The African Manatee (Trichechus Senegalensis, link 1795) in the Ramsar site of Setté Cama: Case at Lake Cachimba

Christy Achtone Nkollo-Kema Kema [1,2*]
Judicaël Régis Kema Kema[3,4]
Jean Bernard Mombo[2]
Christophe Roland Zinga Koumba [5]

Abstract

The West African manatee (Trichechus senegalensis) is classified as vulnerable on the IUCN red list and is highly protected in Gabon. Gabon could be home to one of the highest densities of manatees remaining in Africa. Many people agree on the presence of manatee populations in several lakes and lagoons in Gabon. The aim of this study is to investigate the distribution and abundance of manatees by monitoring. The study was carried out in the catchment area of Lake Cachimba at the Setté Cama Ramsar site. We used three data collection methods: secondary data collection, boat surveys and surveys of markets and landing sites. Data analysis was based on descriptive statistics, manatee encounter rates and carcass encounter rates (number of carcasses/km of river). The chi-square (χ2) goodness-of-fit test was used to determine whether there were significant differences in the abundance of manatee encounter rates between Lake Cachimba and the Mbissi River. The results showed that manatee hotspots in Lake Cachimba are located near the mouth of the Duebi River, along the shore of the village of Cachimba. In addition, fishing activities are a potential threat to the African manatee.

Keywords: African Manatee; Gabon; Cachimba lake; Ramsar site of Setté Cama

[1]Aquatic Species ONG, BP:1306. Libreville, Gabon,
[2]Laboratoire de Géomatique, de Recherche Appliquée et de Conseil, Université Omar Bongo (UOB), BP:17043, Libreville, Gabon,
[3]Laboratoire d'Analyse Spatiale et des Environnements Tropicaux (LANASPET), Faculté des Lettres et Sciences Humaines (FLSH), Université Omar Bongo (UOB), BP:17008 Libreville, Gabon,
[4]Agence Nationale des Parcs Nationaux (ANPN), BP 20379, Libreville, Gabon,
[5]Institut de Recherche en Ecologie Tropicale (IRET-CENAREST), B.P:13354, Libreville, Gabon

*Corresponding author's email: christyachtone@gmail.com

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Introduction

The West African manatee (*Trichechus senegalensis*) is listed as vulnerable in UICN Red list and highly protected in Gabon. Of all sirenians, this species is the least known biologically (Reynolls & Odell 1991). However, this manatee species performs important ecological services such as nutrient cycling in aquatic ecosystems (Bonde et al., 2004).

In addition, some studies currently using the manatee as an indicator species to monitor the degradation of water quality in wetlands. (Bonde et al., 2004, Nkollo-Kema, 2022). Unfortunately, the West African manatee is highly threatened and declining in abundance (IUCN, 2021). The causes of the decline in population have been attributed largely to hunting and incidental capture in fishing nets (Cadenat 1957, Blancou 1960, Dodman et al. 2008, Salami and Odewumi 2022). Gabon may have one of the highest densities of manatees remaining in Africa (Powell 1996, Keith-Diagne 2014, Nkollo-Kema Kema 2022). Many people are unanimous about the presence of manatee populations in several lakes and lagoons of Gabon (Mbina, pers.comm., n.d.). Few boat surveys of West African manatees have been conducted in recent years.

The current conservation status of the West African manatee in lake Cachimba watershed is poorly known, and basic information on populations is lacking. The work presented here estimates the abundance and distribution of the West African manatee in the lake Cachimba watershed, taking into account two types of habitats (i.e., river channel, and lake) and two important hydro-climatic seasons (i.e., the dry season with low water, and wet season with high water). This work contributes to the knowledge on the West African manatee in Gabon and provides important baseline information for conservation of the species, in the lake Cachimba watershed and the initiation of active protection of the West African manatee in this country.

Methods

Study Area

The study was conducted at the watershed of lake Cachimba (4472 acres), Setté Cama Ramsar site (220.000 acres), Ndougou department, Gabon. The watershed includes lake Cachimba and its river channels. The main river in the watershed is the Mbissi river. The section of the Mbissi river studied was from the village of Mbissi to Lake Cachimba (Fig. 1).

The area surrounding Lake Cachimba and the Mbissi river belongs to the wetland living zone classified as a Ramsar site in 1986 by Ramsar agreement. In the lake Cachimba watershed, secondary forests border the Mbissi river Lake Cachimba and are interspersed with swamps. The majority of secondary forests are a result of deforestation due to agricultural activities (Blaney et al.,1997). The average temperature in the area of Lake Cachimba watershed is 24-28°C (Shell Gabon, non publié). Rainfall varies between 1500mm and 1800mm (https://carpe.umd.edu/sites/default/files/documentsarchive/Gamba_SOF2006_fr.pdf).

More than 21 species of fish have been reported in the Lake Cachimba watershed (Houehouhna, 2015), all of which are consumed by humans, and many of which have commercial value in the ornamental market. The main human activity in the area is small scale fishing.

