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Research Article

Catch statistics from artisanal marine fishing: A case of the south coast of Cameroon

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Nowadays, the promotion of advanced approaches and techniques for collecting data on the fisheries statistics is a key to sound policy-development, better decision-making and responsible fisheries management. In African developing countries, artisanal marine fisheries remain the highest producers of fishery resources and the largest fleet. In developing countries with coastlines and decentralized management such as Cameroon, the collection and analysis of fishery data are the main challenges at the regional, divisional and sub-divisional or district levels. The marine artisanal fishery which covers about one-third of the 402 km of coastline and the entire southern coastal zone of Cameroon, need credible fishery statistics because it's published statistics are subject of doubt. To obtain viable statistics which can be utilized to understand the real estimation of catch statistics along the coast, from 1st April to 10th July 2021, we conducted a survey of 1267 fishermen within 32 landing sites in order to reconstruct the fishery statistics and compare them to the statistics published by the 2020 annual report of DDEPIA/MINEPIA. Using standard fishery statistical methods of motorized, non-motorized and beach seine catches, we were able to reconstruct the statistics of the year 2020. The results showed (1) The reconstructed statistics at 10206.9627 tons and a gap of 9786.50273 tons with the 2020 annual report of DDEPIA/MINEPIA; (2) There were three fishing seasons (high, medium and low) with an increasing catch from August to December, and a decreasing catch from January to July; (3) 37 species including 26 families were identified, with *Clupeidae* and Scianidae as the dominant catch species from April to July in the southern coast of Cameroon.

Key words: Catches, small-scale fishing, marine, Cameroon.

INTRODUCTION

Nowadays, one of the challenges fisheries face is the promotion of advanced approaches and techniques for the data collection of fishery statistics, which is a key to sound policy-development, better decision-making and responsible fisheries management (De, et al. 2015). At the regional, national and sectorial level, the inventories of most fishery data collection are carried out by different countries under NGOs and national programs. Capacity building in data collection and fishery statistics has been a high priority for FAO through different projects, especially for marine artisanal fishing (Bazigos, 1974; FAO, 2010a; De, et al. 2011). Knowledge of the status and trends of capture fisheries, including socio-economic aspects, is essential for the planification of the fisheries' monitoring systems, sustainable capture, and environmental protection. Sampling methods, design techniques and statistical approaches based on international standards have been implemented in order to improve routine data collection and to provide the desired precision for estimated fisheries statistics (FAO, 2010b; De, et al. 2011; De, et al. 2015). However, fishery statistics for small-scale fisheries need to be more reliable and comprehensive. In Cameroon, fishery statistics remain important for the development and sustainable management of fishery resources. The Cameroonian coastline is about 402 km long, stretching from Akwayafe river on the south eastern end

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of Nigeria, latitude 4o40'N, and descends to the border with Equatorial Guinea at the Campo River, latitude 2o20'N (Sayer, et al. 1999; MINEPDED, 2012; Pramod, 2020). The coast is divided into three zones, including the west coastal zone (in the South-Western region from the Nigerian border to Moungo River), north coastal zone (in the Littoral region from Moungo River to Nyong River) and south coastal zone (in the Southern region from Nyong River to Ntem River) (Folack, et al. 1995; Ayissi, et al. 2014). Industrial, semi-industrial and marine artisanal fishing are practiced in the Cameroonian Exclusive Economic Zone (EEZ), which is about 15,000 km^2. Cameroon has modest fishery resources dominated by small boats (Pramod, 2020). In the field of marine artisanal fishing, the reporting and estimation of fishery statistics by the institutions in charge have been neglected and abandoned in some areas along the coastline, and the published statistics are not reflective of the reality. In recent decades, the authors of published documents and articles in Cameroon kept reporting the estimated production of marine artisanal fishing at 93.000 tons per year, without any updated statistics or upgrades to the methods of data collection (Ngok, et al. 2005). At the national level, the real status of the data produced and the actual volume of fish production per year has become an issue and a subject of doubt. The Ocean division, which covers the entire southern coastal zone of Cameroon and represents about one-third of its coastline, is also facing the same problem of questionable data collected and published. From the survey conducted by (Djama, et al. 1990; Folack, et al. 1995) to now, it is regrettable that data has not been updated and published for the southern coast of Cameroon (Djama, et al. 1990; Folack, et al. 1995; MINEP, 2011). The literature and published statistics for the areas lack reliable, adequate and accurate information. Capture statistics are also questionable due to the large and dispersed nature of the small-scale fleet. In the whole division, among more than 32 landing sites, there are only 3 stations collecting fishing statistics. To address the issue of statistics, surveys have been conducted in the southern coast of Cameroon to reconstruct the catch statistics for the year 2020 and highlight the gap existing between data published by the Delegation of Ministry of Fisheries, Livestock and Animal Husbandry (DDEPIA/MINEPIA) at Kribi and those reconstructed. The general objective will be to illustrate sampling methods adaptable to developing countries with decentralized fishery management like Cameroon; to introduce knowledge related to the importance of fishery information; to introduce the basic concepts of statistical data analysis and to address practical questions and pertinent examples on data collection and statistical analysis of fisheries in Cameroon.

