

Research Article

Characterization of Marine Artisanal Fisheries and the Impact of By-Catch on Marine Faunal in Southern Cameroon (West-Africa)

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Abstract

Marine fisheries are the primary source of proteins for many people. Unfortunately, despite their importance, they are threatened with numerous anthropogenic influences, warranting urgent and comprehensive management. This work was carried out with the main objective to see the different actors that intervene in maritime artisanal fishing and the impact of this activity on marine fauna (sea turtles, manatees and dolphins) in the localities of Lokoundje and Edea in southern Cameroon (West-Africa). The present study was done under three (3) main objectives:

- Inventory and evaluate the different fisheries and actors (sexes, ages and nationalities)
- Estimate the fishing gears and methods used in the fisheries
- Evaluate the impacts of by-catch on marine flagship species

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The results obtained by these objectives shows that majority of the fishermen are Nigerians and Cameroonians, and that the dominant age group is 30-50 years followed by 10-30 years. It should be noted that the dominant types of canoe in the fisheries are of Nigerian type and the fishing gear mostly used are gillnets, surrounding nets, longlines and beach seine. There are three (3) main marine species accidentally captured in these fisheries. They are manatees, dolphins and marine turtles. The accidental captures varies with fishing camps as there are fisheries where marine mammals are highly captured (example, manatees are mostly captured at Bondjondji and sea turtles are caught in high quantities at Mboa manga). These sea turtles are mostly caught in the dry season than in the rainy season compared to the other mammals. In future it shall be better to set up national programme.

Keywords: By-catch; Eco-tourism; Fishing gears; Marine artisanal fisheries; Marine fauna

Introduction

Human impacts on the world oceans are extensive and varied, warranting urgent and comprehensive management of marine resources in many places [1]. Marine fisheries, are the primary source of proteins for billions of people [2], and globally are the major anthropogenic influence on worldwide marine systems, affecting marine animals population and ecosystem function [3,4]. A central issue for marine fisheries is by-catch or the unintended capture of non target organisms during fishing operations [5,6]. Although the type and amount of by-catch varies greatly between small- and large-scale fisheries and among the diversity of gear type deployed, the total amounts of fisheries by-catch is several million tons globally each year [7]. Marine fisheries are the primary source.

Fisheries by-catch has been identified as a primary driver of population declines in several species of marine megafauna e.g., Elasmobranchs, marine mammals, sea turtles, seabirds, etc., [8]. Marine megafauna species interact with various types of fishing gears because they occupy broad geographic ranges spanning geopolitical boundaries and oceanographic regions that support many different fisheries.

Sea turtles spend the majority of their lives in coastal or pelagic waters where artisanal fisheries and other human activities are active, making in-water sources of mortality critical to the population viability. While all of these factors likely have some negative effect on sea turtle populations, human activity has the largest impact on sea turtles in fisheries by-catch [9,10]. Although directed take of turtles is one form of fisheries impact, and in some regions opportunistic take of captured turtles is still prevalent [11], turtles are generally an unwanted and unwelcome by-product of fishing activities. Because fishing is an important source of protein and livelihood for millions of people worldwide, incidental capture, or by-catch of sea turtles continues to be the most pressing human impact on sea turtle populations globally.

Marine fauna by-catch occurs in a diversity of fishing gears throughout turtles broad geographic ranges in the ocean. Vessels from large-scale and using trawls [12] gillnets [13], seine nets, pound nets [14], longlines [15,16], and many other gears all incur sea

turtle by-catch. Small-scale fisheries (Artisanal fisheries) have a very high, possibly unsustainable level of sea turtles by-catch [11,17,18]. This by-catch occurs in many of the different gear types deployed by artisanal fishermen including longlines, demersal gillnets, griftnets, poundnets, and trawls [11,19,20]. Small-scale gillnets fisheries in particular are a source of growing concern, given their high observed by-catch and mortality rates [11,19,21].

Trawls are known to illegally fish close to shore and by-catch of turtles is high [22]. Carapaces of sea turtles were found at a bar in Douala, one of them measuring 82 cm in length [23]. The young fishermen at Lolabe III were reported to harpoon many juvenile hawksbills in front of their village (the smallest measured about 30 cm), whereas other fishermen complained about leatherbacks getting entangled in their nets and destroying them [22].