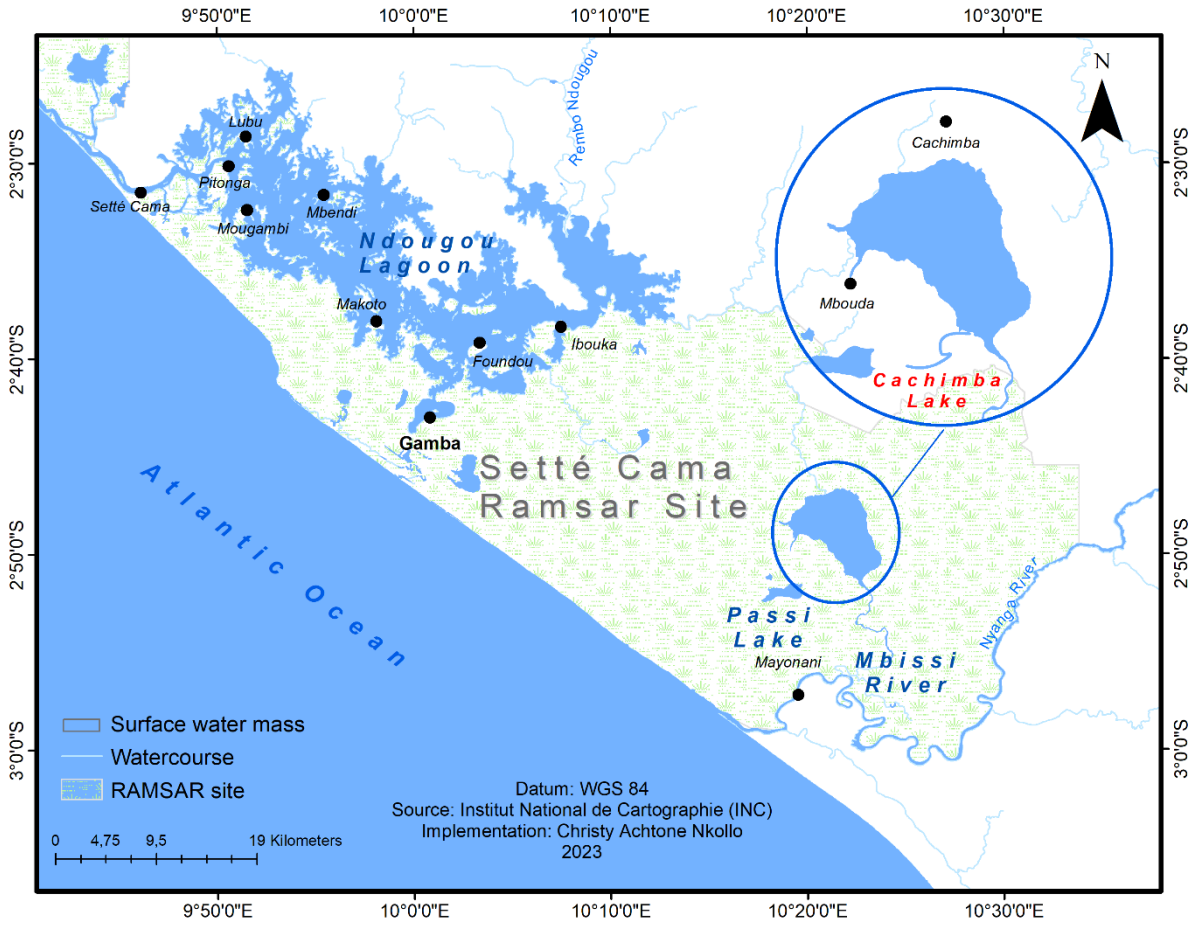

Figure 1: Location of catchment area of Lake Cachimba and the Setté Cama Ramsar site

Data Collection

We surveyed West African manatees on the Mbissi river (233.15 km) and Lake Cachimba (195.64 km) from April to October 2017. We used three data collection methods: secondary data collection on West African manatees in the Nyanga Basin area, day-time boat surveys, night-time boat surveys and surveys of markets and landing sites.

We collected information on manatee mortality and historical distribution from published works and unpublished reports.

We conducted night-time boat surveys using a spotlight. We collected data from 1800 to 0100h by boat in the Mbissi river and lake Cachimba. We used a 7m long boat with a 100-hp outboard

motor. We also used direct observations to count the manatees using a 44900 Waypoint Spotlight of 12v DC Cord. The team was mainly composed of three people: a data recorder, an observer with the spotlight on the front seat and a boat driver. The observer was scanning with the spotlight cone of 180° to detect the presence of manatees. Surveys were conducted at an average speed of 10.5 km/h. Night surveys by boat began within 30 minutes after sunset. During night surveys, we recorded manatee sightings (total number of manatees, manatees' carcasses), environmental conditions (Weather, water conditions), and recorded their positions in a Garmin Geographic Positioning System (GPS) 62 s. The overall water conditions of each survey were classified as 5-excellent, 4-good, 3-favorable, 2-low, or 1-very low.

