIDAE (2)											
<i>Indicator maculatus</i> (Gray, 1847)	Spotted honeyguide			14		14	0,26	LC	R	GC	
<i>Indicator conirostris</i> (Cassin, 1856)	Thick-billed honeyguide		1			10	0,18	LC	R		
PICIDAE (1)											
<i>Dendropicos pyrrhogaster</i> (Malherbe, 1845)	Pic à ventre de feu		1			10	0,18	LC	R	GC	
FALCONIFORMES											
FALCONIDAE (5)											
<i>Falco tinnunculus</i> (Linnaeus, 1758)	Common kestrel		2	6		8	0,15	LC	R/P		
<i>Falco ardosiaceus</i> (Vieillot, 1823)	Grey kestrel		5	7		12	0,22	LC	R		
<i>Falco cuvierii</i> (Smith, 1830)	African hobby		1	5		6	0,11	LC	R		
<i>Falco biarmicus</i> (Temminck, 1825)	Lanner falcon			4		4	0,07	LC	R		
<i>Falco peregrinus</i> (Tunstall, 1771)	Peregrine falcon			2		2	0,04	LC	R/P		
PSITTACIFORMES											
PSITTACIDAE (1)											
<i>Psittacus timneh</i> (Fraser, 1844)	Timneh grey parrot			3		3	0,06	EN	R		
PASSERIFORMES											
ORIOLIDAE (1)											
<i>Oriolus brachyrynchus</i> (Swainson, 1837)	Western black-headed oriole		15	24		39	0,72	LC	R	GC	
VANGIDAE (1)											
<i>Bias musicus</i> (Vieillot, 1818)	Black-and-white flycatcher		14	7		21	0,39	LC	R		
PLATYSTEIRIDAE (2)											
<i>Dyaphorophyia castanea</i> (Fraser, 1843)	Chestnut wattled-eye		13	6		19	0,35	LC	R	GC	
<i>Batis senegalensis</i> (Linnaeus, 1766)	Senegal batis		11	15		26	0,48	LC	R	GC	AO
MALACONOTIDAE (1)											
<i>Tchagra senegalus</i> (Linnaeus, 1766)	Black-crowned tchagra		9	28		37	0,69	LC	R		
DICRURIDAE (1)											
<i>Dicrurus modestus</i> (Hartlaub, 1849)	Velvet-mantled drongo		29	11		40	0,74	LC	R		
MONARCHIDAE (1)											
<i>Terpsiphone rufiventer</i> (Swainson, 1837)	Red-bellied paradise flycatcher		1	7		8	0,15	LC	R	GC	

