Distribution of Dwarf Crocodile (Osteolaemus Tetraspis Cope, 1861) Populations on the Outskirts of the Ebo Forest : Implications for Conservation

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Distribution of Dwarf Crocodile (*Osteolaemus Tetraspis* Cope, 1861) Populations on the Outskirts of the Ebo Forest: Implications for Conservation

Agbor James Ayamba[1*], Tsiaze Kuete Thomas[2], Harrison Nnoko Ajebe[2], Ndjounguep Juscar[2] & Prossie Manual Venceslas[2]

[1]Department of Forestry and Wildlife, University of Buea, Cameroon

[2]Ajemalebu Self Help, Kumba, South West Region, Cameroon

Abstract

Purpose: The study was carried out in three riparian areas of the Ebo forest (Iboti, Lognanga and Ndokmem-North zones) to determine the distribution and status of dwarf crocodiles, and environmental factors influencing their distributions.

Materials and Methods: Survey on the various listed sites were carried out during the months of April, May and June 2023. The Qgis software was used to produce the distribution map of dwarf crocodiles in the periphery of the Ebo forest from the coordinates recorded at 11 water points using a GPS and 37 fishermen/ hunters were interview.

Findings: The species were classified according to their status defined according to the IUCN red list protocol. The study showed that of the 11 water points studied, 6 were home to dwarf crocodiles, representing a proportion of 54.54%. Although we did not observed dwarf crocodiles in the watercourses in the Iboti zone, their presence is more established in the Lognanga zone (60%) than in the Ndokmem-north zone (40%). The average density of dwarf crocodiles in the periphery of the Ebo forest is around 0.50 crocodiles/km of riverbank covered. This implies that the population of dwarf crocodiles is decreasing and there is high need to increase conservation efforts to protect it from disappearing within the Ebo forest area.

Implications to Theory, Practice and Policy: To guarantee the survival and viability of crocodiles in the periphery of the Ebo forest, it is necessary to opt for organic agriculture, monitoring the quality of rivers and water bodies and regular ecological monitoring of crocodiles.

Keywords: *Distribution, Dwarf Crocodile, Ebo Forest, Implications Conservation*

1.0 INTRODUCTION

Conflicts between humans and wild animals have been going on for a long time. Crocodilians are among the largest reptiles alive today and the last descendants of the surviving reptiles of the dinosaur group. In recent years, the destruction of crocodile habitats has taken many forms and the most obvious are drainage, deforestation, conversion to agriculture and pollution. All this is combined with inadequate regulation of the international trade in crocodile skin and meat (Ross, 1998). This has resulted in a decided decline in numbers of many crocodile species and a reduction in their range (Ross, 1998). Certainly, the dwarf crocodiles on the outskirts of the Ebo forest, while helping to maintain the complex in balance in this fragile ecosystem, essentially participate in the conservation of biological diversity in this forest. However, this balance is increasingly disrupted due to anthropogenic activities, hunting and water pollution due to agricultural activities.

The Ebo forest of Cameroon is one of the most intact ecosystem forests in the Gulf of Guinea. Extending over 2000km², it constitutes more than 50% of the key area for Yabassi biodiversity. The forest is located in the Korupmba-Obachap corridor of the West African Guinean Forest biodiversity hotspot. (Mahmoud, 2019). It is home to no less than 160 species of birds, most of which are found exclusively in the Ebo forest (Mahmoud, 2019). There is also a small population of gorillas of unknown taxonomy, a population of Cameroon-Nigeria chimpanzees, forest elephants, drills and red colobus and preuss, crocodiles, various aquatic and semi-aquatic species of fauna and of flora. Many of them are on the International Union for Conservation (IUCN) Red List of Endangered and Critically Endangered Species (Campbell et al., 2019). In the Nkam, the dwarf crocodile Osteolaemus tetraspis is one of the three species of African crocodiles present and exploited (Makongo, 2013). Highly appreciated for the quality of its white, firm flesh and an intermediate flavor between those of fish and chicken, it has become a vulnerable species (Ihlow et al., 2015; Lueg, 2015; Fuisting, 2015). It belongs to class A of protected species in Cameroon (MINEPIA, 2000; MINFOF, 2006). Listed in Appendix 1 of the Washington Convention (CITES) on trade in endangered species and classified as vulnerable in the IUCN Red Book, it is the most common crocodile (Chirio et al., 2007). However, its populations, subject to strong hunting pressure and rapidly declining within these areas. According to Vanga (2011), the continuous and uncontrolled exploitation of fishery resources can lead to a gradual fall in production and a drop in income for those involved in the fishing industry. In Cameroon, the protection of such a species falls within the powers of the State according to article 11 of Law No. 94/01 of January 20, 1994 (Djeukam, 2012) and boils down to the ban on fishing and hunting in water bodies and aquatic forests (Gonwou and LeBreton, 2004).