MATERIALS AND METHODS

Study area

From 1st April to 10th July 2021, a survey was conducted in the southern coast of Cameroon between 2°20'-3°20'N and 9o49'-10o02'E. The area was defined by the Cameroonian government as part of Ocean Division and to cover the entire southern zone of the coastline (Figure 1). The area represents about one-third of the Cameroonian EEZ and is exploitable by marine artisanal fisheries within the 3 nautical mile limit and within estuaries, which are banned to industrial vessels (MINEP, 2011; AQUADOC, 2021). The survey started at Camp Nigerian along the Ntem River, which is the boundary between Cameroon and Equatorial Guinea. The survey ended at Dikobe along the Nyong River, which is the boundary between Ocean Division and Sanaga Maritime Division.

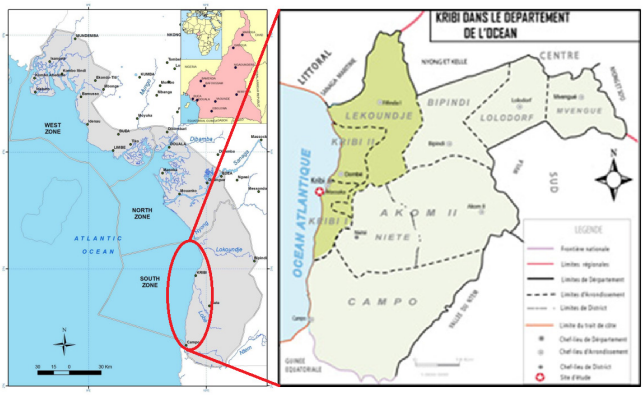

Figure 1. Limits of Cameroonian coastal and marine zones (MINEP, 2010).

Data collection

During our field survey of three months and 10 days, we divided the surveys among four districts, including Lokoundje (10 days), Kribi I (1 month), Kribi II (1 month) and Campo (1 month). We used different materials to collect data at the sites, including a GPS to locate the site, an electronic balance to weigh the landing species, a ruler to measure the total length of the species, a questionnaire to record information provided by the fishermen, a journal to record direct observations and useful information noted in the field, and a cellphone to film and record the interviews. We also used the 2020 annual report of the DDEPIA/MINEPIA to collect published annual statistics. In total, we investigated 32 landing sites including 1267 fishermen along the southern Cameroon coastline (Figure 2). The fishermen and boat owners were categorized into three types, including motorized, non-motorized and beach seine fishermen (Table 1). For each type of boat, the raw data collected from the questionnaires comprised the fishermen's year of experience, site name, approximated monthly Catch Per Unit Fishing Effort (CPUE) and monthly fishing effort.

Table 1. Type of canoes and the age of respondents in the Ocean Division.

Type of canoes	Frequency	Percentage (%)	Range of fishermen experience
	Mouse	Mouse	Mouse
(years)			
Motorized	709	55.96	3-45
Non-Motor-ized	542	42.78	3-55
Beach seine	16	1.26	9-27
Total	1 267	100	3-55

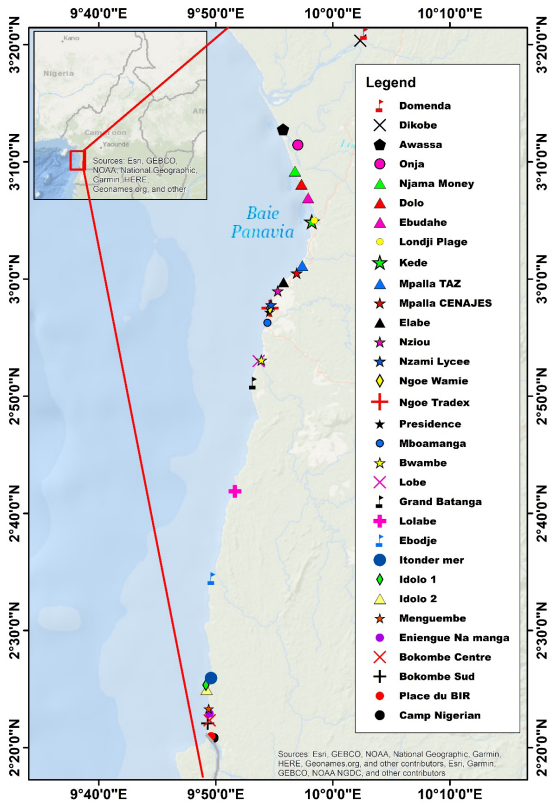

Figure 2. Distribution map of survey sites.

