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## Analysis of the fishing effort and catches of fish in the Bandama River

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### Abstract

Fishing effort and catches were led in three localities of the lower Bandama from July 2013 to June 2014. Tiassalé with 6675 outputs and 40.84% of the catch was the high production area. The highest catches are obtained in March, April and May while the lower catches are recorded in October and June. At Singrobo, fishing effort is estimated at 5942 outputs providing 31.70% of catches. In this area, two catches peaks are noted in December and April, but in October and January, these catches are very low. At N'zianouan, 5360 outputs were recorded for 27.46% of the total catch. However in this locality, the catch peaks are observed in March and May while the lower catch are noted in July and September. The fishing effort in these three localities generally progress in the similar way to the catches. The month with the highest catch has not absolutely the highest effort in these three areas. There is a significant correlation at  $p < 0.05$  between these two variables at on three sites. The conical fishing baskets are the most used devices in the lower Bandama River. They contribute to 57,11% of the total catch of the lower Bandama river.

**Keywords:** Catch composition, Fishing gears, Bandama River, Côte d'Ivoire

### 1. Introduction

The fisheries sector in Ivory Coast, includes continental, lagoon and sea fishing. The continental fishing, artisanal especially, is practiced on the watersheds of rivers, streams and hydroelectric, hydro-agricultural and agropastoral reservoirs [1-5]. However, this activity presents some potential for growth and provides opportunities and income [6].

Indeed, indigenous peoples of the rivers are traditionally farmers. And falling prices of coffee and cocoa in the 1990s has led people to permanently integrate fishing in their daily habit [7]. But, with the arrival of foreign fishermen on the Bandama River, this activity became more commercial in nature and practice all year [8]. This passion for fishing contrast to the absence of reliable data on fishing effort and catches of these fish in the fishery statistics in these rivers. This study introduces a series of publication on the exploitation of these fish in order to increase knowledge about fishing in the Bandama River. It aims to estimate fishing effort and catches and analyze their monthly changes on the Bandama River.

### 2. Materials and Methods

#### 2.1. Study area

The study was carried out on Bandama river in downstream of Taboo lake (6 °00' - 6 °20' N and 4°90' - 5°00' W) characterized by a substrate made of boulders, sand and gravel [8].

This study was led in three areas (figure 1). The first, Tiassalé is located at 5°53N and 53°49 W where three wharves were visited. Then, N'Zianouan where one wharf has visited is located between 6 °00 N and 4 °49 W and the last, Singrobo located at 6 °05 N and 4°55 W present also one wharf.

#### 2.2. Estimation of fishing effort and catches

##### 2.2.1. Investigation of unloadings

The surveys were conducted with all fishermen identified in Tiassalé, N'zianouan and Singrobo. In each locality, the investigation of the boats was made at random.

Every day, the moment that the fishermen come back, the following informations on fishing gears (gillnets, conical fishing baskets, bottom lines and castnets, etc.), number of gears and mesh are collected by investigators of different stations (two investigators per station) and for

Each unloading, the weight of the catch by gear and the total weight of the catches were recorded.

**2.2.2. Estimation of fishing effort**

Fishing effort considered in this study, is all daily fishing trips for all gears used in catching fish. So, from the data collected daily by field investigators, the number of fishing trips per month for each type of fishing gear was calculated in each area.

These data were used to estimate the fishing effort by gear. And for each zone, the summation of fishing efforts for each gear gave the monthly and annual fishing effort.

The activity rate (Ta) was also calculated as the ratio of the number of days used for fishing (Nu) on the number of potential fishing days (Np).

$$Ta = (Nu / Np) \times 100$$

**2.2.3. Utilization rate of fishing gears**

Utilization rates of the main fishing gear (Tu) was calculated in this study. This is the number of fishing trips using a given type of gear, (NEP), relative to the total outputs in the year (Npt).

$$Tu = (Npe / Npt) \times 100$$

Gears are considered in this study, gillnets, conical fishing baskets, bottom lines, castnets and harpoons.

**2.2.4. Total catch and yield per gear**

For each fishing gear, the monthly catch by area (in kg) were calculated by summing the daily catches made during the month in consideration.

The summation of the monthly quantities allowed to calculate the total annual quantity of fishes caught by the fishermen in those areas.