Concerning the dwarf crocodiles of the key biodiversity zone of Yabassi, a study was carried out on the socio-technical-economic characterization of artisanal fishing of the African dwarf crocodile Osteolaemus tetraspis in the Yabassi Division, Littoral Cameroon (Tiogue et al., 2016). However, this study only focused on the socio-technical-economic characterization of artisanal dwarf crocodile fishing. Data on the distribution of dwarf crocodiles within the periphery of Ebo forest is lacking. This research comes to fill the gap to provide information on the distribution of populations of dwarf crocodile (*Osteolaemus tetraspis*) in the periphery of the Ebo forest with a view to contributing to its conservation in their natural habitats in order to ensure their ecological integrity and propose an action plan for their well-being in the surroundings of the Ebo forest. The research aims to determine the distribution of dwarf crocodile (*Osteolaemus tetraspis* Cope, 1861) populations on the outskirts of the Ebo forest and its implications for conservation. Specifically, to map the distribution of dwarf crocodiles

the outskirts of the Ebo forest, evaluate the environmental factors that influence the distribution of dwarf crocodiles in the forest and identify the local conservation status of dwarf crocodiles the outskirts of the Ebo forest.

2.0 MATERIAL AND METHODS
Location of the Study Area

The Ebo forest is located in the Littoral Region of Cameroon between the coordinates 4º 42' 59" N and 10º 35' 56" E, north of the Sanaa River between the Divisions of Nkam and Sanaga Maritime including the Subdivision of Yingui, Yabassi, Edea 2, Ngambe and Massock-Songloulou. The Ebo forest constitutes more than 50% of the key area for biodiversity in Yabassi. It is an important part of the Yabassi landscape (Morgan et al., 2011).
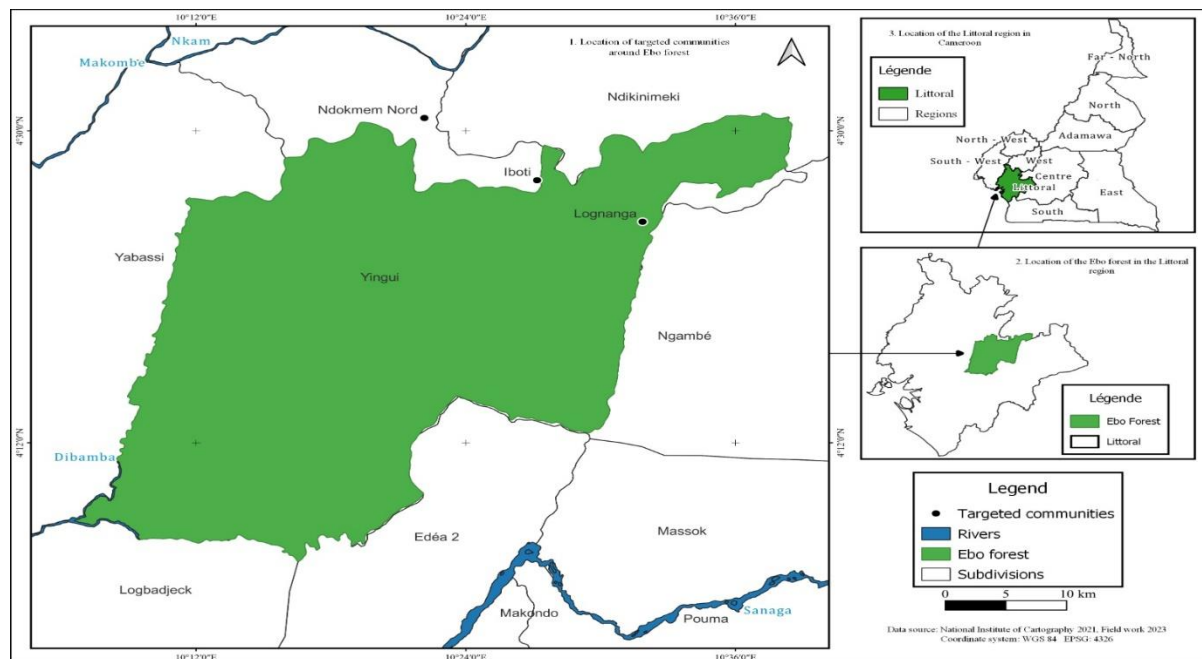

Figure1: Map of the Location of the Ebo Forest and Surrounding Localities (Study Area)

This forest covers an area of approximately 1,500 km², the forest ecosystem is not subject to state protection, although considered the most intact and important of the Gulf, who is himself one of the global (Morgan et al., 2011). For good representativeness, sampling was done in 3 peripheral areas of the Ebo forest (Ndokmem-Nord, Lognanga, and Iboti). The location plan of said area is presented below (Figure 1).