Data processing

In order to reconstruct the fisheries' data, the survey along the coast was divided into three strata including motorized, non-motorized and beach seine canoes. There was not a direct relationship between the type of boat and the fishing gear or fishing technique. Except for the artisanal purse seine (locally called "Washa"), which pertains to a specific type of motorized boat, the fishermen used fishing gear depending on the fishing ground and the types of fishes found in the field at a defined moment or period. Following the description of the guidelines for the collection of capture fishery data, CPUE and fishing effort were the variables collected to estimate the annual total catch of each boat (FAO, 1999). The following formula was used:

Total catch=CPUE × Fishing effort

• A trip of motorized canoes occurred each two or three days, as fishing effort depending on seasons. The fishmen used a combination of gillnet, artisanal purse seine, hook and line, and driftnet as fishing gear.

• A trip of non-motorized canoes occurred daily. The fishermen could fish up to 7 days a week, depending on the season. The fishermen used gillnet and hook and line as fishing gear.

• The number of hauls of beach seine per day between 6 am and 11 am was used as the fishing effort for beach seine canoes. The fishmen could fish from Monday to Sunday depending on the season. They used only beach seine as fishing gear.

After classifying the data per type of canoe (Table 1) and district (Table 2), we combined the data over different months in order to better represent its distribution.

Statistical approach and data analysis

After collecting data from the questionnaires, we computed it in Microsoft Excel in order to generate sheets (Table 3). All the raw data collected has been analyzed using simple statistical methods in Excel as follows:

• C_T: Total annual catch of Ocean Division;

• C_k: Total annual catch for each type of boat;

• C_1, C_2, C_3: Total annual catch of motorized, non-motorized and beach seine canoes, respectively;

• M_j, N_j, B_j: total monthly catch of motorized, non-motorized and beach seine canoes, respectively;

• $CPUE_i$: average catch per unit effort for each type of canoe;

• α, β, γ : monthly fishing effort of motorized, non-motorized and beach seine canoes, respectively.

Results

Reconstruction of the year 2020 catches statistics

During the survey along the southern Cameroon coastline, the investigated fishermen ranged between 3-55-years' experience in the field, with an average of 15 years. The canoes' size range was between 4-14 m long, with an average of 8.99 m long. Among the identified 32 main landing sites of motorized (55.96%), non-motorized (42.78%) and beach seine (1.26%) canoes, most are not registered in the official documents and are fishing without licenses. Identified sites and their fleets have been distributed into four districts in the Ocean Division, including 10 sites at Campo (31.25%), 6 sites at Kribi 1 (18.75%), 13 sites at Kribi 2 (40.63%) and 3 sites at Lokoundje (9.38%). The survey of 1267 fishermen conducted among all the landing sites permitted us to reconstruct the total annual catch of marine artisanal fishing at 10206.9627 tons. The motorized, non-motorized and beach seine catches represented 56.00%, 39.12% and 4.88% of the total catch, respectively (Figure 3). The Campo, Kribi 1, Kribi 2 and Lokoundje district catches represented 16.01%, 24.78%, 52.36% and 6.85% of the total catch, respectively (Figure 4). For the 32 landing sites, we found *Njama Money* (13.68%) as the highest site, followed by *Mboa-manga* (11.43%), *Londji Plage* (11.12%), Onja (8.23%), Awassa (5.48%), *Ebodje* (4.92%), Elabe (4.55%), Lobe (3.91%), Mpalla (Cenajes) (3.21%), *Itonder Mer* (2.79%), Grand Batanga (2.75%), Presidence (2.56%), Mpalla (TAZ) (2.54%), Bwambe (2.34%), Nzami Lycee (2.17%), Bokombe Nord (2%), Nziou (1.91%), Lolabe (1.79%), Ngoe Tradex (1.75%), Idolo 1 (1.63%), Kebe (1.53%), Bokombe Sud (1.32%), Dikobe (1.03%), Camp Nigerian (1.01%), Ngoe Wamie (0.99%), Eniengue Na Manga (0.82%), Idolo 2(0.69%), Meguembe (0.51%), Dolo (0.36%), Domenda (0.34%), Ebudahe (0.32%) and Place du BIR (0.31%) (Figure 5).

Monthly distribution of the catch statistics for the year 2020

Overall, based on the monthly distribution for the combined total catches, the trend was decreasing from January to July and increasing from August to December. The highest catch was observed in December, while the lowest catch was observed in July (Figure 6). During the survey along the southern Cameroon

Table 2. Landing sites per district in the Ocean Division.