Scientific name	Common name	FA	FL	WE	Eff.	Fr (%)	CS	BS	BIO	RR	END.
LANIIDAE (1)											
<i>Lanius collaris</i> (Linnaeus, 1766)	Common fiscal	8	26		34	0,63	LC	R			
CORVIDAE (1)											
<i>Corvus albus</i> (Müller, 1776)	Pied crow		35	15	50	0,93	LC	R			
NICATORIDAE (1)											
<i>Nicator chloris</i> (Valenciennes, 1826)	Western nicator	8			8	0,15	LC	R	GC		
MACROSPHENIDAE (2)											
<i>Sylvietta virens</i> (Cassin, 1859)	Green crombec	22	5		27	0,5	LC	R	GC		
<i>Sylvietta denti</i> (Ogilvie-Grant, 1906)	Lemon-bellied crombec	2	13		33	0,61	LC	R	GC		
CISTICOLIDAE (12)											
<i>Eremomela badiceps</i> (Fraser, 1843)	Rufous-crowned eremomela	8			8	0,15	LC	R	GC		
<i>Apalis sharpii</i> (Shelley, 1884)	Sharpe's apalis		22		22	0,41	LC	R	GC	RR	AO
<i>Camaroptera brachyura</i> (Vieillot, 1820)	Grey-backed camaroptera	4	15		19	0,35	LC	R			
<i>Camaroptera superciliaris</i> (Fraser, 1843)	Yellow-browed camaroptera	8			8	0,15	LC	R	GC		
<i>Camaroptera chloronota</i> (Reichenow, 1895)	Olive-green camaroptera	2	9		11	0,2	LC	R	GC		
<i>Cisticola erythrops</i> (Hartlaub, 1857)	Red-faced cisticola		2		20	0,37	LC	R			
<i>Cisticola cantans</i> (Heuglin, 1869)	Singing cisticola	6	32		38	0,7	LC	R			
<i>Cisticola lateralis</i> (Fraser, 1843)	Whistling cisticola		17		17	0,31	LC	R			
<i>Cisticola aberrans</i> (Smith, 1843)	Rock-loving cisticola		13		24	0,44	LC	R			
<i>Bathmocercus cerviniventris</i> (Sharpe, 1877)	Black-headed rufous warbler	7		7	0,13	DD	R	GC	RR	AO	
<i>Prinia subflava</i> (Gmelin, 1789)	Tawny-flanked prinia		11		11	0,2	LC	R			
<i>Prinia erythropterus</i> (Jardine, 1849)	Red-winged warbler	7	26		33	0,61	LC	R			
ACROCEPHALIDAE (4)											
<i>Acrocephalus schoenobaenus</i> (Linnaeus, 1758)	Sedge warbler	3	9		12	0,22	LC	P			
<i>Acrocephalus scirpaceus</i> (Hermann, 1804)	European reed warbler	8	17		25	0,46	LC	P			
<i>Acrocephalus arundinaceus</i> (Temminck & Schlegel, 1847)	Great reed warbler	4	17		21	0,39	LC	P			
<i>Acrocephalus rufescens</i> (Sharpe & Bouvier, 1876)	Greater swamp warbler	2	13		15	0,29	LC	P			
HIRUNDINIDAE (3)											
<i>Cecropis senegalensis</i> (Linnaeus, 1766)	Mosque swallow			26	26	0,48	LC	R			
<i>Cecropis abyssinica</i> (Guérin-Méneville, 1843)	Lesser striped swallow		28	12	40	0,74	LC	R			
<i>Hirundo rustica</i> (Linnaeus, 1758)	Barn swallow		21		21	0,39	LC	P			
PYCONOTIDAE (11)											
<i>Stelgidillas gracilirostris</i> (Strickland, 1844)	Slender-billed greenbul		13		13	0,24	LC	R			
<i>Bleda syndactylus</i> (Swainson, 1837)	Red-tailed bristlebill	7			7	0,13	LC	R	GC		
<i>Bleda eximus</i> (Hartlaub, 1855)	Green-tailed bristlebil	4			4	0,07	NT	R	GC	RR	AO
<i>Bleda canicapillus</i> (Hartlaub, 1854)	Grey-headed bristlebill	26			26	0,48	LC	R	GC		
<i>Thescelocichla leucopleura</i> (Cassin, 1856)	Swamp palm bulbul		14		14	0,26	LC	R	GC		
<i>Eurillas latirostris</i> (Strickland, 1844)	Yellow- whiskered greenbul	4			4	0,07	LC	R			
<i>Eurillas virens</i> (Cassin, 1858)	Little greenbul	13	25		38	0,7	LC	R			
<i>Eurillas gracilis</i> (Cabanis, 1880)	Little grey greenbul			3	3	0,06	LC	R	GC		
<i>Eurillas ansorgei</i> (Hartert, 1907)	Ansorge's greenbul	4			4	0,07	LC	R	GC		
<i>Eurillas curvirostris</i> (Cassin, 1860)	Cameroon sombre greenbul	7			7	0,13	LC	R	GC		