Accidental and intentional captures of green turtles less than 78 cm in size are common in Cameroon all year round. According to Fretey [24], fishermen catch female Olive ridley with their nets or line during the spawning season. About 400 sea turtles (Green, Olive ridley, hawksbill and leatherback) are caught accidentally in coastal artisanal fisheries in Cameroon; however, detailed information on by-catch rates for each species or fishing effort is not available [25].

The present study was done under three (3) main objectives:

- Inventory and evaluate the different fisheries and actors (sexes, ages and nationalities)
- Estimate the fishing gears and methods used in the fisheries
- Evaluate the impacts of by-catch on sea turtles and other marine flagship species

Materials and Methods

Presentation of the study zone

Geographical situation of the zone: The study zone covers the subdivisions of Lokoundje and Edea I, situated in the division of Ocean and Sanaga Maritime, in the South and Littoral regions of Cameroon respectively. It covers a surface area of 11,280 km². Its geographical coordinates are comprised between (02° 08' & 03° 35' N and 09° 49' & 11° 11' E) with a coast of 75 km long. Its localities are found in the Cameroonian coast which opens to the Atlantic Ocean with a distance of about 402 km [26]. It is bounded West by the Atlantic Ocean, the subdivisions of Mouanko and Dizangue, North by Edea II, South by Kribi and East by Nyété subdivisions. The principal localities are Lokoundje, Londji, Mpolongwe, Mpalla and Mboa-manga. Below figure 1 shows the localities of the study zone.

Pedology and topography: Two types of soil are observed in this zone. The red ferralitic soils have a mother rock which is acidic in nature with a homogenous aspect. The yellow ferralitic soils whose mother rocks are respectively gneiss and micaschistes, occupies the major part of the region. It represents at the surface, a mixture of sand/clay and clay/sand or completely clay soil at the bottom. This is due to the effect of intense erosion. The altitude varies from 0 to 50 m and the highest point is found in an altitude of 120 m [27].

Hydrography and climate: The hydrography of these divisions are very vast and made up of important rivers in which most of them take their sources in the Southern Cameroonian plateau.

River Kienke drains the whole town of Kribi. It is 130 km long with an average water flow of 49.2 m³/s. River Lobe, with its numerous touristic waterfalls, is situated 5 km away from the town of Kribi; river Lokoundje; river Ntem (natural boundary with Equatorial Guinea in the South of Cameroon). All of these rivers empty themselves in the Atlantic Ocean [28].

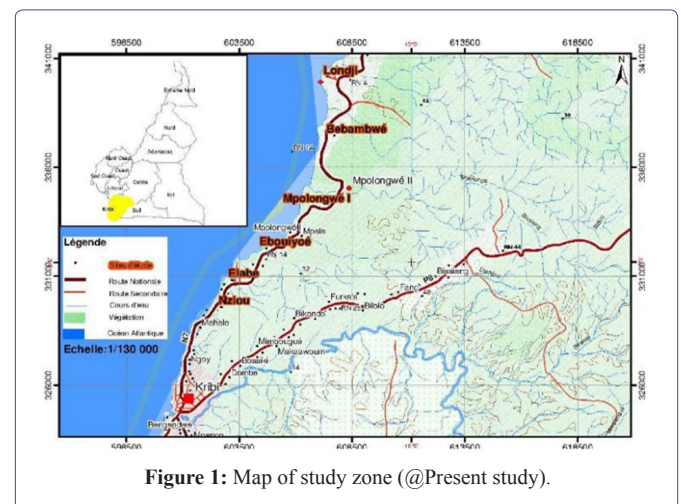


Figure 1: Map of study zone (@Present study).

This region is an equatorial climate zone and of classic guinean domain. It offers two (2) principal climates, the guinean at the interior and the maritime, respectively introduced by the proximity of the sea and by the continent [29]. There are two (2) seasons: A long rainy season which covers eight (8) months (from March to October) with precipitations below 160 mm. The winds blows fast (11 km/h) due to the proximity of the sea. The high rain gauge readings are registered in September (682 mm) while the hottest month is March (28.5°C). Rainfall is very low in December and the month of August is the coldest (24°C).