District	Landing site	Total	%
Lokoundje	Awassa, Domenda et Dikobe	03	9.38
Kribi 2	Onja, Njama-Money, Dolo, Ebudahé, Londji plage, Kede, Mpalla (Taz), Mpalla (CENAJES), Ngoe-Tradex, Elabe, Nziou, Nzami Lycee, Ngoe-Wamie	13	40.63
Kribi 1	Présidence, Mboa-Manga, Bwambe, Lobe, Grand Batanga, Lolabe	06	18.75
Campo	Ebodje, Itonder mer, Idolo 1, Idolo2, Meguembe, Eniengue na manga, Bokombe Nord, Bokombe Sud, Place du BIR, Camp Nigérian.	10	31.25
Total		32	100

Table 3. Formulas computed in Excel software.

$$C_T = \sum_{k=1}^{p} C_k$$

Motorized	Non-motorized	Beach seine
$C_1 = \sum_{j=1}^{m} M_j$	$C_2 = \sum_{j=1}^{m} N_j$	$C_3 = \sum_{j=1}^{m} B_j$
$M_j = \sum_{i=1}^{n} \alpha CPUE_i$	$N_j = \sum_{i=1}^{n} \beta CPUE_i$	$B_j = \sum_{i=1}^{n} \gamma CPUE_i$

Note: C_T: Total annual catch of Ocean Division;
C_k: Total annual catch for each type of boat;
C_1, C_2, C_3: Total annual catch of motorized, non-motorized and beach seine canoes, respectively;
M_j, N_j, B_j: total monthly catch of motorized, non-motorized and beach seine canoes, respectively;
$CPUE_i$: average catch per unit effort for each type of canoe;
α , β , γ : monthly fishing effort of motorized, non-motorized and beach seine canoes, respectively

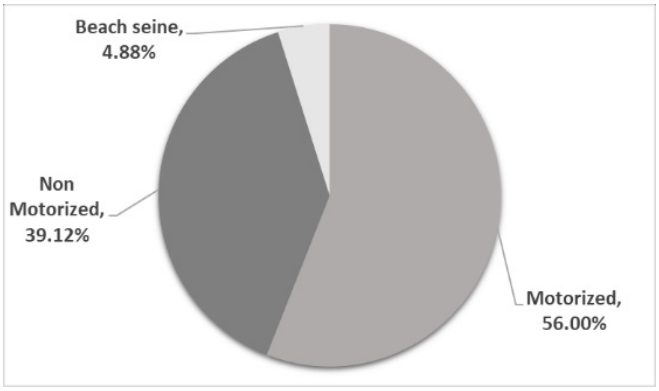

Figure 3. Distribution of 2020 total annual catch per type of canoe in the southern coast of Cameroon.

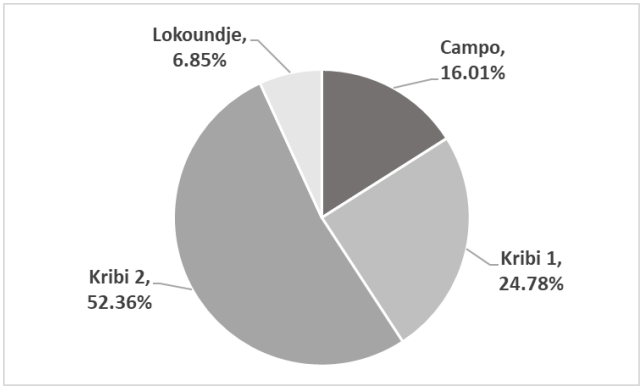

Figure 4. Distribution of 2020 total annual catch per district in the southern coast of Cameroon.

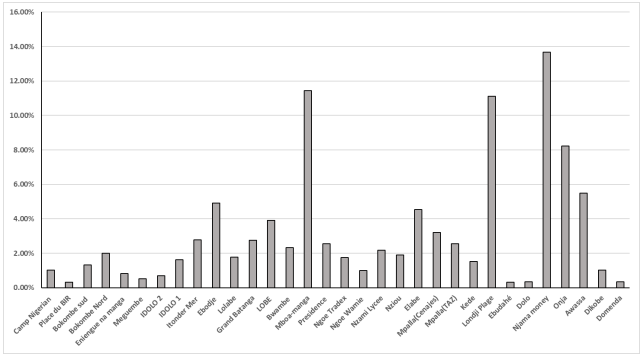

Figure 5. Distribution of annual total catch by landing site.