Data Collection
Establishment of the Distribution Map of Crocodiles in the Periphery of the Ebo Forest

Two approaches were used: The first consisted of making an inventory of dwarf crocodiles on linear transects 1 km long and 1 km equidistance along the 11 water points listed and to measure certain factors such as burrows, footprints and displays for the estimation of the density and abundance of signs or crocodile observed directly along a predefined line (IUCN, 2013). Direct observations were made at night between 10 p.m. and 3 a.m. with a broad reflection flashlight. Night sighting is based on the ability of crocodile eyes to glow in the presence of a light source. The geographical coordinates of all the water points visited were recorded using a GPS (Global Positioning System). These coordinates were subsequently transferred into the Qgis software for the development of the distribution map of dwarf crocodiles in the periphery of the Ebo

forest. The second approach consisted of interviewing members of local communities (fishermen, hunters) of the Ebo forest. Each of the people surveyed was interviewed according to the area or water points that they know best in the peripheral areas of the Ebo forest. The questionnaire includes the following main sections:

i. Knowledge, location and abundance of dwarf crocodiles
ii. Anthropogenic threats to dwarf crocodiles
iii. Actions to be taken for the conservation of dwarf crocodiles in the Ebo forest.

Assessment of Environmental Factors That Influence the Distribution of Dwarf Crocodiles in the Forest

Surveys of grassroots communities were carried out to collect data relating to crocodile attacks and human-induced crocodile mortality. The questions asked to the 37 fishermen/hunters surveyed would not only focus on the number of bloody accidents suffered by people, but also on crocodile attacks on domestic animals, their frequency, their period and their approximate number. Questionnaires relating to the knowledge of villagers were asked in order to analyze people's perceptions of crocodiles (Rakotondrazafy et al., 2008; Ottley et al., 2008).

Identification of the Local Conservation Status of Dwarf Crocodiles in Peripheral Areas of the Ebo Forest

The guidelines for the regional application of the IUCN Red List criteria (Gardenfors et al., 2001; IUCN, 2003) have made it possible to assess the status of crocodile species in forest peripheral areas from Ebo:

Species assessed in the IUCN Global Red List of Threatened Species are classified into nine categories [Extinct (EX); Extinct in the wild (EW); Critically Endangered (CR); Endangered (EN); Vulnerable (VU); Near Threatened (NT); Least Concern (LC); Insufficient Data (DD); Not Assessed (NE)] based on criteria such as rate of decline, population size, geographic distribution area, degree of settlement, and distributional fragmentation. For this study, the criteria below were taken into account:

Population Size

To observe crocodiles during the day and night, observations were combined. With this technique, we combined survey data to estimate the abundance of crocodiles in water points that were not visited. The number of crocodiles in each non-sampled water point is estimated to be equal to the average number assigned by each investigator (Santiapillai et al., 2001) and was used:

- Probably extinct, when crocodiles do not exist in the watering hole but had existed in the past.

- Rare, when the number of crocodiles is less than 10.

- Common, when the number of crocodiles is between 10 and 30.

- Abundant, when the water point is home to more than 30 crocodiles.

Population Density

The density of dwarf crocodiles which represents the number of individuals observed per kilometer of water points covered. For this purpose, the banks of rivers and ponds, up to the level where they are accessible were explored in order to count the dwarf crocodiles observed. Density is expressed by the formula (Navarro-serment, 2003; Platt et al., 2006): Where: D =

n/d, D = density (number of crocodiles/km); n = number of crocodiles observed; d = distance traveled along the bank (km).

Data Analysis

The data collected was recorded in EXCEL 2013 spreadsheet software for descriptive analyses, table design and graphics. ARCgis and Qgis software were used to produce the maps.

3.0 FINDINGS
The Distribution Map of Crocodiles in the Periphery of the Ebo Forest

Of the 11 water points studied, 6 are home to crocodiles, representing a proportion of 54.54%. These water points are distributed in target areas of the Ebo forest. Depending on their size and flow speed, crocodile habitats are grouped into 2 categories: ponds and rivers. Ponds represent 58% of the water points investigated and rivers 42%.