Flora: The flora of these zones is essentially constituted of macrophytes, mangroves and coastal forests. It is distributed as such: the coastal Atlantic forest with *Cesalpiniaceae*, the periodically inundated marshy forest of Sanaga valleys with *Uapaca spp*, the periodically inundated marshy forest of overdue mangroves with *Guibourtia demeusei* and *Oxystigmamanni*. The other part of the zone is constituted of a coastal sandy land yard forest with *Saccoglittis gabonensis* and *Klainedoxa microphylla* on sand and *Anthostema aubryanum* and *Ctenolophon engleranus* on mud. The external mangroves are constituted of *Rhizophora racemosa* and *Pandanus candelabrum* found at the border of the estuary. The principal species found in the mangrove are *Rhizophora mangle* which occupies 90% of the surface of the mangrove forest, *Rhizophora harrisonii*, *Avicenia germinans* and other swampy plants like the *Nypa fruticans* and *Pandanus candelabrum* [30].

Fauna: The ocean fauna undergoes an ecological threat [31]. We distinguish; birds, reptiles, and mammals. The aquatic fauna represented by fish e.g., *Condricthians* (Shark); crustaceans (crabs, crayfish, prawns); mollusks; amphibians; reptiles are essentially constituted of five (5) marine turtle species which undergo high anthropogenic pressure [25], crocodiles, and snakes. Continental water turtles are found in the creeks of rivers Nyong and Lokoundje. Marine mammals which

populate this zone are represented by small cetaceans (Dolphins) and manatees (*Trichechus senegalensis*) who dominate the estuarine waters of river Nyong and Lokoundje.

Human milieu and socio-economic activities: These divisions count an estimated population of 93,246 persons [32]. The principal activities of this milieu are: fishing, sand extraction, agriculture, wood exploitation, hunting and petroleum extraction [33]. Fishing is essentially focused on fish and clams. Hunting is done by Bassa and Ewondos; they capture monkeys and wild herbivores such as hare, antelopes, etc. We count excluding foreigners many tribes who originated from these zones. They are the Batangas (majority in the zone), Mabis, Bakokos, Ewondos, bassas and the Fangs.

Methodology

Data collection: This consist of the way datas were collected. Two main data type were collected; secondary data and primary data collection.

Secondary data: Secondary data was collected by reading other documents under the theme as well as documents downloaded from the Internet. These documents used were of diverse forms: There were University reports and thesis, scientific articles, regulation texts. The research also continued by using documents from CMBA (Cameroon Marine Biology Association) and also other ministries concerned totally or partially in the domain such as MINEPIA (Ministry of Fisheries and Livestock's Industries) [34] and MINFOF (Ministry of Fauna and Forests).

Primary data: Primary data was obtained after series of steps.

Population study and sampling: The population study was composed of fishermen and high authorities who are implied in fishing.

Choice of fishing camps: With the aid of who is specialized in the domain and in the zone, eleven fisheries were selected amongst about 15 existing in the study zone, giving 73% of the total fisheries. The selection of the fisheries was based on the following criteria:

- Effective and intensity of fishing in the locality
- The accessibility of the fisheries

Choice of fishermen in the fisheries: Geographical coordinates were taken and the states of the fisheries were given by the local authorities and leaders of the fisheries in each fishery. The selection of fishermen was taken at random depending on those willing to be interviewed but we made sure to have as much information as possible. Out of total of 100 fishermen planned to be interviewed, 88 were interviewed. A frequency of 88% of fishermen in the eleven villages studied. The frequency of sampling is calculated as thus;

$$F = \frac{n}{N} \times 100$$

Where:

F is the percentage of fishermen interviewed

n is the number of fishermen interviewed

N is the total number of fishermen found in the fishery

Interviews in the field: This step was carried out by two persons. A technician in the field and a Master's student from institute of fisheries and aquatic sciences, Yabassi. We spent two weeks of each month

in the field for data collection. The methodology of data collection was done through interviews towards the fishermen. This interview was done either individually or in group to all the voluntary fishermen. The questionnaires were used in order to get some relevant information on the number of fishermen that intervened in the activity, their sexes, their ages, nationalities, their fishing frequencies, the different fishing methods used on different fishing gears, the periods of abundance of sea turtles, etc. This information provided clues on the population of actors that are found in the fisheries.