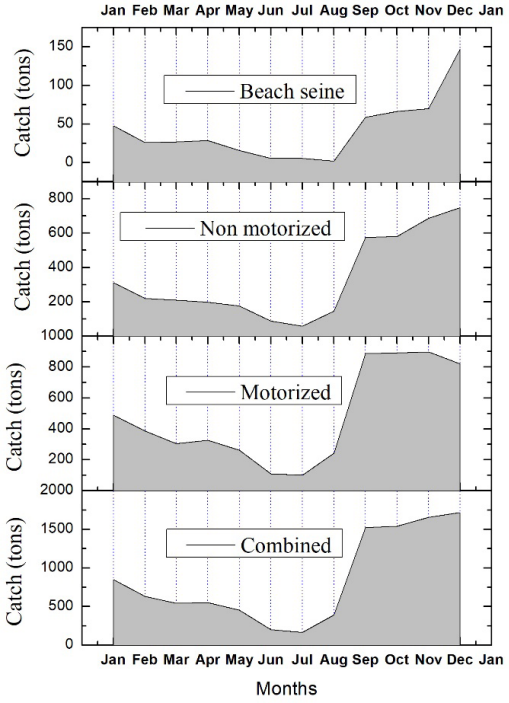

Figure 6. Monthly distribution of 2020 total annual catch of beach seine, non-motorized, motorized and combined canoes.

For the motorized canoes, the trend was decreasing from January to July, increasing from August to November, and observed a drop in December. The highest catch was observed in November, while the lowest was observed in July. For the non-motorized canoes, the trend was decreasing from January to July, and increasing from August to December. The highest month was December, while the lowest was July. For the beach seine canoes, the trend was decreasing from January to August, and increasing from September to December. The highest month was December, while the lowest month was August.

Highlight the gap existing between the data reconstructed and that published by MINEPIA/DDEPIA

From the 2020 annual report of the DDEPIA/MINEPIA, the DDEPIA at Kribi published a total annual catch of 420.46 tons, representing the statistics collected throughout the entire division in 2020. Based on our survey, the catch of 2020 was 10206.9627 tons. The gap between the two statistics was 9786.50273 tons, representing about 23.28 times the declared statistics. In the annual report, there is an absence of detailed statistics per month and district to help us compare the gaps. The statistics in the annual report are just vague estimations and extrapolations. The data of the National Institute of Statistics for the year 2020 is also not yet available online to compare the data.

Species and their size composition during the survey

We used the Fish base website to identify species at the 32 sites in order to highlight target species of marine artisanal fishing in the southern coast of Cameroon from 1st April to 10th July 2021. We have identified in total 37 species and 26 families including their local, scientific and family names, and randomly collected biological data including maximum and minimum total length and weight (Table 4). The marine artisanal fishing practiced in the southern coast of Cameroon takes place in a mixed fishery with pelagic species as the most abundant species during the survey. According to information recorded in the field (interviews and personal observations), the most captured family was *Clupeidae*, followed by the family of *Sciaenidae*.

Table 4. Type of identified species in the southern coast of Cameroon between March and July 2021.