Table 1: Distribution of Dwarf Crocodiles in the Ebo Forest

Target areas	Presence of dwarf crocodiles	Footprint	Burrows (nests)
Ndogmem-North	40%	33.00%	44.44%
Iboti	0%	22.22%	27.77%
Lognanga	60%	44.44%	27.77%

The investigated rivers keep water all year round. Most of the waters are invaded by plants like *Pteridium aqulinum*, etc. Furthermore, the data collected coupled with those obtained by surveys made it possible to establish the distribution map of crocodiles in the periphery of the Ebo forest.
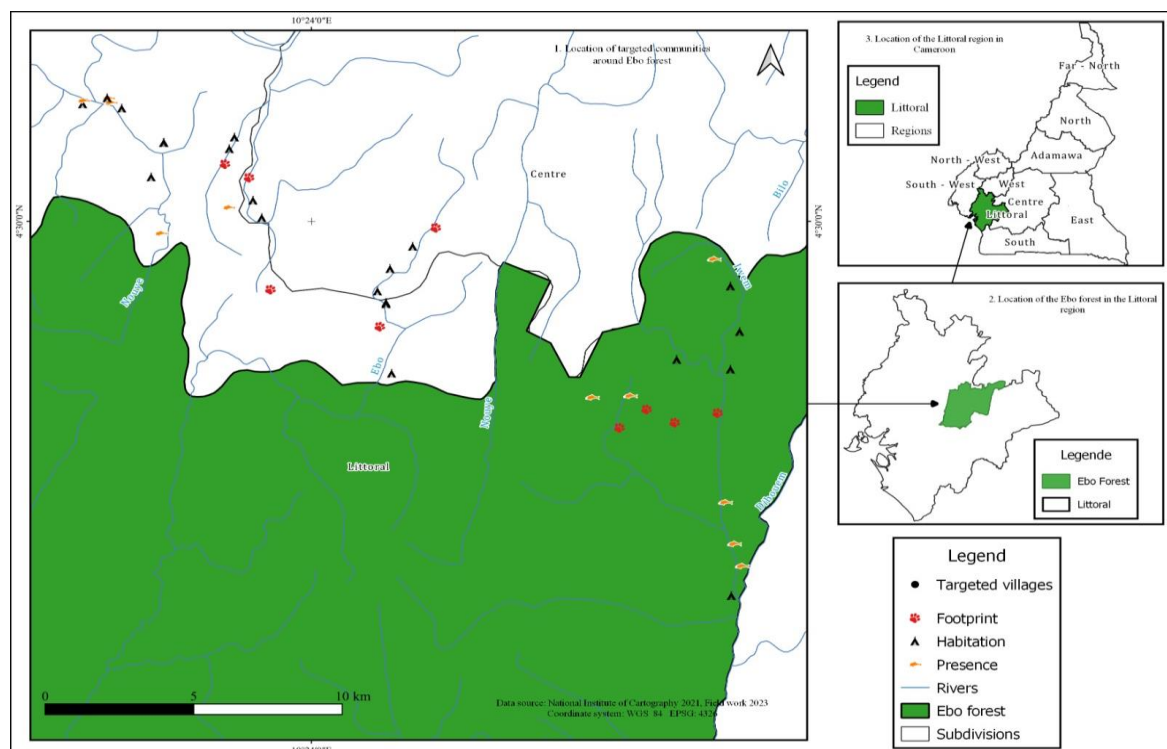

Figure 2: Distribution Map of Dwarf Crocodiles, Their Footprints and Their Burrows in the Periphery of the Ebo Forest

Dwarf crocodiles are not present in most of the waters of the three target areas bordering the Ebo forest (Table 1). Although not having observed dwarf crocodiles in the waterways of the

Iboti area. Some factors of their presence such as burrows, footprints and manifestations were observed. Their presence is more established in the Lognanga zone (60%) than in the Ndokmem-north zone (40%).

Assessment of Environmental Factors That Influence the Distribution of Dwarf Crocodiles in the Forest