We conducted day-time boat surveys to record observations of manatee mortality (carcass, strandings, manatee in gillnets). These surveys were conducted at an average speed of 19km/h. More than 50% of the fishing boat observed were approached to verify the presence of manatees by capture.

Monthly, we monitored the landing sites in Mayonami village and fishermen's markets at Gamba. The purpose of our surveys was to collect data on manatee bushmeat. The surveys were composed of an average of two observers: one people from local community and a member of the World Wildlife Fund (WWF) Gabon team. Monitoring was usually carried out between 07:00 and 12:00. We collected the following data on the observed species: length, potential source of mortality, capture site.

An extensive review of the available information on the presence of manatees in the Nyanga Basin area was conducted. The information was analyzed to identify areas of capture, hunting, observation areas and type of use the species. Historical and opportunistic data, both published or

unpublished, consisting of solicited or voluntary reports of captures or hunting cases by laypeople, fishermen, scientists and government officials were also documented.

Data Analysis

Manatee abundance and distribution was calculated using the method developed by Ferry and Frochot in 1958, which involves counting the number of manatees along a track. We calculated the total number of manatees and the encounter rate for each of the sites studied (Lake Cachimba and Mbissi river):

(1)

$$\frac{number\ manatees\ observed}{number\ of\ kilometres\ covered}$$

We used descriptive statistics to summarize the manatee population, manatee carcasses. In addition to manatees encounter rates, we also calculated carcasses encounter rate:

(2)

$$\frac{Number\ manatees\ carcass\ observed}{Number\ of\ kilometres\ covered}$$

(3)

$$\frac{Number\ manatees\ carcass\ observed}{Patrols}$$

We used Chi square (χ^2) test of fit to determine if there were significant differences in the abundance of manatee encounter rates between Lake Cachimba and the Mbissi river. Analysis of the variation in the nature and level of aggregation, as well as analysis of manatee occurrence hotspots in the Nyanga Basin area (lake Cachimba and Mbissi river), were calculated using QGIS 3.32 software. For all tests, $\alpha = 0.05$.

Results

Field Effort

A total of 7 surveys, corresponding to a total distance of 429.79 km, were conducted in the Nyanga Basin area. The total duration of the survey was 82.62h. In the Mbissi river, the duration of the surveys was 43.01 h and 39.61 h in lake Cachimba from April to October 2017. A total of 85.74% of surveys were conducted in Lake Cachimba (n=6) and 100% surveys in the Mbissi river (n=7).

Estimation of relative abundance

A total of 57 manatees were recorded. The average number of West African manatee observed per survey was 8.14 (± 2.06 SE). The total abundance of manatee in the Nyanga basin area (Lake Cachimba and Mbissi river) was 57 individuals, with a density of 0.13 animals/km. The relative abundance was 0.28 animals /km in lake Cachimba and 0.08 animal /km in the Mbissi river. The overall encountered rate was 0.69 sighting per hours in the Nyanga Basin area. In Nyanga Basin area, the encountered rate was higher in Lake Cachimba than in the Mbissi river. Indeed, an encountered rate of 1.39 sighting per hours was observed in Lake Cachimba and 0.05 sighting per hours in the Mbissi river.

The relative number of detections per season in the Nyanga Basin area was also calculated:

(4)

$$\frac{Number\ manatees\ observed}{observation\ per\ season}$$

The season with the highest number of manatee detections was the dry season (June to August) with 1.31 animals/h, followed by the wet season (March to June and September to October) with 0.58 animals/h. In the Mbissi river, the season with the least number of animals was the wet

season with 0.03 animals/h (Figure 2). Similarly, the season with fewest animals in Lake Cachimba was the wet season with 0.79 animals/h.