N°	Local name	Common name	Scientific name	Family	Total length (cm) Min-Max	Total weight (kg) Min-Max
1	Sole	Soles	*Cynoglossus senegalensis*	Soleidae	11.2-50.2	0.1-0.45
2	Sole commune	Guinean tongue-sole	*Cynoglossus monodi*		14-23	0.35-0.48
3	Dorade rose	common seabream	*Pagrus africanus*	Sparidae	21-30	0.135-0.51
4	Bossu noir	Pink dentex	*Dentex gibbosus*		24-28.9	0.12-0.57
5	Bossu blanc	Morocco dentex	*Dentex maroccanus*		15-29	0.10-.0.58
6	Bar	Cassava croaker	*Pseudotolithus senegalensis*	Sciaenidae	29-70.5	0.45-3.45
7	Bar longue tête	Longneck croaker	*Pseudotolithus typus*		53-80	1.105-3.55
8	Ombrine	Canary drum	*Umbrina canariensis*		35-45	0.48-0.55
9	Disque blanc	African sicklefish	*Drepane africana*	Drepaneidae	19.9-42	0.27-0.7
10	Disque rose	Concertina fish	*Drepane longimana*		19.9-42	0.28-0.7
11	Disque noir	Spotted sicklefish	*Drepane punctata*		18-40	0.27-0.8
12	Machoiran	Bagrid catfish	*Chrysichthys nigrodigitatus*	Claroteidae	30.5-50	0.275-1.02
13	Carangue	Crevalle jack	*Caranx hippos*	Carangidae	15-35	0.1-0.5
14	Carpe rouge	African red snapper	*Lutjanus agennes*	Lutjanidae	19.9-70	0.81-7.8
15	Carpe rose	Gorean snapper	*Lutjanus goreensis*		18-70	0.78 -7.9
16	Carpe noir	Common carp	*Cyprinus carpio*	Cyprinidae	37.8-80	0.81-8.3
17	Maquereau de mer	West African Spanish mackerel	*Scomberomorus tritor*	Scombridae	30-80	0.5-4.53
18	Raie guitare	Blackchin guitarfish	*Glaucostegus cemiculus*	Glaucostegidae	50-250	0.45-35
19	Bonga	Bonga shad	*Ethmalosa fimbriata*	Clupeidae	20-21	0.08-0.10
20	Sardinelle	Round sardinella	*Sardinella aurita*		17-20	0.085-0.095
21	Brochet	Guachanche barracuda	*Sphyraena guachancho*	Sphyraenidae	40-130	0.77-12.2
22	Capitaine	Giant African threadfin	*Polydactylus quadrifilis*		30-110	0.35-6.8
23	Mulet	Flathead grey mullet	*Mugil cephalus*	Polynemidae	25-28	0.141-0.152
24	Congre	Guinean conger	*Paraconger notialis*		50-75	0.73-0.95
25	Poisson Ceinture	Largehead hairtail	*Trichiurus lepturus*	Mugilidae	50-70	0.58-0.74
26	Turbot	Flounder	*Syacium micrurum*		14-34	0.135-0.43
27	Requin blanc	Bull shark	*Carcharhinus leucas*	Congridae	25-110	0.245-8.5
28	Porc épic de mer	Spot-fin porcupinefish	*Diodon hystrix*		20-47	0.28-2.35
29	Dorade rouge	Seabream	*Pagrus caeruleostictus*	Trichiuridae	21-28	0.135-0.2
30	Dorade grise	Atlantic emperor	*Lethrinus atlanticus*	Lethrinidae	20-27	0.128-0.2
31	Calamar sèche	Veined squid	*Loligo forbesii*	Loliginidae	20-27	0.245-0.57
32	Poisson perroquet arc en ciel	Rainbow parrotfish	*Scarus guacamaia*	Scaridae	22-32	0.195-0.635
33	Poisson perroquet claire	Globehead parrotfish	*Scarus globiceps*		17-30	0.098-0.55
34	Barbillon	Goatfish	*Mullus argentinae*	Mullidae	14-35	0.028-0.55
35	Poisson volant	Flyingfish	*Exocoetus volitans*	Diodontidae	30-34.5	0.3-0.355
36	Mérou rouge	Bluespotted seabass	*Cephalopholis taeniops*	Sparidae	15-20	0.131-0.30
37	Mérou noire	Dogtooth grouper	*Epinephelus caninus*		15-24	0.112-0.32

DISCUSSION

Reconstruction of the year 2020 catches statistics

In small-scale fisheries, especially in Africa, the collection of fishery data through sample-based surveys should be an assumption used to estimate the annual catches from fish landings. The collection and analysis of fishery data and information is a costly and timely exercise and limited by budget and personnel constraints (De, et al. 2015). The problem of insufficient human and financial resources allocated for data collection has often resulted in poor-quality information, which has further led to the omission or limited use of statistics for fishery management and policy development. Our survey was able to reconstruct 10206.9627 tons of catch in the southern coastal zone of Cameroon, which represents about one-third of the coastline. At the regional and divisional levels of Cameroon, fishery statistics are just vague estimations and extrapolations which make it difficult to know the actual volume of fish

production (Belhabib, et al. 2015). At the national level, the annual production of fish was reported at 176.000 tons in 2015, and Cameroon was expected to reach an annual production of 290.000 tons of fish in 2020 (MINEPIA, 2011). Placing the remaining estimation of marine artisanal fishing production at 93.000 tons raises the doubt of data's credibility. However, the DSCE document's prediction that the national production of fish would reach 290.000 tons by 2020 was probably highly erroneous due to the fact that local statistics cannot be well collected or controlled (MINEPIA, 2013). This situation is not advantageous for fishery management strategies in Cameroon and bias the sustainable management of its resources. Reporting incorrect statistics goes against the code of conduct for responsible management of fisheries adopted by the FAO. Although the government of Cameroon has put in place strategies to increase production by funding industrial fishing, marine artisanal fishing, inland fishing and aquaculture; the main problem remains the lack of knowledge of existing landing sites and the number of fishermen actively involved in these activities.

Monthly distribution of the catch statistics for the year 2020

Overall, the total catches from the Ocean division show the trend of catches decreasing from January to July and increasing from August to December. The catch in December was the highest, and that in July was the lowest. Marine artisanal fishery is known to be dominated by immigrant fishermen (85%) mainly from Nigeria, Ghana and Benin (Djama, 1992; IDAF, 1993; Meke, et al. 2020). Cameroon's coastal catch is known by some authors to be influenced by three seasons, including a high catch season of about 6 months from September to February of the following year, a small or transitional catch season of about 2 months from March to April, and a low catch season of about 4 months from May to August (MINEPIA, 2009; Meke, et al. 2020).

