(RESEARCH ARTICLE)

Check for updates

# Ecological restoration of mammalian fauna in reclaimed areas East of Taï National Park (Southwest, Côte d'Ivoire)

Kramoko BAMBA [1, *], Roger Malé KELY [1, 2], Kone N'GANON [1], Ange Edgar Habib MONKET [2], Alban Yao Fernand TIECOURA [1] and Béné Jean-Claude KOFFI [1]

[1] Biodiversity and Tropical Ecology Laboratory ; Department of Biodiversity and Sustainable Ecosystem Management ; Environmental Training and Research Unit ; Jean Lorougnon Guédé University, BP 150 Daloa, Côte d'Ivoire.
[2] Ministry of the Environment, Sustainable Development and Ecological Transition 20 BP 650 Abidjan 20, Côte d'Ivoire.

## Abstract

The degradation of natural environments in Côte d'Ivoire is increasing to the point that animal species are increasingly confined to protected areas. These protected areas, such as the Taï National Park (TNP), which constitute the last refuge for certain species, are also subject to strong human pressures. In the south-east of the TNP, an area occupied by farms was reclaimed between 2012 and 2015 and protected. This work aims to determine the state of colonization of the reclaimed area in the east of the TNP in order to contribute to the sustainable conservation of mammals in the park. Data were collected using linear transects, reconnaissance walks and camera trapping. A total of 24 mammalian species belonging to 5 orders (Rodents, Carnivores, Artiodactyls, Primates and Bats) were identified. These orders are more concentrated in the north and center of the park. Evidence of poaching was an indication of observed anthropogenic threats. The IUCN international conservation status indicates that among the mammals observed, 16 species are of Least Concern, 05 Near Threatened, 02 Vulnerable (Zebra Duiker, Marsh Mongoose) and 01 Endangered species (Jentink's Duiker).

**Keywords:** Sustainable conservation; Mammals; Taï National Park; Côte d'Ivoire

## 1. Introduction

Mammals are one of the most important components of terrestrial ecosystems [1]. They play an important role in the functioning of ecosystems, participating in seed dispersal, regulating the structure of flora and plant diversity through herbivores [2]. The African continent is home to a large number of mammal species with more than 1,116 species belonging to 57 families and 16 orders [3]. Unfortunately, mammalian fauna is highly threatened with extinction by anthropogenic actions [4, 5, 6]. In Côte d'Ivoire, one of the measures implemented by the State to combat the erosion of biodiversity in general and fauna in particular, is the creation of classified forests and a large network of protected areas including the Taï National Park (PNT) [2, 7]. The southeastern part of this forest block has been infiltrated by local populations who have created cocoa and coffee plantations there. These clearing areas expanded with the socio-political crisis that Côte d'Ivoire experienced in 2010. Faced with this observation, an operation to recover and develop areas occupied by crops in the PNT was carried out by the PNT managers (OIPR) in 2012. At the end of this operation, 6,310 ha in the Soubré sector, which had been the subject of intensive agriculture, were thus destroyed between 2012 and 2015 [8]. The amplification of monitoring operations encouraged the natural regeneration of vegetation, which was the subject of scientific monitoring. Thus, the forest cover rate (intact forest) of the Park increased from 97.7% in 2015 to 98.4% in 2018 [7, 9]. In addition, these preliminary results of this monitoring supported a good recovery of plant cover. However, to date, there is no scientific data on the return of mammalian fauna to the recovered area east of the PNT, in

---

[*] Corresponding author: Kramoko BAMBA

terms of species, abundance and factors that determine the possible flow of fauna. The general objective of this study is to determine the colonization status of the recovered area in the east of the PNT by mammals with a view to contributing to their sustainable conservation in the park. Specifically, it involves (i) determining the diversity and abundance of mammalian fauna in the recovered area, (ii) assessing the spatial distribution of mammalian fauna and (iii) identifying and prioritizing the threat factors that determine the possible flow of fauna.