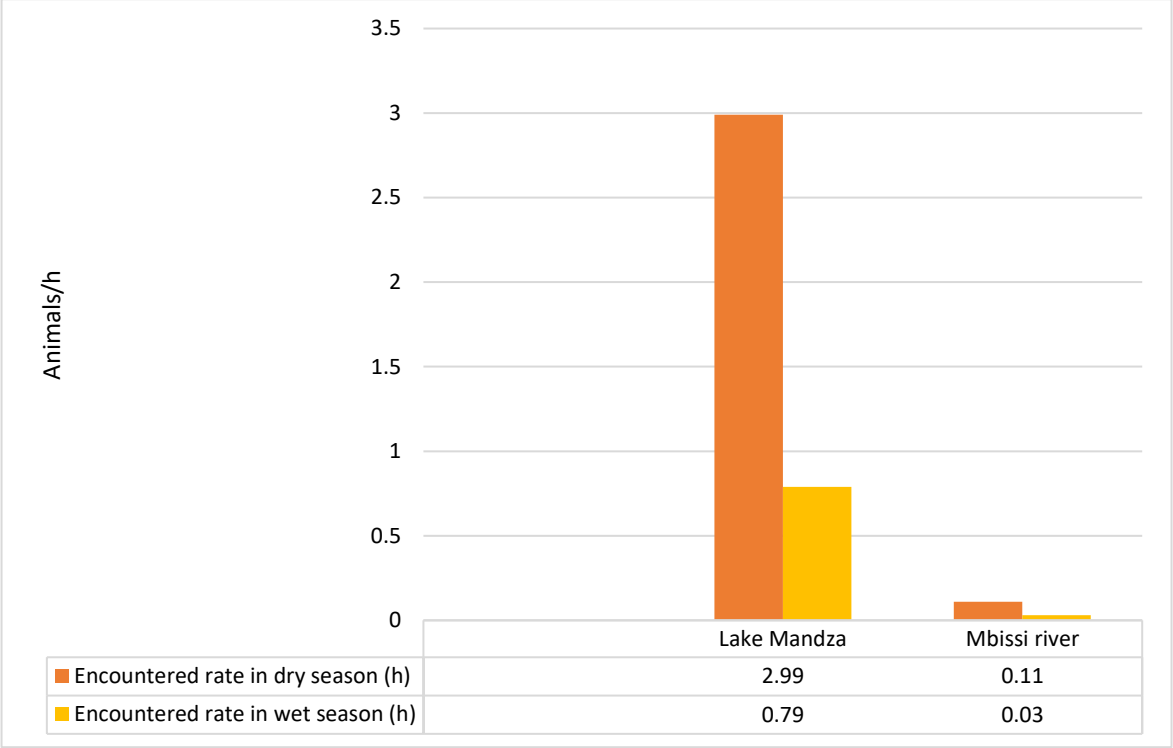

Figure 2. Relative abundance of manatee by season and sites studied in the Nyanga Basin area.

However a significant difference was observed for the relative abundance of manatees in the dry season between Lake Cachimba and the Mbissi river (χ^2= 17.19; df=1 ; *P*=3.381 e-05). There is also a significant difference in the relative abundance of manatees in the wet season between Lake Cachimba and the Mbissi river (χ^2= 32.111; df=1; *P*=1.456 e-08).

Distribution of West African manatees

West African manatees were mainly clustered along Lake Cachimba (Fig. 3). Specifically, West African manatees in the Lake Cachimba showed a clustered distribution pattern. In contrast, the data don't allow for assessment of the distribution pattern in the Mbissi river. Manatees hotspots

in Lake Cachimba are located near the mouth of the Duebi river along the shore of the village of Cachimba.