According to other authors, the southern coastal catch at the Kribi Campo area is known to be influenced by four seasons, including a major rainy season from mid-August to November (3 and a half months), a major dry season from December to mid-March (3 and a half months), a minor rainy season from mid-March to June (3 and a half months) and a minor dry season from July to mid-August (MINEPIA, 2011).

Based on our findings combined with those of other authors such as (MINEPIA, 2009; MINEP, 2011) and (Meke, et al. 2020), three fishing seasons can also be well distinguished such as

• A high catch season of 5 months from August to December corresponding to the major rainy season and one month of the main dry season;

• A small or transitional season of 3 months from January to March corresponding to the main dry season and

• A low catch season of 4 months from April to July corresponding to the minor rainy and minor dry seasons.

During the high catch season of fish, locally called "*Evo'o*", the fishermen perform very well due to the high presence of fish, which increases the production in the coastal area. The fishermen perform with an average of 3, 6 and 6 outings per week for motorized, non-motorized and beach seine, respectively. During the small catch or transitional fishing season locally called "*Moyenne saison*", the production of fish decreased with the arrival of persistent sun. Despite the fact that the number of outings per week was the same as in the high catch season, the catches decreased due to the drop in the presence of fish and the increase in temperature in comparison to the major rainy season.

During the low catch season locally called "*Evounda*":

• With the small rains from April to May, the fishermen performed an average of 2, 5 and 4 outings per week for motorized, non-motorized and beach seine, respectively. The fish production decreased due to the continued drop in the presence of fish.

• With the increase in temperature during the minor dry season, the fishermen performed an average of 2, 4 and 3 outings per week for motorized, non-motorized and beach seine.

The fish production was not very considerable due to the drop in the number of fish as well as environmental conditions including temperature and the presence of high waves in the coastal area. The drop in motorized catches in December can be explained by the fact that the majority of immigrant fishermen from Nigeria, Ghana and Benin would go home to spend the new year with their families. Based on our personal investigations and contrary to the non-motorized and beach seine canoes dominated by native fishermen, this was a cultural habit of foreign fishermen that influenced the production by motorized canoes in December.

Highlight the gap existing between the reconstructed data and that published by MINEPIA/DDEPIA

Using low-cost sampling methods for artisanal fishing, which can provide a high degree of accuracy to improve data estimation, is beneficial to developing countries. In developing countries such as Cameroon, the gaps observed in marine artisanal fishing between published statistics and those reconstructed are mostly due to:

• The poverty of landing sites and villages along the coastline, which are under-equipped and have outdated infrastructure.

• The inadequacies of the production tools and a narrow trade market.

• The absence of transportation facilities and stations for both fishermen and authorities in charge of data collection.

• The lack of monitoring and data collection systems for fisheries.

• The absence of adequate law enforcement assets.

The data processing location of these wide landing sites should be located in the coastal cities, where data can be well managed. In the Ocean division there are several sites that provide better statistics, such as *Mboa-Manga* (Kribi 1), *Londji Plage* (Lokoundje) and *Njama Money* (Kribi 2), due to their proximity to a downtown area and bigger markets. Other sites are very difficult to access, especially during the rainy season due to the condition of the roads. The huge gap identified in

our study can also be explained by the presence of only three institutional stations to collect fishery data along the southern coast of Cameroon, including *Ebodje* (Campo sub-division), *Mboa-Manga* (Kribi 1 sub-division) and *Londji Plage* (Kribi 2 sub-division). Our study also showed the gap in data collection sites among the 32 sites. The distribution of sites could be divided into the sub-divisions:

• Among the 6 identified landing sites in Campo district, only *Ebodje* and Camp Nigerian constantly collected data due to the high concentration of smoked and dried fish markets and of commercial exchange between Cameroon and Equatorial Guinea on the Ntem river.

• Among the 10 sites in Kribi 1, only *Mboa-Manga* site constantly collected data due to its adapted landing infrastructure and the presence of a management committee in charge called CECOPAK (Centre Communautaire de Pêche Artisanale de Kribi).

• Among the 13 sites in Kribi 1, only Londji site collected data due to the presence of a high concentration of canoes, a big market of fresh and smoked fish, and a training center for marine artisanal fishermen put in place by the MINEPIA.

• Among the 3 sites in Lokoundje, there was not a single data collection site due to the difficult access to Awassa (only by boat) and to the 2 big markets at Domenda and Dikobe.

