OPEN ACCESS

Haya: The Saudi Journal of Life Sciences
Abbreviated Key Title: Haya Saudi J Life Sci
ISSN 2415-623X (Print) | ISSN 2415-6221 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Fish Fauna Production in the Bandama River at the Lamto Scientific Reserve (Côte d'Ivoire)

Yedehi Euphrasie Adou[1]*, Kassi Georges Blahoua[2], Souleymane Konate[1], Seydou Tiho[1], Sébastien Barot[3]

[1]Research Unit on Ecology and Biodiversity, Laboratory of Ecology and Sustainable Development, Nangui Abrogoua University, Abidjan, 02 P.O. Box 801 Abidjan 02, Côte d'Ivoire
[2]Research Unit on Hydrobiology, Laboratory of Natural Environments and Biodiversity Conservation, Félix Houphouët-Boigny University, Abidjan, 22 P.O. Box 582 Abidjan 22, Côte d'Ivoire
[3]Sorbonne University, UMR 7618 IEES-Paris (IRD, CNRS, Paris Diderot University, UPEC, INRA)

DOI: https://doi.org/10.36348/sjls.2025.v10i04.003 | **Received:** 14.02.2025 | **Accepted:** 22.03.2025 | **Published:** 04.04.2025

***Corresponding author:** Yedehi Euphrasie Adou
Research Unit on Ecology and Biodiversity, Laboratory of Ecology and Sustainable Development, Nangui Abrogoua University, Abidjan, 02 P.O. Box 801 Abidjan 02, Côte d'Ivoire

Abstract

The increasing intensification of the exploitation of fishery resources in Africa in general and in Côte d'Ivoire in particular, associated with the processes of degradation of the natural environment, pose real risks of regression, disappearance of species and reduction of fish production. So, knowledge of fishing parameters is very important in the strategy implemented by managers of this sector on Ivorian rivers and bodies of water. Thus, the composition of catches, fishing effort and fishing gear production were studied in the Bandama River from July 2023 to June 2024. The data was collected by experimental fishing with gillnets and traps to which fishing data were added artisanal fishing carried out during the sampling days. A total of 41 species belonging to 5 orders and 13 families of fish with a biomass of 18896 kg were identified. Siluriformes (44%) and Perciformes (26%) were dominant. The highest fishing efforts and CPUEs were obtained with gillnets and papolo traps. The values were maximum in the rainy season. Annual production was 7285.74 Kg for the gillnets and 5066.53 Kg for the papolo traps. The results of this study revealed that fish from the Bandama River at Lamto are overexploited. This constitutes a basic element for decision-making in the quest for a protection and conservation strategy of the fishing resources of this protected area in Côte d'Ivoire.

Keywords: Fish, Production, Fishing gear, Lamto.

INTRODUCTION

In aquatic ecosystems, fish are the best known organisms because of their size, their abundance and especially their economic importance (Karr, 1981). Thus, knowledge of the fish fauna of African courses and bodies of water is of concern to both scientists and development officials because the growing intensification of the fishery exploitation resources in the continental environment in Africa associated with processes of degradation of the natural environment pose real risks of regression, disappearance of species and reduction in fish production (Lalèyè *et al.*, 2004). Therefore, Monchowui *et al.*, (2008) propose conservation and rational management measures for fish stocks. These measures take into account the ecology, composition and the exploitation level of fish fauna of the water. Thus, it's well known that a conservation measure for fish fauna necessarily requires good knowledge of fish species, the indices that characterize their distribution (Wu *et al.*, 2011; Kamelan *et al.*, 2013; Adou *et al.*, 2023) and their level of exploitation (Kantoussan, 2007). The lack of information on these different aspects constitutes a disability in the development and implementation of development and management plans for the fish fauna protection. In Côte d'Ivoire, studies relating to the characteristics of fishing production have focused mainly on the species composition, the total catch and the catch per unit effort (PUE) (Albaret and Laë, 2003).

Several studies on the assessment on the fish exploitation level in Ivorian rivers and water bodies have been carried out (Da Costa *et al.*, 1998; Tah *et al.*, 2009; Coulibaly *et al.*, 2017; Cissé *et al.*, 2019; Kien *et al.*, 2021; Bédia *et al.*, 2021). Among these studies conducted, there is no information regarding fish production from the Bandama river at the Lamto nature reserve. However, this part of the river, which is supposed to be a protected area, is subject to illegal fishing activities by local populations, which activities result in the loss of biodiversity and the reduction of fish stocks in this hydro system. It is therefore appropriate to know the existing fish stocks in this area for sustainable management of this resource.

This study aimed to evaluate the ichthyological production community of the Bandama river in the Lamto zone by characterizing the gears fishing effort and catch per unit effort of gears.