## 2. Methodology

### 2.1. Study site

This study was carried out in the South-East of the PNT between latitudes 4°50' and 13°0' N and longitudes 1°0' and 17°50' W more precisely in the Nawa region, Soubré sector (Figure 1). It covers an area of 6310 ha [8]. Rainfall varies from 1,400 to 2,500 mm of rain per year [10, 11]. Two seasons alternate in the PNT. The rainy season is between February and December and the dry season is in January. The average annual temperature varies between 23°C and 28°C and air humidity around 85 and 90% can reach 100% at night [12]. The relief of the PNT is made up of a set of hills, fairly uniform and crisscrossed by numerous very branched watercourses. The park has a particular relief with Mount Nienokoué (396 m altitude) and the Grabo chain (50 km long and 2 km wide). The lowlands are flat, 100 to 150 m wide, marshy and with a slight longitudinal slope [13].
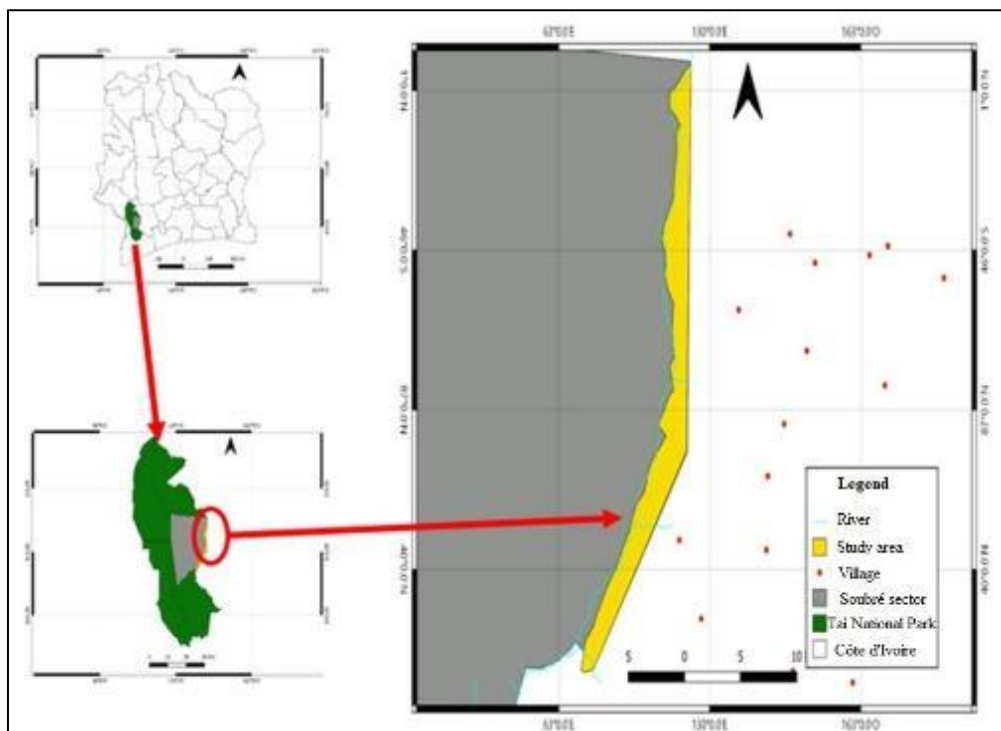


**Figure 1** Geographical location of the study area

### 2.2. 2 Data Collection Methods

#### 2.2.1. Linear transects

This method is based on the detection along predefined (virtual) transects of either the animals themselves (direct observations) or the signs of their presence (indirect observations). These indirect signs include nests, droppings, footprints, vocalizations, food remains, etc. During this study, a systematic design of 14 linear transects, each 500 m long and oriented North-South, were laid out in the recovered area ; two contiguous transects were separated by 1 km and two parallel transects were separated by 500 m. The transects were traveled slowly and silently with an average speed of about 0.5 km/h. No deviation was allowed during these routes. When a sign is observed, the time, the type of sign, the number of signs, the species, the perpendicular distance and the GPS coordinates are noted [14].