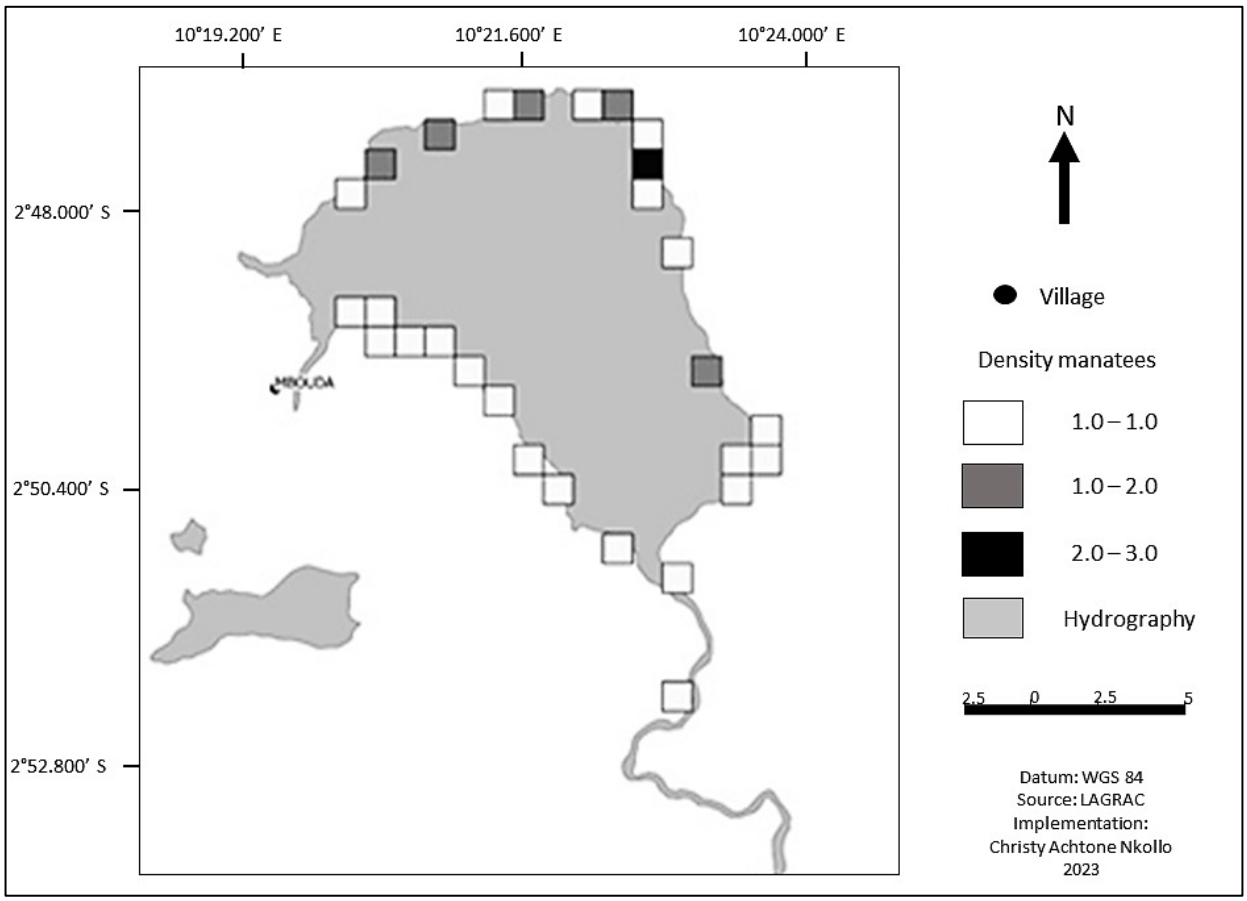

Figure 3: Density map of West African manatee in the Lake Cachimba watershed

Figure 4. (a) Photograph of a dead juvenile manatee found in the Mbissi river.

Only one dead manatee was observed during our boat surveys in the Nyanga Basin area from April to October 2016. It died in the Mbissi river, near the shore. This manatee was a juvenile. The causes of this mortality are not determined. If juveniles are under heavy pressure, this may have consequences for the viability of the manatee in Lake Cachimba. No West African manatees captured when the boat surveys covered a distance of 429.79. Although fishermen's reports mention cases of manatee mortality in relation to gillnets (Table 1).

Figure 4. (b) Manatee head on the carcass. This part of the animal's body is illegally trafficked by traditional healers.

Secondary data compiled and our interviews documented West African manatee mortality in Lake Cachimba and the Mbissi river (Nyanga Basin area in the Gamba Protected Areas Complex). We compiled 74 mortality records from 1997 and 2013 (Table 1). Most (n = 30) were from the Gamba Protected Areas Complex and the Nyanga Basin area (n=23). The main causes of mortality were hunting and entanglement. 58.10% of the data collected on dead manatees were provided by reports using interview methods.

Table 1. Manatee deaths reported in the Nyanga Basin area and cause of death categories

Dates	Specific location	No. of manatees	Total weight (kg)	Causes of deaths	Data collection methods	Type of source	Source
2013	Mbissi river	20	Und.	Hunting and entanglement	Interviews	Powerpoint présentation	S. Louembet, pers.comm., 03 September 2013
2013	Nyanga Basin area	23	Und.	Hunting and entanglement	Interviews	Survey report	J.R. Kema Kema, pers.comm. 11 June 2013
2007	Lake Cachimba (Cachimba)	0	-	_	Surveys by boat	Technical report	Keith-Diagne & Collins, pers.comm. 2007.
2003	Gamba Protected Areas Complex	30	400	Hunting and entanglement	Markets surveys	Scientific paper	(Thibault & Blaney, 2003).
1997	Nyanga Basin area	1	Und.	Hunting	Opportunistic data	Technical report	Blaney et al., 1997

Und. =Undetermined

Fishing activities as a potential threat to West African manatees

Fishing activities were very high in Lake Cachimba and the Mbissi river with a rate of 0.33 fishing activities per km. Some 36.17% of all fishing observations were with fishing boats (n=141). During the day-time surveys, a high density of fishing activities was observed in the Lake Cachimba watershed (Figure 4). Some 87.94% of fishing activities observations were recorded during day-time boat surveys. Figure 4 below shows the spatial distribution of areas with a high risk of fishing boat collisions or entanglement with manatees by season (wet season and dry season) in the Lake Cachimba basin.