The surveys made it possible to identify the sources of conflict in the target areas of the Ebo forest. These are the demand for bushmeat (70.27%), the strong demographic growth which induces the conversion of wildlife habitat into agricultural space (21.62%), poverty (8.11%) which predisposes populations to absolute dependence on natural resources (Figure 3).
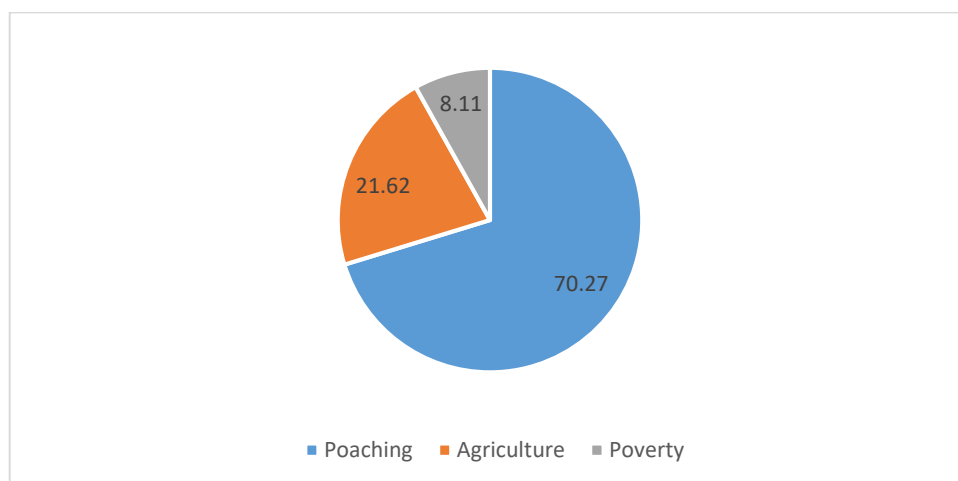

Figure 3: Source of the Human-Dwarf Crocodile Conflict in the Outskirts of the Ebo Forest

The human-crocodile conflicts identified around the Ebo forest are linked to human behavior (poaching of crocodiles, destruction of habitat and anarchic exploitation of natural products).

Poaching Activities in Target Areas of the Ebo Forest

The Ebo forest has long been the target of poachers coming from neighboring villages and Eastern Cameroon in search of once highly prized crocodile skins with a fairly high monetary value. Dwarf crocodiles are poached partly for consumption and marketing (Figure 6).
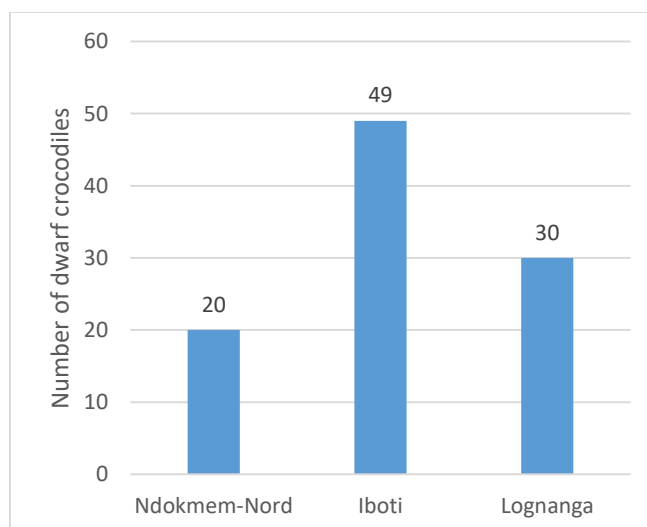

Figure 4: Number of Crocodiles Killed by Target Location in the Ebo Forest 2022-2023

Nevertheless, dwarf crocodiles are poached (Figure 4) in the periphery of the Ebo forest by fishermen/hunters in search of dwarf crocodile meat using some mostly rudimentary poaching methods (Figure 5).
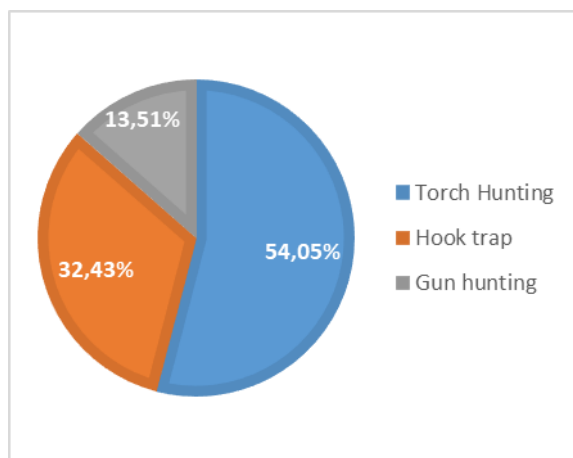