The performance of different gears was calculated by taking the ratio of the total catch of the gear on the total catch of all gears considered

$$Ri = (Pi / Pt) \times 100$$

With:

Ri = Yield of gear i,

Pi = Total catch of the gear i,

Pt = Total catch all gear considered.

**2.3. Statistical analysis**

The test of khi-deux was used to compare the averages of activities per site. The statistical significance was set at 5%. STATISTICA Version 7.1 software was used for this purpose.

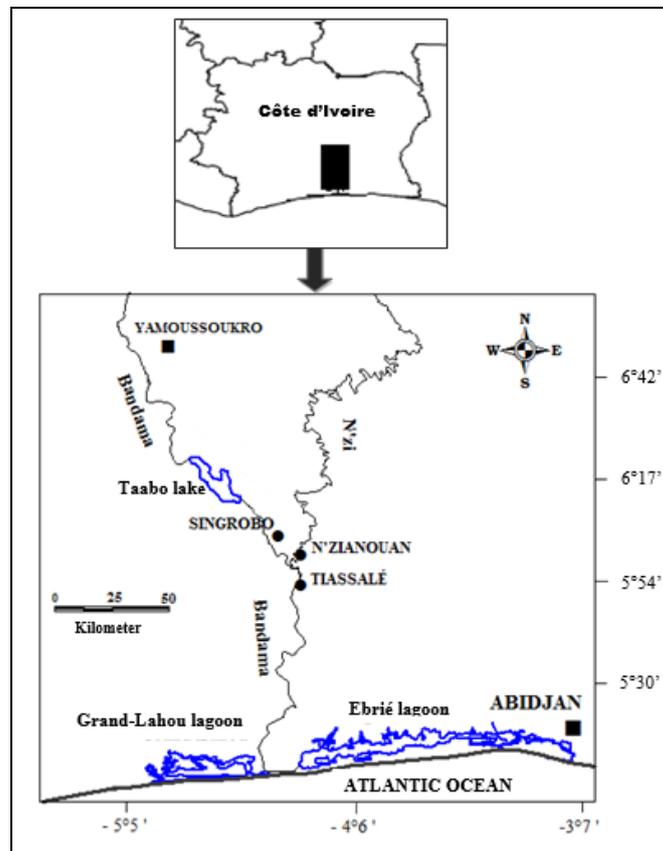


Fig 1: Map of study area indicating the sampled and investigation sites localitie

**3. Results**

**3.1. Fishing activity rate**

Table I shows the monthly variation of the activity rate calculated in the different sampling sites.

The highest rates in all localities are recorded all year, except for September and January where we noted 24 to 27 days of fishing.

Regarding Tiassalé, the lowest activity rates was noted in September with 25 days of fishing for a maximum rate of 31 days in July, March and May. In this locality, 352 days of the

year were used for fishing with an average of 29 days per months.

At Singrobo, the lowest rate was observed in January (26 days) and the highest in July, March and May (31 days each). The average rate was 29 days per month to an annual rate of 350 days.

In N'Zianouan area, the lowest values were obtained in September (24 days of fishing) and the highest in July, March and May (31 days each). The monthly average is 29 days per month for an annual total of 351 days.

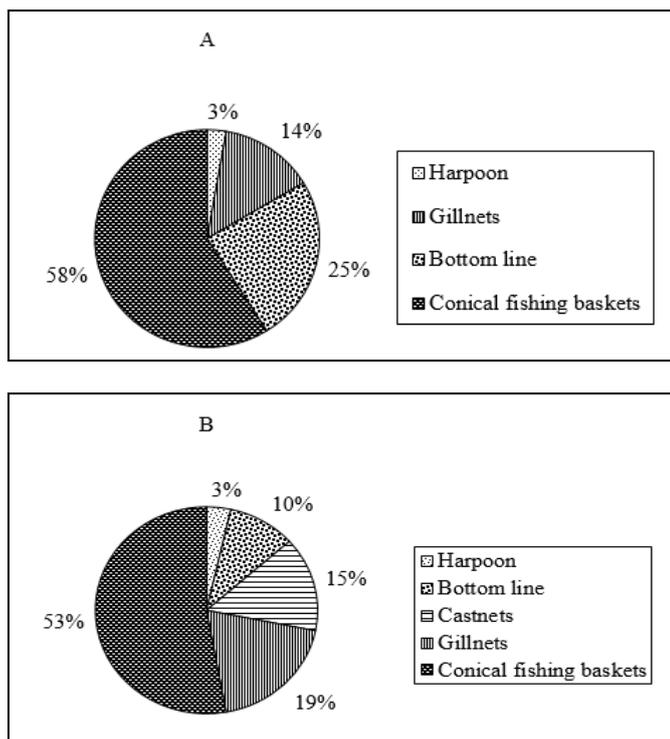
### 3.2. Rate of use of fishing gear.