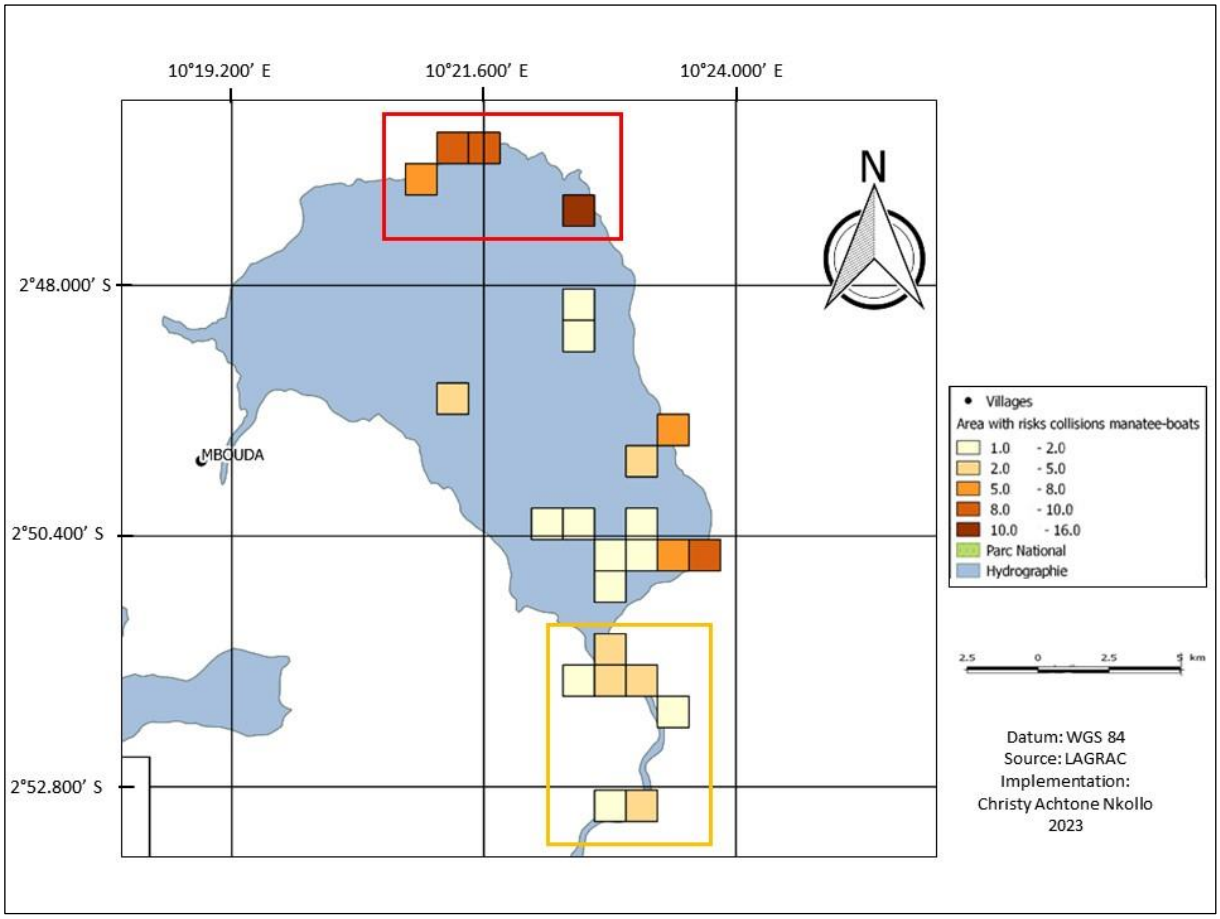

Figure 5: Prediction map indicating areas with risks of collisions/entanglement in the Cachimba Lake Watershed.

Discussions

This study provided an update of the current status of West African manatee in the Lake Cachimba watershed. The results revealed a highest density of West African manatees in the Setté Cama Ramsar particularly Lake Cachimba. This is confirmed by the study of Kema Kema Nkollo et al. (2017) who indicate a density of 0.93 observations per hour for the Ndougou lagoon localized in the Setté Cama Ramsar site. From 2006 to 2007, boats surveys by Diagne (unpublished) indicated a significant relative abundance of manatee, estimated at 0.87 sightings per 1.4hours for Lake Cachimba. This relative abundance highlights that this area may support the largest West African manatee population in Gabon and in Africa (Diagne, 2015).

The high relative abundance of the manatee in Lake Cachimba can be explained by its legal status, which makes it a fully protected species in Gabon under decree n°164/PR/MEF of 19th January 2011 relating to the forestry code. Moreover, the enforcement of the law and lack of marketing roads have reduced hunting in the area. Other fishing gear (sennes) causing the capture of manatees were prohibited by the fishing decree n°0076/MEFCR/DGEF/DPMCM of 29 March 1986 relating to the fishing code. In addition, a possible reason why counts in the Mbissi river were low is that manatee abundance and distribution may have responded to increased human activity. For example, Houehouna (2016) reported that number of fishing activities has recently increased in this area. The low number of manatees in the Mbissi river could be the result of a change in the team's surveys and data collection methods: nighttime boat surveys with spotlights. The spotlight used allowed easy detection of manatees but manatee size was difficult estimate. A difference in the observations of manatees was found between wet and dry seasons. This is explained by the fact that manatees migrate according to water level. Thus, in case of high-water level, manatees are observed in the small rivers of Lake Cachimba. The study of Kouadio (2004)

showed that African manatees tend to congregate in deep pools during the dry seasons in Fresco lagoon (Ivoiry Coast).