Figure 5: Distribution of Fishermen/Hunters According to Poaching Methods in the Ebo Forest
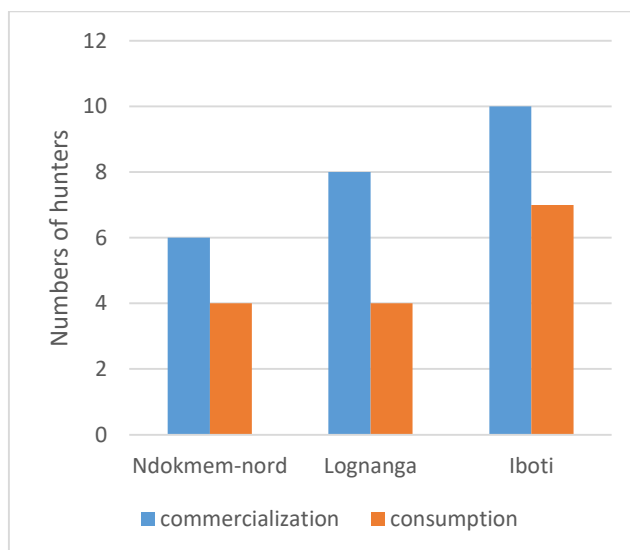

Figure 6: Distribution of Reasons for Poaching of Dwarf Crocodiles in the Target Localities of the Ebo Forest

Other actors identified in the purchase of poached dwarf crocodile products are restaurants, mainly those in the city of Douala, which offer crocodile meat in their menus.

Agricultural Activities in the Target Areas of the Ebo Forest

Agriculture is the main activity of the populations living near the Ebo forest. The crops cultivated in order of importance are cocoa (41%), cassava and plantain (36%), oil palm (8%) (Figure 7). Cocoa has been the main cash crop of the villages bordering the Ebo forest over the last 10 years and the areas sown are increasing annually.
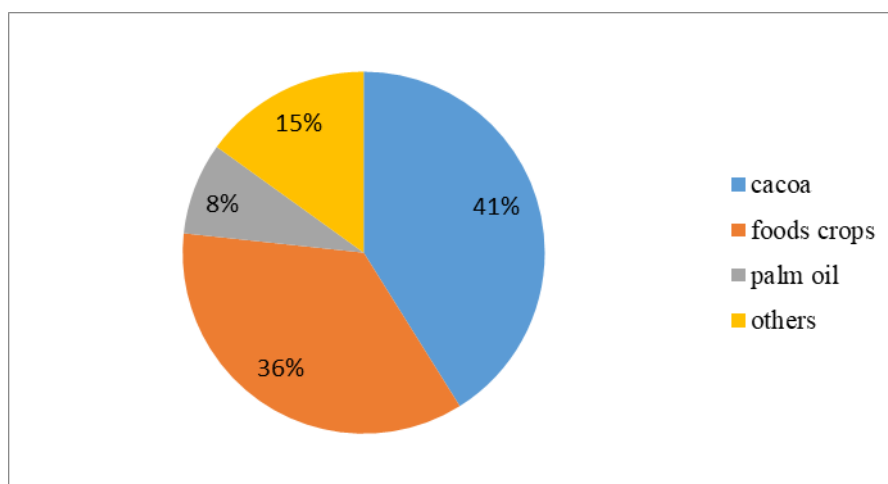
Figure 7: Distribution of the Type of Crops Grown in the Target Localities of the Ebo Forest

This could be explained by the availability of land for agriculture leading producers to plant more areas for cocoa to the detriment of other food crops. It was noted during our market investigations, the sale of pesticides from the West (ridomile, calomile, mocape, etc.), prohibited in Cameroon and sold at a relatively low price. Following the seasonal flooding noted in areas during flood periods, chemical substances used in agriculture are spreading in the Ebo forest, dangerously compromising the balance of aquatic biological diversity, in particular that of dwarf crocodiles.

Local Conservation Status of Crocodiles in the Peripheral Areas of the Ebo Forest