A total of 11 fisheries were covered out of about 15 (73%) using the same questionnaires on the fishermen found. The rest of the uncovered fisheries were not visited because of their minute size and also because the fishermen over there fish just for household consumption. All the camps were not covered at the same time; we started at Lokoundje estuary to Hondja'a. During our inquiries in these localities, we realized that most fishermen from Kribi came and fished in these zones. We therefore decided to continue our inquiries in the Southern region instead of going in the Littoral region as defined in the theme of study. We therefore continued from Londji to Mpolongwe I, Mpolongwe II to Mpalla and finally Ngoyé to Mboa manga.

The survey was conducted from March 13th to May 9th 2017 using questionnaires and observations. The data collected was regularly verified by the field supervisor, a biologist. Fishermen were selected randomly and the survey was conducted in the afternoon when they were done with work. Others were interviewed immediately they came back from their fishing trips. In certain areas where data were available, we collected certain information's from the Ministry of Fisheries and Livestocks which are the managers of fishing activities. Data collection was also facilitated by local fisheries officers as they gave us information's about the total number of boats, active boats and the nationalities of the fishermen found in the fisheries.

With the information obtained from the fishermen through the use of questionnaires, we were able to determine the by-catch which was reported in the form of By-Catch Rate or By-Catch per Unit Effort (BPUE). This by-catch rate was generally calculated as the number of turtles captured relative to the associated amount of fishing efforts observed.

Direct observation in the field: In camps where communication was difficult, there was a guide (interpreter) who translated some questions in their mother tongue and in some areas the questionnaires were translated in pidgin for some Nigerians who could not speak French. The direct observations were done in order to confirm the answers obtained using the questionnaires. We also went with them in the sea to see how and where they usually carry their fishing activities.

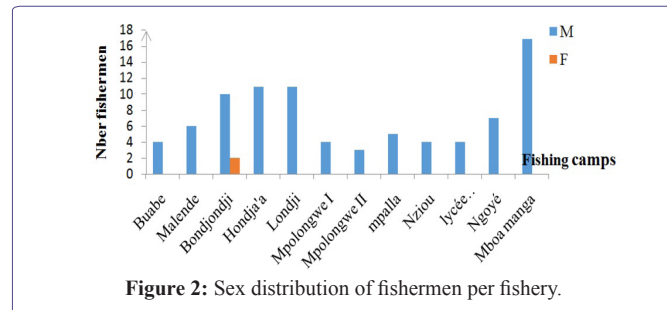
Results and Discussion

Results

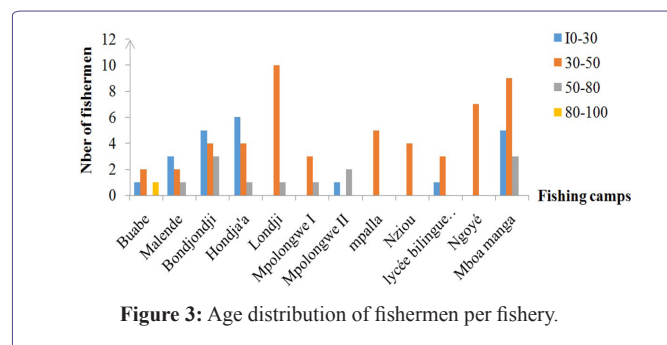
Proportion of fishermen's nationalities per fishery visited: Globally, Cameroonians are dominant over other nationalities, with 83%, Nigerians 14.8% and Beninese 2.3%. Comparing the nationalities per fishery, Nigerians are dominant at Londji with 73% of the total number of fishermen interviewed at Londji.

Sex distribution of fishermen per fishery: There, appear fisheries where females went fishing using a canoe and this appears only at

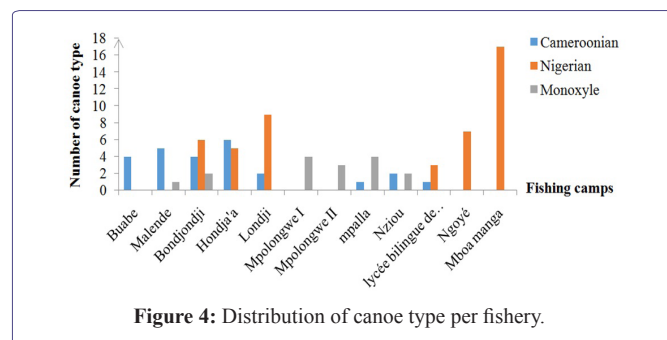
Bondjondji even though dominated by men. Below figure 2 shows the sex distribution fishermen in the fisheries visited.