Scientific name	Common name	FA	FL	WE	Eff.	Fr (%)	CS	BS	BIO	RR	END.
<i>Pycnonotus barbatus</i> (Desfontaine, 1789)	Common bulbul			118		118	2,19	LC	R		
SCOTOCERCIDAE (1)											
<i>Hylia prasina</i> (Cassin, 1855)	Green hylia	27	15		42	0,78	LC	R	GC		
PELLORNEIDAE (1)											
<i>Illadopsis fulvescens</i> (Cassin, 1859)	Brown illadopsis	7	1		8	0,15	LC	R	GC		
STURNIDAE (2)											
<i>Lamproornis splendidus</i> (Vieillot, 1822)	Splendid glossy starling	14	29		43	0,8	LC	R			
<i>Hylopsar cupreocauda</i> (Hartlaub, 1857)	Copper-tailed glossy starling	5	2		7	0,13	NT	R	GC	RR	AO
TURDIDAE (1)											
<i>Stizorhina finschi</i> (Sharpe, 1870)	Finsch's flycatcher thrush	3	9		12	0,22	LC	R	GC		AO
MUSCICAPIDAE (7)											
<i>Alethe diademata</i> (Bonaparte, 1850)	White-tailed alethe	5			5	0,09	LC	R	GC		
<i>Muscicapa cassini</i> (Heine, 1859)	Cassin's flycatcher	25	9		34	0,63	LC	R	GC		
<i>Bradornis ussheri</i> (Sharpe, 1871)	Ussher's flycatcher	29	6		35	0,65	LC	R	GC		
<i>Fraseria cinerascens</i> (Hartlaub, 1857)	White-browed forest flycatcher	59	12		71	1,32	LC	R	GC		
<i>Fraseria olivascens</i> (Cassin, 1859)	Olivaceous flycatcher	31	8		39	0,72	LC	R	GC		
<i>Stiphrornis erythrothorax</i> (Hartlaub, 1855)	Forest robin	6	12		18	0,33	LC	R	GC		
<i>Ficedula hypoleuca</i> (Pallas, 1764)	Pied flycatcher	1	19		29	0,54	LC	P			
NECTARINIIDAE (10)											
<i>Deleornis fraseri</i> (Jardine & Selby, 1843)	Fraser's sunbird	6	2		8	0,15	LC	R	GC		
<i>Anthreptes gabonicus</i> (Hartlaub, 1861)	Brown sunbird	31			31	0,57	LC	R	GC		
<i>Anthreptes seimundi</i> (Ogilvie-Grant, 1908)	Little green sunbird	1	5		15	0,29	LC	R	GC		
<i>Anthreptes rectirostris</i> (Shaw, 1811)	Green sunbird	6	17		23	0,43	LC	R	GC		
<i>Hedydipna collaris</i> (Vieillot, 1819)	Collared sunbird	14	22		36	0,67	LC	R			
<i>Cyanomitra olivacea</i> (Smith, 1840)	Olive sunbird	28	12		40	0,74	LC	R			
<i>Chalcomitra adelberti</i> (Gervais, 1833)	Buff-throated sunbird	31			31	0,57	LC	R	GC		AO
<i>Cinnyris minullus</i> (Reichenow, 1899)	Tiny sunbird	8	2		10	0,18	LC	R	GC		
<i>Cinnyris superbus</i> (Shaw, 1811)	Superb sunbird	5	15		20	0,37	LC	R	GC		
<i>Cinnyris venustus</i> (Shaw, 1799)	Variable sunbird	1	7		8	0,15	LC	R			
PLOCEIDAE (9)											
<i>Euplectes hordeaceus</i> (Linnaeus, 1758)	Black-winged (red) bishop	2	2	22	0,41	LC	R				
<i>Euplectes macroura</i> (Gmelin, 1789)	Yellow-mantled widowbird	24	3	27	0,5	LC	R				
<i>Ploceus cucullatus</i> (Müller, 1776)	Village weaver	14	17	157	2,91	LC	R				
<i>Ploceus tricolor</i> (Hartlaub, 1854)	Yellow-mantled weaver	19	4	23	0,43	LC	R	GC			
<i>Ploceus nigerrimus</i> (Vieillot, 1819)	Vieillot's black weaver	19	5	24	0,44	LC	R	GC			
<i>Malimbus scutatus</i> (Cassin, 1849)	Red-vented malimbe	7	1	8	0,15	LC	R	GC			AO
<i>Malimbus nitens</i> (Gray, 1831)	Blue-billed malimbe	3		3	0,06	LC	R	GC			
<i>Malimbus rubricollis</i> (Swainson, 1838)	Red-headed malimbe	5	22		27	0,5	LC	R	GC		
<i>Ploceus nigricollis</i> (Vieillot, 1805)	Black-necked weaver	19	5	24	0,44	LC	R				
ESTRILDIDAE (10)											
<i>Spermophaga haematina</i> (Vieillot, 1805)	Western bluebill	18	9		27	0,5	LC	R	GC		
<i>Pyrenestes sanguineus</i> (Swainson, 1837)	Crimson seedcracker	2	7		27	0,5	LC	R			