*2.2.2. Reconnaissance walk*

This involves walking in the study area following predetermined routes of least resistance in search of evidence of presence. The deviation of obstacles does not exceed 40°. This method has the advantage of allowing the team to move more quickly in the study area and cover more space in a short period, while having minimal impact on the environment [14]. The different information collected when an index is observed on the linear transects is the same as that recorded during reconnaissance walks.

*2.2.3. Camera trapping*

The camera trapping used in this study constitutes one of the most recent, reliable and effective methodological approaches for sampling a large number of species, particularly mammals. This technique has several advantages including autonomy in collecting data day and night (24/7 operation), the possibility of providing tangible and verifiable evidence of the presence of species that are difficult to detect by humans in the natural environment [15]. A total of 05 camera traps were installed between 40-50 cm from the ground on trees in the study area using a device adapted to the space (clear area and open canopy so as not to have in the field of vision, plants likely to be moved by the wind or obstacles such as tree trunks). The orientation of the camera trap is chosen according to the clues indicating the presence or passage of animals and sunlight (due North or South).

*2.2.4. Data analysis*

The identification of animal species was done with the guide to African mammals [15]. PAST (version 2.17c) and QGIS Version (3.10.6) software were used for data analysis. PAST (version 2.17c) software was used to determine abundance, Shannon-Weaver diversity index values and Piélou equitability. As for QGIS Version (3.10.6) software, it was used to develop spatial distribution maps.

## 3. Results

### 3.1. Diversity of mammalian fauna in the recovered area of the PNT

Analysis of the camera trap data recorded a total of 432 images of mammals in the recovered area. These images allow us to count 18 species of mammals divided into nine 9 families 16 genera and five 5 orders: Rodents (Earth Mouse, African Atherure, Emin's Giant Rat, Red-footed Funisciurus, Stanger's Giant Squirrel), Artiodactyls (Bongo, Royal Antelope, Maxwell's Duiker, Black-backed Duiker, Black Duiker, Forest Buffalo, Bushbuck, Zebra Duiker, Jentink's Duiker, River Pig, African Hylocere), Carnivores (Brown Mongoose, Swamp Mongoose, Liberian Mongoose, Johnston's Genet, African Civet), Primates (White-nosed Monkey, Demidoff's Bushbaby) and Chiroptera (Plume Bat). The order Rodentia is the most representative (67.12% ; N = 290), follower by Artiodactyla (16.66% ; N = 72). Next comes the order Carnivora (14.81% ; N = 64). Finally, the orders Chiroptera and Primates are the least representative, each with (0.69% ; N = 3). These differences in the frequencies of the observed inventoried species are significant according to the non-parametric Kruskal-Wallis test, p-value = 4.0610-6 < 0.05).

The reconnaissance walk data allowed us to collect a total of 108 mammal presence indices. These indices consist of direct observations (DO) (N = 1) and indirect observations (IO) (N = 107), represented by footprints (79, 61%), droppings and food remains (17.40%), burrows (2.3%), and vocalizations (0.69%). In total, 19 mammal species were identified using this method.

The transect routes made it possible to identify a total of (N = 62) indirect mammal presence indices. These observations mainly consist of footprints (N = 57 ; 91.20%), droppings (N = 4 ; 6.45%), and burrows (N = 1 ; 1.61%). In total, 15 mammal species were identified, the majority of presence indices belonging to the order Artiodactyla (N = 46 ; 74.19%). The lowest presence indices were observed in Carnivores and Rodents (N=8 ; 12.90%) (Table I).