Habitat distribution

Night watch by boat with spotlight provided a good picture of manatee distribution in the Lake Cachimba watershed, regardless season. Although those night watches by boat only covered about two-third of the Mbissi river and whole of Lake Cachimba, the contrast in manatee distribution coincides with surveys conducted from 2006 to 2007 in the same areas (Keith-Diagne, 2015). Almost all the manatees recorded, whatever the season, were grouped together at the outlet of the Douebi river which flows into Lake Cachimba. The reasons for these gatherings remain unclear. However, we assume that the strong presence of manatees in this area can be explained by the low fishing effort and the abundance of food (mangroves and papyrus). Manatees have excellent navigational skills and return to their preferred feedings area year after year (Keith-Diagne, 2008). Difficult to access and shallow, the Douebi river was a preferred habitat for the West African manatee. During the wet season, the majority of manatees may migrate to the Douebi river.

Manatees are only observed in the dry season in Mbissi river. This can be justified by the fact that small rivers are more important in the Mbissi than in Lake Cachimba. However, with regard to feeding areas, no feedings sign was observed during these surveys. Moreover, the movements of the West African manatee in the area in relation to the rainy and dry season were affected by water level changes (Powell, 1985)

Manatee mortality

The compilation of secondary data has shown that West African manatee mortality in the Lake Cachimba watershed resulted mainly of hunting and fishing activities. The trade of West African manatee bushmeat is well documented in Gabon and elsewhere in West Africa (Powell, 1996;

Reeves et al., 1988, Dimbot 2021). But the data at the scale of the Lake Cachimba watershed are very poor. Compared to data from others African countries, West African manatee mortality seems to be underestimated. Indeed, studies recording West African manatee mortality in the Lake Cachimba watershed were conducted between 1998 and 2007. A lack of data on manatee mortality over 10 years has been observed. The decree of law n°164/PR/MEF on the integral protection of the manatees in Gabon could encourage hunters to be more careful. Indeed, people hesitated to talk about the manatees. Moreover, only one carcass was recorded during the 7 months of surveys. Further, data on high manatee mortality were provided by bushmeat survey at the scale of the Gamba Complex including Lake Cachimba watershed. It was difficult to know the frequency of manatee killed in the Lake Cachimba watershed. In addition, most of the data on manatee mortality was provided by interviews. Nevertheless, the values given by the local community may be biased by a number of human factors. Interviewees may choose to withhold information or conversely, exaggerate or invent information to impress the interviewer (Franzini et al. 2013).

In the secondary data compiled, no manatee mortality was caused by boat collisions and no manatees were reported with propeller scars in the Lake Cachimba watershed. Most of the recorded deaths are the result of entanglements and hunting. However, wildlife-vehicle collisions are a significant source of mortality for many species (Bauduin et al., 2013). Vehicle-boat collision threats have been observed with manatees (Aipanjiguly et al., 2003; Calleson and Kipp Frohlich, 2007; Nkollo-Kema Kema (unpublished)). Moreover, informal discussions with fishermen of Lake Cachimba watershed indicate that collisions have been recorded monthly by fishermen particularly in Lake Cachimba. The lack of manatee carcasses caused by collisions may be explained by the fact that the local community like the bushmeat of manatees (Kema Kema, pers. comm., 11 June 2013, Blaney et al. 2001, Diagne, 2015). The analysis performed from the

distribution of fishing activities and manatees predicted the areas with highest risks for manatees: banks of Lake Cachimba, side of Cachimba village. All fishing activities (observations of fishing gear and fishing boats) were cross-checked been with manatee distribution. However, biases in the collection of activity data (58.33% of months were sampled) may lead to the redefinition of the map on areas of higher risk for manatees. However, the change in higher risks areas was not significant because the period with high fishing activity was sampled: the dry season.

The use of an interview method to study of manatee mortality in the Lake Cachimba watershed will be useful to better assess the level of mortality of West African manatee and potential threats to them at the watershed scale. Although this interview method includes little bias (Franzini et al., 2013), it could provide a good indication of manatee conservation status (Arevalo-Gonzalez et al., 2014).

Limitations and challenges

Limitations were associated with the approach used during this study. The relative abundance of manatee has been underestimated for several reasons. First reason: detection estimates in this study due to observer perception are associated with groups, not individuals. Whereas Langtimm et al. (2011) found a positive relationship between group size and detection probability (but this model would be logistically difficult to implement at such a large scale). For logistical reasons, visibility in this study accounted for variation in sea state but not for variation in light levels. Further, the nighttime surveys with spotlight were less appropriate methods for assessing manatee abundance and distribution. The use of 30-minute spotlight scans to count individual manatees from a small boat platform is an effective and repeatable method for monitoring sirenians in typical habitats worldwide (LaCommare et al., 2012). However, heavy fishing boats traffic and turbidity make it difficult to observe manatees during boat-based point surveys. Another problem with the

methodology used is the small sample size, spread over several months, which makes it difficult to estimate the abundance of West African manatees in the Lake Cachimba watershed. Although only 7 months of data were collected, two seasons (dry season and wet season) were sampled in order to obtain a robust estimate of relative abundance. However, the boat used during the surveys may have caused an underestimation of the relative abundance of manatees in the area. Indeed, a boat equipped with a 100 Hp motor was used and not all surveys were conducted near the shore due to the water depth.