Scientific name	Common name	FA	FL	WE	Eff.	Fr (%)	CS	BS	BIO	RR	END.
<i>Estrilda melpoda</i> (Vieillot, 1817)	Orange-cheeked waxbill		37		37	0,69	LC	R	SG		
<i>Estrilda troglodytes</i> (Lichtenstein, 1823)	Black-rumped waxbill		34		34	0,63	LC	R	GC		
<i>Nigrita fusconotus</i> (Fraser, 1843)	White-breasted negrofinch	25	6		31	0,57	LC	R	GC		
<i>Nigrita bicolor</i> (Hartlaub, 1844)	Chestnut-breasted negrofinch	36			36	0,67	LC	R			
<i>Nigrita canicapillus</i> (Strickland, 1841)	Grey-headed (crowned) negrofinch	15	6		21	0,39	LC	R			
<i>Spermestes cucullatus</i> (Swainson, 1837)	Bronze mannikin		67	15	82	1,52	LC	R			
<i>Spermestes bicolor</i> (Fraser, 1843)	Black-and-white mannikin		26	1	36	0,67	LC	R			
<i>Spermestes fringilloides</i> (Lafresnaye, 1835)	Magpie mannikin		32	4	36	0,67	LC				
VIDUIDAE (1)											R
<i>Vidua macroura</i> (Pallas, 1764)	Pin-tailed whydah		32		32	0,59	LC				
PASSERIDAE (1)											R
<i>Passer griseus</i> (Vieillot, 1817)	Northern grey-headed sparrow		85	14	99	1,84	LC				
MOTACILLIDAE (3)											R
<i>Anthus leucophrys</i> (Vieillot, 1818)	Plain-backed pipit		21		21	0,39	LC	R			
<i>Motacilla clara</i> (Sharpe, 1908)	Mountain wagtail			26	26	0,48	LC	R			
<i>Motacilla aguimp</i> (Dumont, 1821)	African pied wagtail		28	12	40	0,74	LC				
Species number (S)		101	127	53	190						
Shannon diversity index (H')		4,13	4,41	2,85	4,72						
Equitability index (E)		0,89	0,9	0,72	0,9						

*BS : Biogeographic status ; BIO : Biome ; CS : Conservation status; DD: Data Deficient; Eff. : Numbers of birds population; EN: Endangered species; END : Endemic to West Africa; FA : Forests areas ; FL : Fallow land ; Fr : Relative frequency ; GC : Guinea-Congolese forest biome birds species; LC: Least Concern; M: Intra-African Migratory species ; NT: Near Threatened ; P: Palearctic Migratory species ; R: Resident espclies; RR: Restricted range species; SG : Guinea-soudanese savannah biome birds species; WE : Wetland ; *: Nocturnal species.*