### 3.2. Relative abundance of mammal species inventoried in the recovered area of the PNT

The relative abundances of the 18 species identified through the camera traps indicate that the most representative species are *Cricetomys emini* (33.34% ; N=144), intermediately, abundant species include *Atherurus africanus* (16.20% ; N=70), *Funisciurus pyropus* (15.50% ; N=67), and *Atilax paludinosus* (10.87% ; N=47). Finally, the least abundant species are *Philantomba maxwellii* (9.25% ; N=40), *Tragelaphus scriptus* (1.85% ; N=8) and *Cephalophus zebra* (0.23% ; N=1).

According to the reconnaissance walks, the most abundant species were *Philantomba maxwellii* (19.45% ; N= 21), *Syncerus caffer nanus* and *Tragelaphus scriptus* (16.66% ; N= 18). However, *Potamochoerus porcus* (11.11% ; N= 12) and *Cephalophus niger* (7.4% ; N= 8) were in low numbers.

At the linear transect level, the most abundant species were *Syncerus caffer nanus* (19.36% ; N= 12) and *Philantomba maxwellii* (12.90% ; N= 8). Then, the most abundant species included *Tragelaphus scriptus*, *Crossarchus obscurus* (11.29% ; N= 7), *Potamochoerus porcus* (8.06% ; N= 5). Finally, the least abundant are represented by *Tragelaphus eurycerus* (3.22% ; N= 2), *Cephalophus jentinki* and *Civettictis civetta* (1.61% ; N= 1) (Table I).

The observed frequency differences are highly significant according to the Kruskal-Wallis test, p-value = 9.6910-6 < 0.05.

### 3.3. Overall specific diversity of mammals in the recovered area of the NTP

The synthesis of mammal species inventoried using different methods confirms the presence of 24 mammal species belonging to 5 orders, 11 families, and 20 genera. Within this group of inventoried mammals, the most representative orders are Rodents (51.17% ; N=308) and Artiodactyls (34.38% ; N=207). Next comes the order Carnivores (12.62% ; N=76). Finally, the least representative orders are Chiroptera (3.46% ; N=6) and Primates (2.54% ; N=5).

The diversity of mammalian species in the recovered area was determined by diversity indices such as the Shannon index (H) and the equitability index (E). These indices are (H = 2.48) and (J = 0.78) respectively (Table 1).

**Table 1** Specific richness of mammals in the recovered area east of the PNT

| Common name | Scientific name | Staff (N) | Frequencies (%) |
|---|---|---|---|
| Bongo | *Tragelaphus eurycerus* | 3 | 0,49 |
| Royal antelope | *Neotragus pygmaeus* | 10 | 1,66 |
| Maxwell's Duiker | *Philantomba maxwellii* | 69 | 11,47 |
| Black-backed Duiker | *Cephalophus dorsalis* | 8 | 1,32 |
| Black Duiker | *Cephalophus niger* | 23 | 3,82 |
| Forest Buffalo | *Syncerus caffer nanus* | 36 | 5,98 |
| Bushbuck | *Tragelaphus scriptus* | 33 | 5,48 |
| Zebra Duiker | *Cephalophus zebra* | 2 | 0,33 |
| Jentink's Duiker | *Cephalophus jentinki* | 2 | 0,33 |
| River Pig, | *Potamochoerus porcus* | 17 | 2,82 |
| African Hylocere | *Hylochoerus meinertzhageni* | 4 | 0,66 |
| Brown Mongoose | *Crossarchus obscurus* | 12 | 1,99 |
| Liberian Mongoose | *Liberiictis kuhni* | 3 | 0,49 |
| Swamp Mongoose | *Atilax paludinosus* | 47 | 7,8 |
| Johnston's Genet | *Genetta johnstoni* | 2 | 0,33 |
| African Civet | *Civettictis civetta* | 12 | 1,99 |
| Plume Bat | *Eidolon helvum* | 6 | 0,99 |
| White-nosed Monkey | *Cercopithecus petaurista* | 4 | 0,66 |
| Demidoff's Bushbaby | *Galagoides demidoff* | 1 | 0,16 |
| Earth Mouse | *Apodemus sylvaticus* | 5 | 0,83 |
| African Atherure | *Atherurus africanus* | 76 | 12,62 |
| Emin's Giant Rat | *Cricetomys emini* | 148 | 24,58 |

| Red-footed Funisciurus | *Funisciurus pyropus* | 67 | 11,12 |
|---|---|---|---|
| Stanger's Giant Squirrel | *Protoxerus stangeri* | 12 | 1,99 |
| Shannon Diversity Index (H) | | H = 2,48 | |
| Pielou Fairness Index (J) | | J = 0,78 | |
| TOTAL | | 602 | 100 |