Abundance of Crocodile Species in the Peripheral Areas of the Ebo Forest

The various observations and survey data from hunters living near the Ebo forest made it possible to group the crocodiles in the target areas into 3 classes.
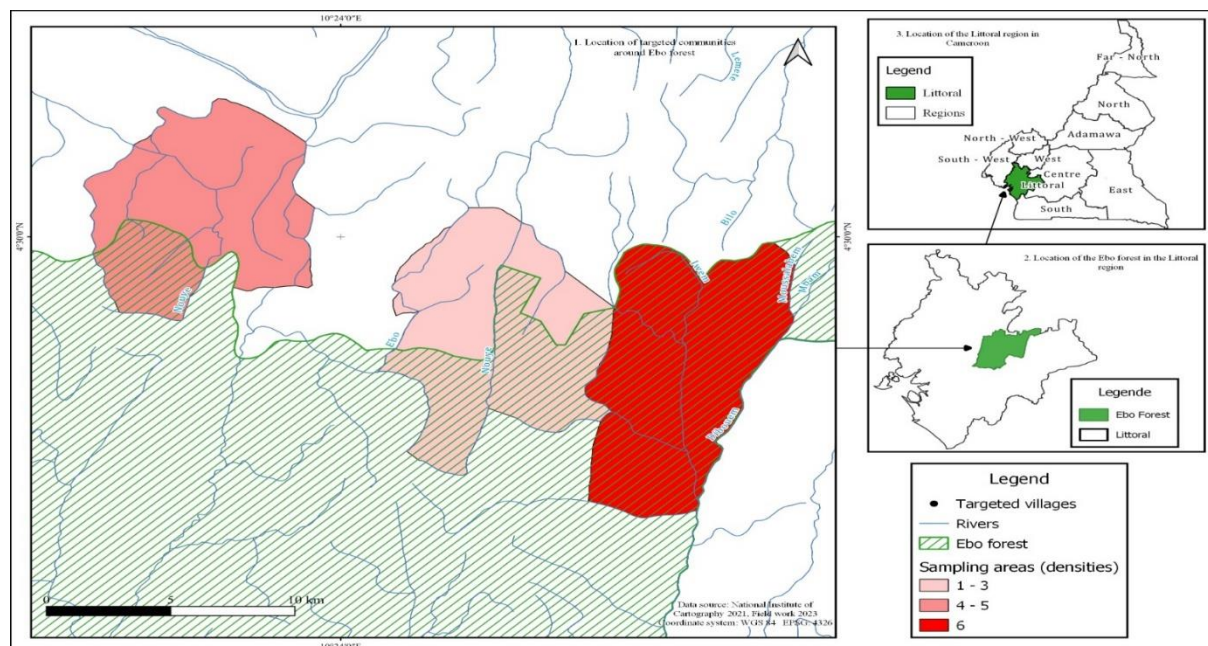

Figure 8: Spatial Abundance of Crocodile Abundance Classes in the Periphery of the Ebo Forest

From the analyses of this figure, it appears that:

i. Dwarf crocodiles would probably have disappeared in the Iboti area (0 individuals observed)

ii. The presence of dwarf crocodiles is more established in the Lognanga zone (6 individuals observed) than in the Ndokmem-north zone (4 individuals observed)

Density of Crocodiles

Crocodile density represents the number of individuals observed per kilometer of riverbank traveled. It is one of the best parameters which allows you to appreciate the abundance of dwarf crocodiles in the outskirts of the Ebo forest.

Table 2: Densities of Crocodiles from Water Points Sampled in the Three Peripheral Areas of the Ebo Forest

Peripheral areas of the Ebo forest	Number of crocodiles	Distance traveled (km)	Density (crocodiles/km)
Ndokmem-north	4	5.5	0.72
Iboti	0	4.5	0
Lognanga	6	7.5	0.8
Total	10	17.5	
Average density (crocodiles/km)			0.50

The average density of crocodiles in the periphery of the Ebo forest is 0.50 crocodiles/km of riverbank traveled. It is higher in the Lognanga zone (0.8 crocodiles/km) and the Ndokmem-north zone (0.72 crocodiles/km) than in the Iboti zone (0 crocodiles/km) (Table 2).

Local Status of Dwarf Crocodiles

Considering the various data obtained on the abundance, the pressure indicators on the species of dwarf crocodiles in their home range and referring to the structure of the threat categories according to the IUCN criteria, the *Osteolaemus tetraspis* have sufficient data to be classified in a category (Table 3).

Table 3: Characterization of the Conservation Status of Dwarf Crocodiles in the Ebo Forest

Features	*Osteolaemus tetraspis*
Past distribution	The entire Ebo forest
Distribution present	-
Current workforce	< 100 individuals
Population stable, increasing or decreasing	Decreasing
Ability to disperse to other regions	Yes
Threat	poaching, agricultural extension
Did the taxon disappear due to unfavorable conditions	No
Reproductive capacity of the taxon	-
Habitat fragmentation	Habitat in fragmentation
Status	Insufficient data (DD)

In summary, we can say that the dwarf crocodile (*Osteolaemus tetraspis*) is a "Critically Endangered CR" threatened taxon that needs special attention.

Discussion

The Distribution of Crocodiles in the Periphery of the Ebo Forest

Of the 11 water points studied, 6 are home to crocodiles, representing a proportion of 54.54%. The presence of dwarf crocodiles is therefore effectively established in the peripheral areas of the Ebo forest and these results are in accordance with the observations of (Kpéra, 2002) and (Kpéra et al., 2003; Platt et al., 2006 and Chirio et al., 2007) estimate that crocodiles are only found in permanent waters. This justifies the presence of dwarf crocodiles in most of the permanent peripheral waters of the Ebo forest such as rivers. To this end, crocodiles modify their habitat by digging burrows which they occupy in unfavorable conditions such as extreme temperatures (the dry season). These burrows are sometimes partially submerged, with the entrance below the water surface.