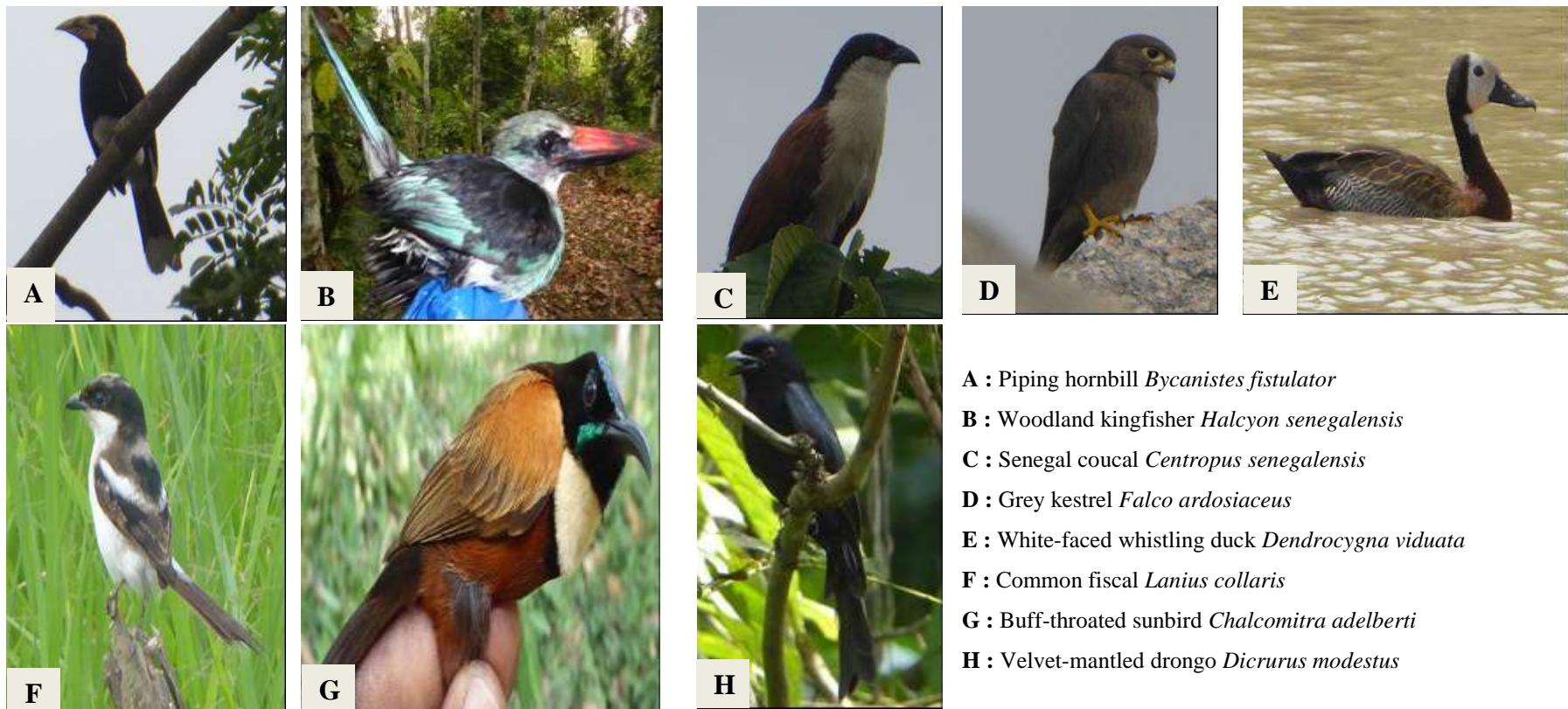


Figure 2: Photographs of some bird species encountered in the BCA (Photo: Ahon, 2018)

Comparison between the lists of bird species in the three habitat types yielded three coefficients of similarity (Cs). From these Cs, only, a homogeneity appears between bird populations in forest areas (FA) and fallow areas (FL) with a value of Cs 60.53%.

The BCA is characterized by five bird species of international conservation concern (Table 1). One is the Timneh's Grey Parrot *Psittacus timneh* (Fraser, 1844), which is classified as Endangered (EN); three species in the Near Threatened (NT) category, namely the Pallid harrier *Circus macrourus* (Gmelin, 1770), the Green-tailed bristlebil *Bleda eximius* (Hartlaub, 1855) and the Copper-tailed glossy starling *Hylopsar cupreocauda* (Hartlaub, 1857) and a species of the category Insufficiently documented (DD), the Black-headed rufous warbler *Bathmocercus cerviniventris* (Sharpe, 1877). The other species recorded are in the Least Concern (LC) category. Also, four species of restricted distribution (RR), eight described as West African endemic (AO), 71 species (37.37% of the BCA's species richness) are inferred from the Guinean-Congolese forests (GC) and one species characteristic of the Sudano-Guinean savannah biome (SG) has been inventoried (Table 1). In terms of biogeographic status, 10 palearctic migratory species (5.26%), seven intra-African migratory species (3.68%) and 12 mixed-status species (6.32%) have been recorded.