## 3.4. Distribution of mammalian fauna in the recovered area of the PNT

Artiodactyls are present in the North, Center, and South of the reconstruction area. However, they are observed more in the Center and at the Center-North boundary. Rodents are present in the North, Center, and South of the reconstruction area. However, they are observed more in the Center and less in the North and at the Center-North boundary. Carnivores are present in the Center and South of the reconstruction area. However, they are observed more in the Center. Primates are present in the North, Center, and South of the reconstruction area. Bats were observed only in the Center of the reconstruction area. Artiodactyls, Rodents, and Primates were most observed in the 3 sectors (North, Center, and South) (Figure 2).
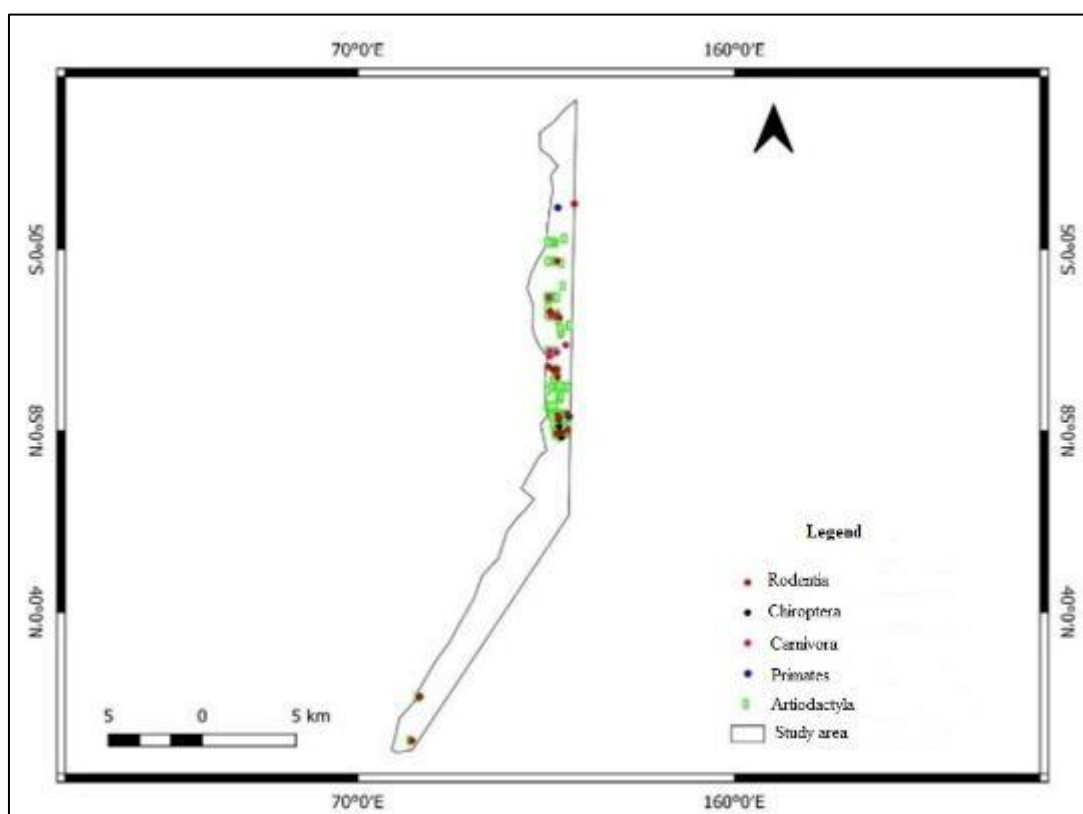