Fishing gear are composed of gillnets, conical fishing baskets, bottom lines, castnets and harpoon. The conical fishing baskets are the most gear used in the study area (54% of outputs). On the whole of the study area, figure 2 shows that Ivorians preferentially use conical fishing baskets (58% of fishing trips) and bottom lines (25% of fishing trips). They do not use

castnets. Foreigners also prefer conical fishing baskets (53% of fishing trips) then gillnets (19% of fishing trips) and the castnets (15% of fishing trips). At Tiassalé, N'Zianouan and Singrobo, conical fishing basket outputs are the highest with respectively 50%, 54% and 65%. While, the gillnets come in second position with 19% in the two first localities and 15% at Singrobo.

**Table 1:** Variation in fishing activity rate in the localities of Tiassalé, Singrobo and N'Zianouan on the Bandama River.

Months	Jul-13	Au-13	sept-13	oct-13	nov-13	Dec-13	Jan-14	Feb-14	marc-14	apr-14	may-14	Jun-14
Tiassalé	31	30	25	28	30	29	29	28	31	30	31	30
Singrobo	31	29	27	30	28	30	26	27	31	30	31	30
N'Zianouan	31	27	24	30	30	29	30	28	31	30	31	30



**Fig 2:** Use rate of the main fishing gears by the Ivorians (A) and foreign (B) on the lower Bandama River from July 2013 to June 2014.

### 3.3. Fishing effort and total catch

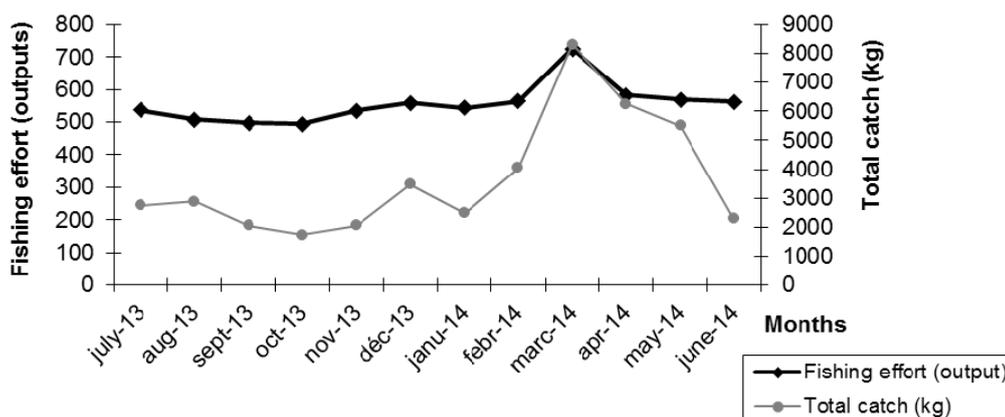
Figure 3 shows the evolution of fishing effort and the total production of Tiassalé, Singrobo and N'Zianouan. The total catch estimated from the study area from July 2013 to June 2014 is 107434.73 kg. The maximum catch (17680.11 kg) was obtained in March and the minimum (4562.69 kg) in October with an average of 8952.89±3879.46 kg per month. This capture is distributed as follows according to localities:

43879.19 kg to Tiassalé (40.84% of the catches) with a monthly average of 3656.60±2033.35 kg; 34053.3 kg at Singrobo (31.70%) for a monthly average equal to 2837.78±1007.64 kg; N'Zianouan to 29502.24 kg (27.46%) with an average of 2458.52±1130.95 kg per month. There is a significant difference according to monthly average weight among Tiassalé and Singrobo ( $\chi^2=500,57; p<0,05$ ), Tiassalé and N'Zianouan ( $\chi^2=892,05; p<0,05$ ), Singrobo and N'Zianouan ( $\chi^2 = 58,40; p<0,05$ ) (Table II).

Fishing effort obtained in the study area from July 2013 to June 2014 is 17977 fishing trips. The number of output is higher in March (1848) and lowest in September (1197) to a monthly average of 1498.08 ± 189.12 fishing trips. Fishing effort varies from one site to another.