Species and their size compositions during the survey

Among the declared 557 species in Cameroon's marine and coastal water, we have identified 37 species from 1st April to 10th July 2021 (Ayissi, et al. 2011; MINEPDED, 2012). While some authors have identified 11 major fish families, we have identified 26 families based on the local names (Krakstad, et al. 2006). Other authors have reported more than 21 family species commonly caught along Cameroon's coastline from Campo to Bakassi (Ayissi, et al. 2014; Meke, et al. 2020). The authors have also reported *Clupeidae* and *Sciaenidae* as the main catches on Cameroon's coast. Compared to their research citation, only the Ariidae family was absent from our data due to the fact that the identified species was limited during the survey period. The Ariidae species may be present in the southern coast of Cameroon, but this survey would need to be extended for the whole year to have a clear idea about it. Among the list of the 37 identified species, some have been documented as either vulnerable, endangered, near threatened, critically endangered or data deficient in Cameroon, including *Carcharhinus leucas, Epinephelus Caninus and Cephalopholis taeniops* (Vivien, 1991; Wells, et al 1995; Chiambeng, 2006; MINEP, 2011). Because it is commonly known that in African developing countries, such as Cameroon, few initiatives have been taken to protect fish species, some actions should be taken by the government and NGOs to protect identified species as vulnerable and endangered in the coastal waters.

Suggestions and further research

It is known that the marine artisanal fishery sector in Cameroon is dominated by immigrants from other African countries (Djama, 1992; Belhabib, et al. 2015; Meke, et al. 2020). They are a limitation to the development of data collection systems due to culture barriers, and consequently a limitation to the coherent management of the sector. To improve the data collection and statistical estimations of marine artisanal fishery in Cameroon, we recommend:

• To put in place a more comprehensive data collection system.

• To conduct surveys along the entire coastline and update the actual number of fishermen.

• To build more infrastructure to access fishing villages, landing sites and markets.

• To encourage fishermen to be grouped in associations.

• To fund more artisanal fishermen in their activities.

• To train and familiarize the fishing community with the FAO code of conduct for responsible fisheries.

• To add a number of stations and reinforce the capability of human resources to collect data.

• To reinforce the application of the decree no09/MTPT of 08 June 1968 on the matriculation of motorized and non-motorized canoes or similar canoes.

Concerning the limitations of our research along the coastline, some areas lack details on the number of fishermen, fleets and catches. We could not access the pygmy landing sites (locally called Bagyeli) between Lolabe and *Ebodje* due to the absence of transport facilities and their primitive behaviors (traditionally migrant people). The research also missed some fishermen between *Ebodje* and *Itonder Mer* due to the poor road network infrastructure in the area. There are not landing sites between Lolabe and Grang Batanga due to the presence of the infrastructure of the deep-sea Port Authority of Kribi (PAK).

Concerning further research, repeatedly studying the status and trends of capture fisheries and integrating socio-economic dynamics of fishing communities into future surveys will be essential in assessing the impacts of resource statuses and improving the planification of the fisheries' monitoring systems, sustainable capture and environmental protection. The study of species identification in the Ocean division should be extended to the whole year, as well as the biological and capture data of dominant species in the field.

CONCLUSION

In this study, we investigated the catch statistics from artisanal marine fishing in the southern coast of Cameroon. The survey of 1267 fishermen among 32 landing sites along the southern coast of Cameroon permitted us to reconstruct the catch statistics of the year 2020 based on canoes with different motor systems. This study showed:

• A reconstructed catch statistic of 10206.9627 tons and a gap of 9786.50273 tons with the 2020 annual report of DDEPIA/MINEPIA.

• Three fishing seasons (high, medium and low) with an increasing catch from August to December and a decreasing catch from January to July.

• 37 species including 26 families were identified with *Clupeidae* and Scianidae as the dominant catches from 1st April to 10th July 2021 in the southern coast of Cameroon.

To improve the data collection and statistical estimation of marine artisanal fishery in Cameroon, we recommend:

• To put in place a more comprehensive data collection system,

• To conduct surveys along the entire coastline and update the actual number of fishermen;

• To build more infrastructure to access fishing villages, landing sites and markets;

• To encourage fishermen to be grouped in associations;

• To fund more artisanal fishermen in their activities;

• To train and familiarize the fishing community with the FAO code of conduct for responsible fisheries;

• To add a number of stations and reinforce the capability of human resources to collect data; and

• To reinforce the application of the decree no 09/MTPT of 08 June 1968 on the matriculation of motorized and non-motorized canoes or similar canoes.

We also recommend for further studies:

• To repeat the study of the status and trends of capture fisheries, integrating socio-economic dynamics of fishing communities and

• To extend the study of species identification in the Ocean division to the whole year, as well as the biological and capture data of dominant species in the field.

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