**Figure 2** Spatial distribution of mammalian fauna in the recovered area of the PNT

## 3.5. Anthropogenic threats to mammalian fauna in the recovered area of the PNT

The threats detected are primarily anthropogenic in nature. Thus, two forms of human activity are clearly evident. These are threats related to poaching (snare traps, empty cartridge cases, gunshots) and disturbances related to agricultural plantations.

The ranking of threat factors affecting mammalian fauna was based primarily on poaching evidence. The most frequently encountered threats are infiltration via poachers' trails (34.93%, N=29). Next come snare traps (32.53%, N=27), empty cartridge cases (25.3%, N=21), and gunshots (2.4%, N=2). Finally, the least frequently encountered threats are related to agricultural plantations (N=4 ; 4.81%).

## 4. Discussion

The study methodologies used in the reclaimed area east of Taï National Park made it possible to inventory a total of 24 mammalian species divided into 20 genera, 11 families, and five (05) orders. The most representative orders are rodents followed by artiodactyls, carnivores. The least representative are primates and bats. The various data collected on the mammalian fauna during this study in the recovered area are not consistent with that of the ecological monitoring report of phase 14 and 15 of the PNT [16,17] which obtained 38 mammalian species or 63.15% of the mammalian species inventoried during phase 14 and 15. This difference in conformity could be explained on the one hand, by the fact that they used more camera traps in their methodologies and also by the small area of the recovered area compared to the large part of the PNT, on the other hand to human pressure [18]. The presence indices of Primates (0.83%) and Bats (0.99%) were rare in the study area compared to the Orders of Rodents (51.16%), Artiodactyls (34.38%) and Carnivores (12.62%). The scarcity of primate and bat species in natural habitats would be due to the combined actions of deforestation and poaching [19, 4]). Indeed, most of these species are frugivores and better adapted to primary forests. In addition, the camera traps were mainly used for terrestrial species, but these two groups of animals are mainly arboreal. The species Philantomba maxwellii, Syncerus caffer nanus, Tragelaphus scriptus, Atilax paludinosus and Funisciurus pyrropus were the most abundant in the study area. Previous studies have observed similar abundances of these species in various habitat types [20]. The abundance of these species could be justified by their good reproductive capacity, a very varied diet and their good adaptation to disturbed habitats [18].

Analysis of the distribution map shows that Rodents, Artiodactyls, Carnivores are more present in the Center and at the edge of the Center-North of the recovered area. This strong presence could be explained by the fact that these areas would shelter abundant and regularly available food resources. Also, the mammalian fauna tends to feed on agricultural products that it finds in old plantations and on the periphery of this area occupied by crops. The strong presence of mammals in cultivated areas is recurrent in Côte d'Ivoire [21]. As for the southern area where data collection was solely focused on camera traps from 2022, we only identified a weak presence of Bats and primates. This rarity in mammals could be explained by the method used alone and especially by the small number (03) of camera traps installed in this area. Agriculture and poaching are the main types of threats that have been recorded in the recovered area, a total of 5 types of evidence have been observed. These include snare traps, maintained fields, poachers' tracks, empty cartridge cases, gunshots. Among these evidences, poaching was the most recorded with a total of 79 (95.18%). The various infiltrations of farmers observed in the park for several years in the Soubré area could be proof of this pressure. Poaching remains a concern because of its negative impact on wildlife [22]. For the conservation value of the mammalian fauna of the recovered area, our work has confirmed the presence of three species known as "special status" on the IUCN Red List [23]. These are one (1) endangered (EN) species (Jentink's duiker) and two (2) vulnerable (VU) species (Liberian mongoose, and Zebra duiker). Other species inventoried in the reclaimed area include five (5) near-threatened (NT) species (bongo, black-backed duiker, forest buffalo, white-nosed rattler) and 16 others of least concern (LC).