DISCUSSION

The avifauna of the BCA of Soubre hydroelectric dam is rich and diversified with 190 species belonging to 57 families and grouped into 19 orders. The number of species listed in the BCA, representing 25.13 % of the whole of the birds species met in Côte d'Ivoire which was 756 [24]. This specific richness of birds in the BCA is higher than that obtained in the classified forest of Téné, in the Banco national park and in the classified forest of Besso which contain 93[25], 165 [26] and 170 [27] species respectively. However, for a longer study period than this study, the Ehotilé Islands National Park [28] and the Tanoé-Ehy swampy forest [29] record respectively the same number (190) and many more bird species (274). On the other hand, the bird specific richness of the BCA is lower than that obtained by [30] in Taï national park and [31] in the future M'Brimbo voluntary reserve, which were respectively 238 and 204 bird species.

In terms of conservation values, the remarkable presence of bird species of global interest protection among which one threatened species (endangered) and three other

species close to threat (near-threatened) ; four restricted-range species, eight endemic species to West Africa, shows that the BCA would deserve special attention as other species could be identified in subsequent studies or may give an additional indication of conservation status. Four of the 14 restricted species (28.57%) recorded in Côte d'Ivoire [21, 22] were found in the BCA. This appears to be representative for this very small conservation area (in comparative of the Taï National Park). The relatively high number of species in the Guinean-Congolese forest biome illustrates the good conservation status. The dominance of resident species (84.26%) could be due to the fact that the environment offers ideal conditions in all seasons for the installation and maintenance of these species [32]. On the other hand, migratory species (8.94%) are not really dependent on these habitats because they only use them for one period of the year [33]. Among the three type of habitats surveyed, fallow lands have the best results (highest number of bird species (127), the highest indices ($H' = 4.41$; $E = 0.9$) compared to wetlands which has only 53 species and lowest index ($H' = 2.85$; $E = 0.72$). This would be explained by the existence ecological constraints which would be more important at the wetland level than in fallow land. Indeed, wetlands (the Sassandra River in particular) are regularly exposed to fishing activities thus reducing the available food and would disturb breeding birds as some of these environments could be used as perches, dormitories, breeding sites, nesting sites and refuge from possible predators or in case of disturbance [25, 33, 34, 35, 35, 36, 37]. It has been shown that diversity is greater in stands in low stress environments and is lower than in those with high ecological constraints [38]. In addition, fallow land may offer certain favourable conditions, for example: nesting facilities for some birds; other birds with a bushy tendency will find sufficient vegetative structures at different stages of evolution to continue nesting as in their natural forest habitat. These fallows also provide the birds with an appreciable amount of food, which attracts many omnivorous birds [33].

CONCLUSION

This study shows that with 190 bird species, the BCA contains a large and highly diverse bird community. Globally, the family Cisticolidae are the most represented with 12 species and Resident species were the most abundant with 84,74% of the birds species in this site. The greatest number of bird species, diversity and equitability index were observed in the fallow areas. Indeed, in terms of the avifaunal potential of the site, it

should be noted that it hosts five species of birds whose protection is of global interest; four restricted range species distribution; eight West African endemic species ; 71 species of birds confined to the Guineo-Congolese forest biome and 17 migratory species. Thus, the presence of these species with special statuses (vulnerable, near-threatened, restricted distribution, West African endemic, particular biome, migratory, etc.) is comforting and indicates that the BCA is to be erected as an Important Bird Area for the conservation of birds. Further studies will certainly be necessary and will give much more argument regarding the importance of this site for biodiversity conservation.

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