At Tiassalé, 6675 fishing trips were done with a monthly average of 557±60 fishing trips. In the Singrobo locality, the 5942 fishing trips of fishing effort has been noted with an average of 496±79 fishing trips per month. N'Zianouan landings totaled 5360 fishing trips to a monthly average of 447 ± 93.67 fishing trips. The average fishing effort is significantly different among Tiassalé and Singrobo ( $\chi^2 = 8, 89; p<0,05$ ), Tiassalé and N'zianouan ( $\chi^2=20,57; p<0,05$ ). The difference is not significant among Singrobo and N'zianouan ( $\chi^2=2,43; p>0,05$ ) (Table II).

The variation of the total catches in Tiassalé shows a maximum value of 8323 kg in March against the lowest in October (1738.88 kg). Regarding Singrobo, production increase saw tooth with two peaks, the most important in December (4714.09 kg) and the lower in April (3992.34 kg). At N'Zianouan, the production is highest in March (5381.88 kg) and lowest in September (1193.4 kg). The curve of the catches and the fishing effort in these three localities generally increase similarly. The peaks of high and low catch coincide with those of the fishing effort, except the months of May and June.



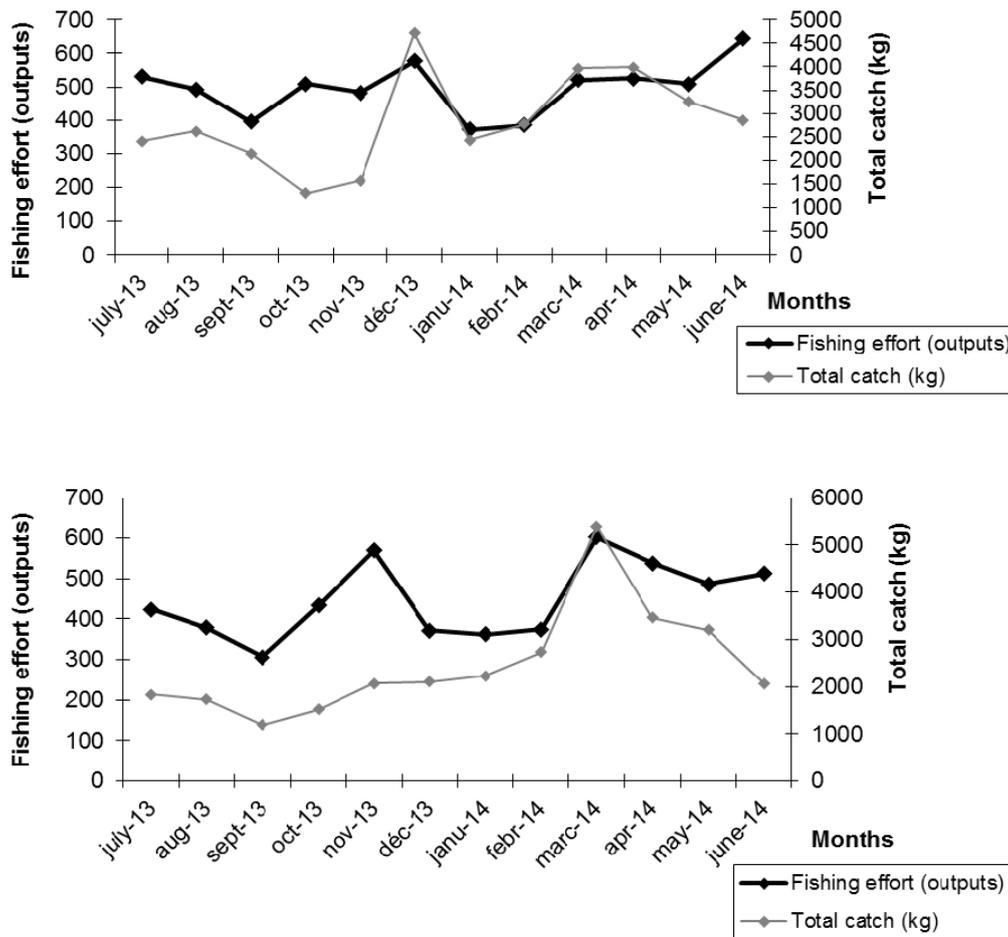


Fig 2: Evolution of the total catch, depending on the fishing effort at Tiassalé (A), Singrobo (B) and N'Zianouan (C) on the lower Bandama river

Table 2: Chi-square ( $\chi^2$ ) test applied to the average values of fishing effort and total catch recorded from July 2013 to June 2014 on the lower Bandama River. \* significant difference ( $p < 0,05$ ).