## 5. Conclusion

It appears from our study that 24 mammalian species grouped into five orders (Artiodactyls, Rodents, Carnivores, Primates and Bats) and eleven (11) families were observed in the recovered area. The most representative orders are rodents. Then, in an intermediate manner, comes the order of Carnivores. Finally, the least representative orders are Bats and Primates. The different distributions showed that mammalian species are present almost throughout the recovered area in the North, Center and South. Artiodactyls, rodents, and primates were the most observed in the 3 sectors of the recovered area. Carnivores were observed in the Center and South while Bats were observed only in the Center of the recovered area. As for anthropogenic threats, the various poaching indices observed, the tracks and snare traps are the most representative alongside empty cartridge cases and gunshots. The IUCN international conservation status (2023) indicates that among the species inventoried, 05 are near threatened (NT), 02 species are vulnerable (VU) (Liberian mongoose, zebra duiker) and 01 species is endangered (EN) (Jentink's duiker).

## Compliance with ethical standards

we express our most sincere and warmest thanks to Captain KONE Sanga Souleymane, respectively responsible for Ecological Monitoring at the South-West Zone Directorate (DZSO) of the Taï National Park and also to Lieutenant DEA Gui, Chief of the Soubré sector for the welcome, advice and support during the data collection, without forgetting these brave forest commando agents of the OIPR.

*Disclosure of conflict of interest*

The authors declare that there is no conflict of interest for this article.

*Contribution des auteurs*

KONE N'GANON collected the data, KONE N'GANON and BAMBA KRAMOKO performed the data processing, statistical analysis, and manuscript writing. The other co-authors contributed to proofreading and improving the article.

## References

[1] Lemma A. & Tekalign W. (2020). Abundance, Species Diversity, and Distribution of Diurnal Mammals

[2] Legese K., Bekele A. & Kiros S. (2019). A Survey of large and medium-sized mammals in Wabe forest fragments, Gurage zone, Ethiopia. *International Journal of Avian & Wildlife Biology* 4(2): 32- 38.in Humbo Community-Based Forest Area, Southern Ethiopia. *International Journal of Zoology* 1-5.

[3] Jorgensen S.E., Costanza R. & Fu-Liu X. (2005). Handbook of ecological indicators for assessment of ecosystem health. London: CRC press, 498 pp.

[4] Bitty A.E., Gonedelé Bi SB., Bene J-C.K., Kouassi P. & McGraw WS. (2015). Cocoa farming and primate extirpation inside Cote d'Ivoire's protected areas. *Tropical Conservation Science,* 8(1): 95-113.

[5] Kablan Y.A., Diarrassouba A., Mundry R., Campbell G., Normand E., Kühl H., Koné I. & Boesch C. (2017). Effects of anti-poaching patrols on the distribution of large mammals in Taï national Park, Côte d'Ivoire. *Oryx* 53(3): 1-10.

[6] Diarrassouba A., Gnagbo A., Kouakou C.Y., Campbell G., Tiedoué M.R., Tondossama A., Kühl H.S. & Koné I. (2019). Differential response of seven duiker species to human activities in Taï National Park, Côte d'Ivoire. *African Journal of Ecology*, 2019 : 1-11.

[7] Kouakou J-L., Gonedele Bi S., Bitty E.A., Kouakou Y.C., Yao A.K., Kassé K.B., Ouattara S., (2020). Ivory Coast without ivory: Massive extinction of African forest elephants in      Cote d'Ivoire. PL0S ONE 15(10).

[8] OIPR. (2014) b. Plan d'Aménagement et de Gestion (PAG) du Parc national de Taï 2014-2018. Rapport d'aménagement, 131 p.