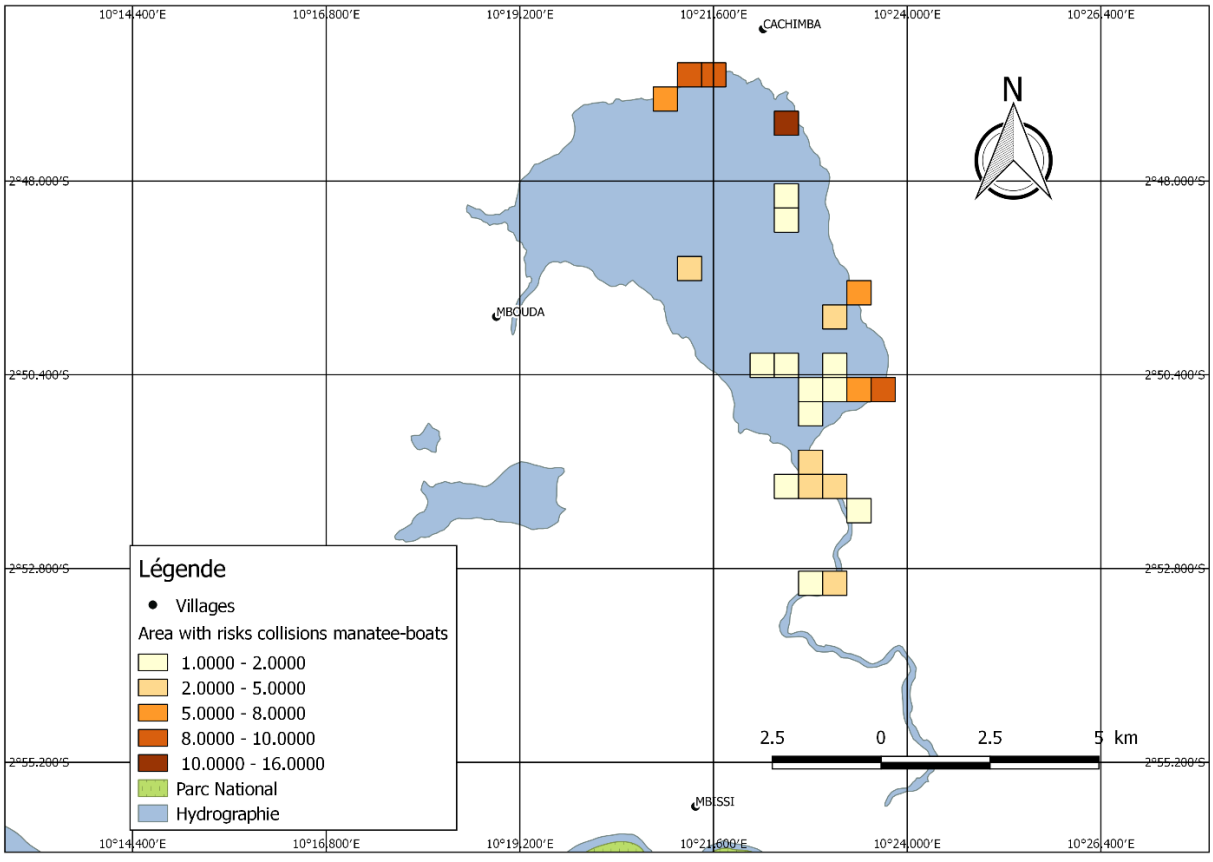

Figure 6: Prediction map indicating areas with risks of collisions / entanglement in the Cachimba Lake Watershed.

Based on the results of this study, we recommend that due to the high mortality of manatees in the Lake Cachimba catchment, monitoring should be continued by agents of the Ministry of Water and Forests. In addition, monitoring using the method of interviewing fishermen by the Ministry of Fisheries and Aquaculture brigade should enable a better assessment of manatee mortality in this area. The application of the law on the total protection of manatee in Gabon, should be strongly implemented to reduce manatee hunting and maintain its important population.

Finally, as a measure we propose the protection of the banks of Lake Cachimba, in particular the outlet of the Douebi River. This area should be the subject of a management plan for the catchment area of Lake Cachimba and the Setté Cam Ramsar site in order to reduce the impact of fishing activities on the manatee population.

Conclusion

This study provides important baseline data for monitoring the population of the West African manatees in the Lake Cachimba watershed of Gabon. It highlights the importance of providing better documentation of current manatee mortality, particularly the risks from manatee-boats collisions. In addition, this study also highlighted the urgency of law enforcement for the protection of the mouth of the Douebi river in Lake Cachimba.

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