Age distribution of fishermen per fishery: Age distribution of fishermen in the different fisheries shows that there are only two age groups dominant. With 30-50 (10 individuals) the most dominant followed by 10-30 (6 individuals). Below figure 3 presents the age distribution of fishermen found in the localities visited.



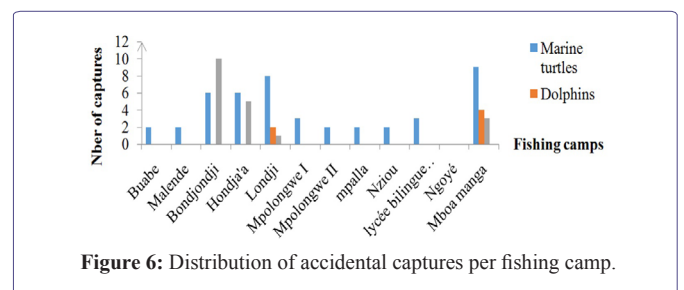
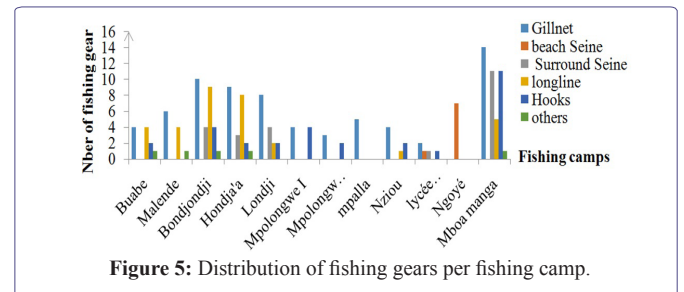
Distribution of canoe type per fishery: The canoes of Nigerian type are dominant in Mboa manga, Ngoyé, Bondjondji and Londji, while canoes of Cameroonian type are dominant in Buabe, Malende and Hondja'a and finally in Mpolongwe I & II, and Mpalla. Below figure 4 presents the dominant canoe type found in the fisheries visited.



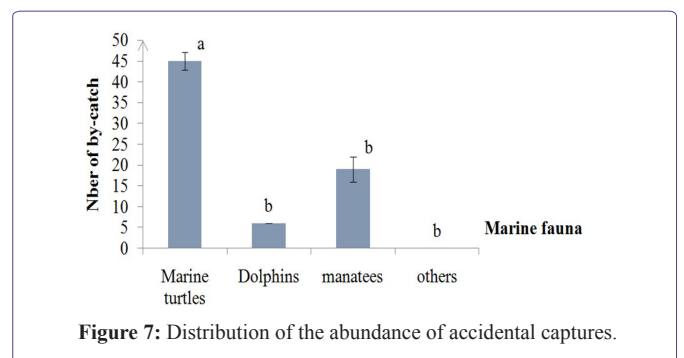
Distribution of fishing gears per fishing camp: Three main fishing gears (gillnets, surround seines and longlines) are dominant in almost all the fishing camps. Below figure 5 represents the distribution gear of in the fisheries visited.

Distribution of accidental captures per fishing camp: Sea turtles are the most abundant marine mammal caught. The figure shows that the capture of manatees are dominant over sea turtles at Bondjondji

while the rest of the fishing camps are dominated by the capture of sea turtles with the highest being at Mboa manga. Below figure 6 shows the distribution of accidental captures of marine fauna in the fishing camps visited.