[9] Bakayoko A., Malan D.F., Neuba D.F.R., Kouadio Y.L. & Nehoun B. (2018). Suivi de La restauration végétale naturelle des zones aménagées dans les secteurs de Djapadji, Soubré et ADK/V6 du Parc national de Taï. Rapport de suivi des zones récupérées, Abidjan (Côte d'Ivoire), 24 p.

[10] MINEF. (1999). Diversité biologique de la Côte d'Ivoire. Rapport de synthèse. Abidjan, Côte d'Ivoire, 273 p.

[11] Brou Y.T. (2009). Impacts des modifications bioclimatiques et de l'amenuisement des terres forestières dans les paysanneries ivoiriennes : quelles solutions pour une agriculture durable en Côte d'Ivoire ? *Cuadernos Geographicos,* 45 : 13-29.

[12] Kablan Y.A. (2019). Impact des mesures de surveillance sur la distribution de quelques grands mammifères au Parc National de Taï (Sud-Ouest de la Côte d'Ivoire). Thèse de Doctorat en Ecologie Tropicale Animale, UFR Biosciences, Université de Cocody, Abidjan (Côte d'Ivoire), 139 p.

[13] Lauginie F. (2007). Conservation de la nature et aires protégées en Côte d'Ivoire.NEI/Hachette et  Afrique Nature, Abidjan. 668 p.

[14] WCF (2016). Inventaires biologiques pour la création du Parc National du Moyen-Bafing.Siège: 69 chemin de Planta 1223 Cologny, Switzerland. wcf@wildchimps.org. 80 p.

[15] Varma S., Pittet A., Jamadagni H. S., (2006). Experimenting usage of camera-traps forpopulation dynamics study of the Asian elephant (*Elephas maximus)* in southern India. *Current science*, vol. 91, N°3: 324-331.

[16] Tiédoué M.R., Diarrassouba A. & Tondossama A. (2019). – Etat de conservation du Parc national de Taï : Résultats du suivi écologique, Phase 14. Office Ivoirien des Parcs et Réserves/Direction de Zone Sud-ouest. Soubré, Côte d'Ivoire. 42p.

[17] Tiédoué M.R., Diarrassouba A. & Tondossama A. (2023). – Etat de conservation du Parcnational de Taï : Résultats du suivi écologique, Phase 15. Office Ivoiriendes Parcs et Réserves/Direction de Zone Sud-ouest. Soubré, Côte d'Ivoire. 36p.

[18] Gonedelé Bi S. & Bitty A.E. (2013). Conservation of threatened Primates of Dassioko Sud and Port Gauthier Forest reserves in coastal Côte d'Ivoire. Final Report to Primate Conservation Inc., Charlestown, RI, 19 p.

[19] Gonédélé Bi S., Bitty E.A., Ouattara K. & McGraw W.S. (2014). Primate surveys in Cote d'Ivoire's Sassandra-Bandama interfluvial region with notes on a remnant population of black and white colobus. *African Journal of Ecology*. 52 :491-498.

[20] Akpatou K.B., Yao K.A., & Bohoussou K.H. (2018). Diversité et Abondance Relative des Mammifères des Forêts Classées de Mabi et de Yaya au Sud-Est de la Côte d'Ivoire : Un État des Lieux. *European Journal of Scientific Research*,150 (2): 213-228.

[21] Béné J-C.K., Kouakou C-V., Kpangui K.B., Vroh Bi T.A., Djaha K. & Adou Yao C.Y. (2018). Diversité de la faune sauvage mammalienne dans les agroforêts à cacaoyer de la zone de contact forêt-savane au centre de la Côte d'Ivoire. *Journal of Animal &Plant Sciences,* 35 (3): 5734-5748.

[22] Caspary H.U., Koné I., Prouot C. & De Pauw M. (2001). La chasse et la filière viande de brousse dans l'espace Taï, Côte d'Ivoire. Rapport final GTZ, Djouroutou (Côte d'Ivoire), 98 p.

[23] UICN Liste rouge des espèces menacées de l'UICN. 2023. Version 2020.2. ISSN2307-8235.