Assessment of Environmental Factors That Influence the Distribution of Dwarf Crocodiles in the Forest

The conquest of cultivable and exploitable land not only leads to habitat loss, but also to the reduction of populations of dwarf crocodiles. Because of human activities to transform banks and banks, many habitats become cultivation areas. Likewise, the animals are increasingly pushed out and the culling of those that remain in these localities inflicts a similarly enormous loss on the remaining crocodile population (Rakotondrazafy et al., 2008).

Local Conservation Status of Crocodiles in the Peripheral Areas of the Ebo Forest

The average density of crocodiles in the periphery of the Ebo forest is 0.50 crocodiles/km of riverbank traveled. It is higher in the Lognanga zone (0.8 crocodiles/km) and the Ndokmem-north zone (0.72 crocodiles/km) than in the Iboti zone (0 crocodiles/km). Generally speaking, despite the data collection season (full rainy season) which is not very favorable for better understanding all the contours and other behavioral aspects of crocodilians, the density of crocodiles appears lower in the outskirts of the Ebo forest reflecting their numerical scarcity. Unlike in Tanzania where a high density of crocodiles is observed in Rufiji (16.90 crocodiles/km) in the Selous Wildlife Reserve (Brown et al., 2004). The high density of crocodiles can be explained by the fact that water and shelter are maintained stably and food is sufficient. Our results, however, remain an image at a given time of the situation of this forest and should be taken with a nuance since the data were collected in the rainy season, a period which is not too favorable for the estimation of abundance. from wildlife. It remains to better appreciate the optimal density of dwarf crocodiles per body of water in the periphery of the Ebo forest. *Osteolaemus tetraspis* is critically endangered (CR).

At the international level, with a population of 25,000 to 100,000, Osteolaemus tetraspis classified in the (VU) category. The main problem with this species is still the lack of reliable data. Without such information, the status of the species cannot be determined. Although the Crocodile Specialist Group lists the species as a Least Concern internationally due to its distribution and healthy population sizes in some areas, the Red List since 1996 has classified it as "Vulnerable". to reflect the uncertainty of its status in nature. The lack of data is explained by the fact that the implementation of National Parks has been slow in Central Africa and the skin of Osteolaemus tetrapis has little value and therefore all attention was focused on Crocodylus niloticus, to the detriment of this species. Determining the last habitats of *Osteolaemus tetraspis* and their abundance becomes one of the priorities to ensure the survival of this species in the periphery of the Ebo forest. There is a high need to step up the conservation efforts of *Osteolaemus tetraspis* and the protection of the Ebo forest area.

4.0 CONCLUSION AND RECOMMENDATION

Conclusion

At the end of this study, which aimed to establish the map of distribution of dwarf crocodile populations (*Osteolaemus tetraspis*) and determine human-wildlife interaction in the periphery of the Ebo forest. A map of the distribution areas of dwarf crocodiles as well as the status of conflicts in the periphery of the Ebo forest could be determined, an identification of the conservation status of dwarf crocodiles in the periphery of the Ebo forest could be made. It appears that three large peripheral areas of the Ebo forest were investigated, these are the Ndokmem-North zone, the Iboti zone and the Lognanga zone. The presence of dwarf crocodiles is more established in the Lognanga zone (6 individuals observed) than in the Ndokmem-north zone (4 individuals observed), unlike the Iboti zone where no individuals were observed but nevertheless we had to find certain factors of their presence such as burrows, footprints and manifestations. Excessive hunting and agriculture are the main causes of conflicts between humans and dwarf crocodiles. Concerning the status of dwarf crocodiles in the periphery of the Ebo forest we can say that this taxon is threatened "Critically Endangered CR" and that it needs special attention. All analysis done, there are still actions to be taken for the conservation and good ecological monitoring of dwarf crocodiles. This will allow, on the one hand, to inform management and development decisions on the periphery of the Ebo forest by providing information on the state and evolution of its ecosystem and on the other hand, to satisfy the information needs of the national and international scientific community.

Recommendations

To help improve the management system for this species, we propose:

i. Intensify monitoring and raise awareness of the economic, social and environmental importance of dwarf crocodiles;
ii. To opt for organic and sustainable agriculture;
iii. Monitoring the quality of rivers and bodies of water and regular ecological monitoring of dwarf crocodiles;
iv. Promote ecotourism;
v. Encourage local communities to develop other less destructive and more sustainable income generating activities, such as honey production, small ruminant farming.

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