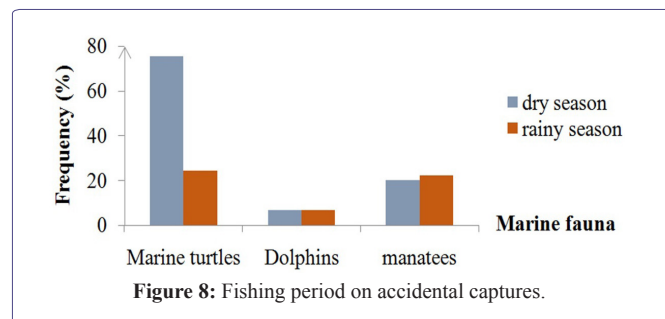
Distribution of the abundance of accidental captures: The capture of sea turtles is significantly ($p < 0.05$) higher than those of dolphins and manatees. The distribution of sea turtles is $45 \pm 2/\text{yr}$, dolphins $6 \pm 0/\text{yr}$, and manatees $19 \pm 3/\text{yr}$. Below figure 7 presents the abundance of by-catch of marine fauna in the fishing camps visited.



Distribution of fishing periods on accidental captures: Sea turtles are totally dependent on season compared to the other mammals as they are mostly caught in the dry season (75.6%) than in the rainy season (24.4%) (That is, March, November and December). Below figure 8 presents the frequency of marine fauna captures with seasons.

Fate of accidental captures: From all inquiries made towards all the fishermen in the different fisheries, the results obtained showed that all the mammals captured accidentally are consumed. This is to compensate the proteins which would have been obtained from fish. There are some mammals which are picked by fishermen, others caught unintentionally while others are intentionally killed when they attack the fishermen's nets, e.g., manatees. These manatees are mammals

which have been reported to be very aggressive and they destroy the fishermen's nets. Nevertheless, the fate of these mammals is for home consumption.



Discussions

The proportion of fishermen's nationality in the localities visited shows that globally, Cameroonians are dominant over Nigerians with 83% and 14.8% respectively. Looking per fishery, Nigerians dominate at Londji. This result coincides with the results obtained by Ayissi & Jiofack [35]. Other author observed that 80% of the fishermen were dominated by foreigners, mostly Nigerians at Londji. This is because the fishing camps visited, are villages owned by Cameroonians (Mostly Batangas), few foreigners are found living in those villages and also because Londji is a touristic village thus foreigners are bound to come in the village.

The sex distribution of the fisheries is dominated by males. Just few women were seen going fishing with men. This could be due to the fact that fishing is a domain where division of labor is well structured as women have their task to play in this activity. They are in charge of smoking and commercialization of fish brought at the landing site.

The age distribution of fishermen in the fisheries shows that the group 30-50 is the most dominant followed by 10-30. This result coincides with that obtained by Chiambeng & Holvoet [36] where they discovered that 83% of the fishermen are dominated by individuals in the age group 15-35. This is because most fishermen found in this age group are very active and are mostly canoe owners.

The canoe type with respect to fisheries shows that canoes of Nigerian types are dominant over Cameroonian types. This is because Nigerian canoes are highly recommended by the population and also because most Cameroonian canoe fabricators have been trained to construct Nigerian canoe types.

The distribution of fishing gears in all the fisheries shows that gill-nets, surround seines, longlines and hooks are dominant in some fisheries. This coincides with the results obtained by Moore, et al. [37]. This is because gillnets and longlines are the first tools bought by a man who wants to engage in fishing activities and also these gears bring much catch to the fishermen as it operates over a broad space in the water.

The distribution of accidental captures in different fisheries shows that sea turtles and manatees are the most hunted in Mboa manga and Bondjondji respectively. This result is the same as that obtained by Moore, et al. [37] and Fretey [23]. This could be due to the fact that

there is a very high number of unregulated fishing gears deployed in the water and also these fishermen always fish near the nesting or feeding side (near rocks for sea turtles and in the mangroves for manatees) of these mammals.

The distribution of fishing periods on accidental captures shows that marine turtles are mostly captured during the dry season than in the rainy season. This coincides with the results obtained by Ndoun-gue [38] where marine turtles are mostly caught in the dry sea season (65%) than in the rainy season (35%). This could be due to the fact that these high captures occur during the spawning periods of these marine turtles. That is, in March, November and December.

All the accidental captures are consumed by the fishermen. This coincides with the result obtained by Ayissi & Jiofack [35]. They observed that 1228 sea turtles, 97 cetaceans, and 292 manatees were caught by local fishermen in the Cameroonian coastal communities. These mammals are caught intentionally and accidentally but their fate is for consumption.

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