Localities	Average Fishing effort	$\chi^2$	Average Total catch	$\chi^2$
Tiassalé	557±60,39	8,892*	3656,60±2033,35	500,58*
Singrobo	496±79,81		2837,78±1007,64	
Tiassalé	557±60,39	20,574*	3656,60±2033,35	892,05*
N'Zianouan	447±93,67		2458,52±1130,95	
Singrobo	496±79,81	2,438	2837,78±1007,64	58,4*
N'Zianouan	447±93,67		2458,52±1130,95	

Also, the month with the highest capture has absolutely the highest fishing effort in all three zones. The Spearman test applied to these two variables showed a significant correlation ( $p < 0.05$ ) at the three sites.

**3.4. Performance by gear**

The yields of different gears in the study area varied from one gear to another. Over the whole of the study area, the conical fishing baskets are the best performing gear with 60.29% of the total catch. Then follow gillnets respectively (26.45% of catches), castnets (8.38% of catches) and bottom lines (2.51% of catches). The harpoon gives 2.37% of the total catches. At Tiassalé, conical fishing baskets contribute to 60.81% of fish catches. Then come gillnets (21.95%) and castnets (10.89%). The harpoon (3.47%) and bottom lines (2.88%) weakly involved in the quantity of fish caught in that locality. Percentages calculated Singrobo traps show that conical fishing baskets (65.24% of catches) and gillnets (29.37%) have the highest yields. castnets (2.44% of catches), bottom lines

(2.05%) and the harpoons (0.9%) of the catches have the lowest yields.

At N'Zianouan, the conical fishing baskets with 54.23% of catches remain the gear that contribute most to the total catch of fish. Gillnets follow with 31.22% of catches. The yield of the castnets (11.53%) is higher than that of bottom lines (3.02%).

**4. Discussion**

Fishing activity on the Bandama River is practiced throughout the year without interruption.

Our results show a significantly positive correlation between fishing effort and total catches. The distribution of fishing effort and the total catch by area, indicate that the Tiassalé station was at the top of the landing sites, with an annual production estimated at 43879.19 kg for 6675 fishing trips. The higher production of this town would be linked to three factors: the number of fishing trips carried on this site, the number of fishermen and fishing site in this locality, the

presence of several markets to sell the product. Our results confirm those of <sup>[9]</sup> on Ayamé I and Buyo lakes and <sup>[10]</sup> about fishing of Mugilidae on Grand Lahou lagoon.

In general, the largest catches were obtained between December and May and the lowest from September to November.

However, the combination of catch per unit effort and catch per unit area would help to better understand the dynamic of exploited ecosystems.

According to <sup>[11]</sup>, the catch per unit effort by weight is a good indicator of exploitation of aquatic water. For continental aquatic environments submitted to significant exploitation, PUE decrease during the flood and gradually increase during the recession with a maximum in low water <sup>[4]</sup>. Our results are in agreement with this assertion because, the highest catch per unit effort values were obtained in dry season with the low water level and the lowest catch per unit effort values were obtained with the increasing of water level. This situation could be attributed to hydrological variations of Taabo Lake localized in upstream of study area. Moreover, the decrease of the catches could be due, according to <sup>[12]</sup>, to the abandon of the fishing by native fishermen during the rainy season for fear of drowning and/or in aid of agriculture. However in dry season, with the low level of water course and the lesser opening of hydroelectric dam, the fish become more accessible and vulnerable to the fishing gears, which lead to high catch. <sup>[12]</sup> And <sup>[4]</sup> saw the same result on Ayamé I and Buyo lakes.

## 5. Conclusion

This study allowed to note that fishing activity is led every day and all year. The conical fishing baskets are the gears the most used and produce nearly half of the total production of the lower Bandama River. These are 17977 fishing trips for 107434.73 kg of fish caught which were collected during the study year.

This study showed that Tiassalé zone present the highest fishing effort and catch. The influence of the opening and closing of hydroelectric dam in this part of Bandama River caused saw tooth evolution of fishing activity.

## 6. Acknowledgments

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