MATERIAL AND METHODS

1-Sampling area and period

The Bandama river basin is entirely located in Côte d'Ivoire. It has its source in the north of Côte d'Ivoire at an altitude of 480 m between the towns of Korhogo and Boundiali. The main bed of the Bandama basin is 1050 km long and occupies an area of 97,500 km2 (Lévêque *et al*., 1983; Traoré, 1996). Due to its North-South orientation, it therefore covers different zones in terms of climate and biogeography. This study was carried out on the Bandama river which surrounds the Lamto scientific reserve (6°9" - 6°15"N and 5°0' - 5°02' W) from July 2023 to June 2024 (Fig 1). This reserve is located in the central part of Côte d'Ivoire (West Africa), at the tip of the "V Baoulé" between the Guinean savannah and the semi-deciduous forest and has an area of 2500 hectares. The gallery forest which is located along the Bandama River represents the natural limit of this reserve. The study area benefits from four seasons including a long rainy season (April to July), a short dry season (August), a short rainy season (September to October) and a long dry season (November to February). Three stations were defined, namely the first Loumbossou (LB) considered as the upstream of the backwater of the river, then the second Yoboué station (YB) which is halfway and the last Gbahan (GB) downstream of the study area.

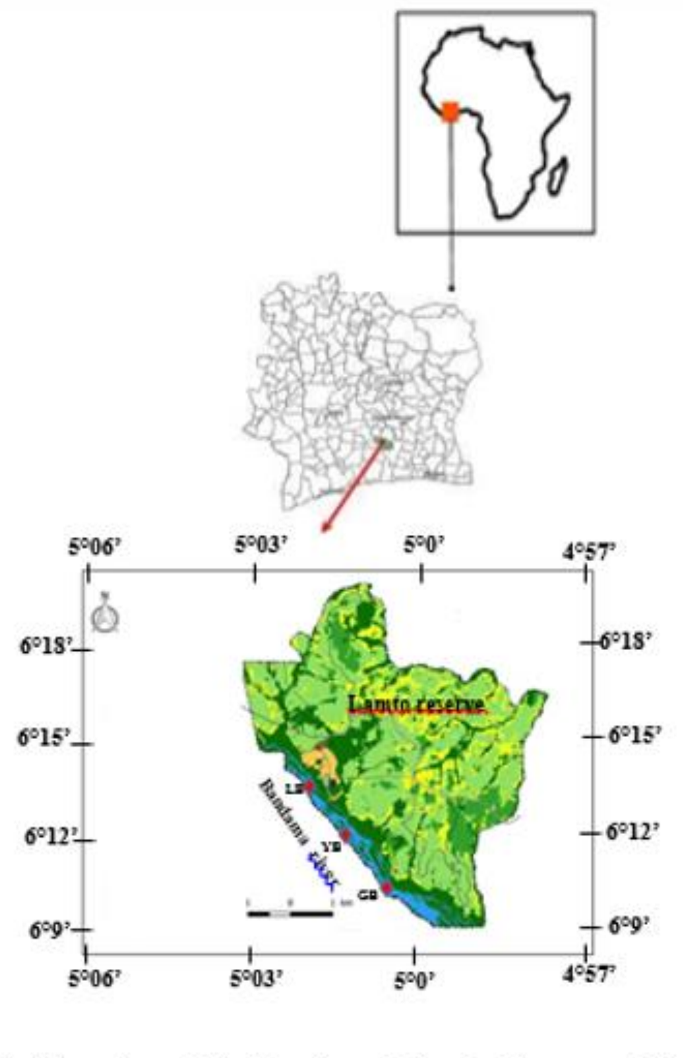

Fig. 1. Geographical location of the Bandama River in Lamto and the sampling sites

2-Data collection

Data from artisanal and experimental fisheries were compiled to determine the diversity and fish production exploited from July 2023 to June 2024.

2-1-Sampling of fish

Ichthyofauna sampling was done monthly in the three stations with gillnets and traps. The fish were identified using the identification keys from Paugy *et al*., (2003a, b). They were weighed individually with a Kitcen Scale brand electronic scale with a precision of 1 g and counted.

2-2-Survey on the activity of fishermen

For data collection, daily monitoring of fishing activities and a repeated survey of fishermen and their fishing techniques were carried out in the three chosen stations. During these different missions, the daily catches of the fishermen were examined. The fishermen are chosen at random and for each landing. The following information's were recorded : Departure date of and return from fishing; Gear type used; Mass and number of individuals per species; Total mass of the socket and Specific composition of the catch. The fish identification and their classification into ecological units were carried out according to the key defined by Paugy *et al*., (2003a, b). The last part was devoted to direct observations in the field to verify the information collected from the actors. These surveys made it possible to determine fishing efforts.

1-3-Data analysis

Collected data allowed to calculate the numerical and weight abundances. Numerical and weight abundances were used to compare the dominance of fish orders, families and species in the catches.

The numerical (%N) or weight (%P) abundances in this study were calculated by taking the ratio of the number of individuals (n) or the mass of individuals (p) of a taxonomic group (order or family) to the total number of individuals (Nt) or the total mass of individuals (Pt) multiplied by one hundred.

$N = (n/Nt) \times 100$

$P = (p/Pt) \times 100$

The fishing effort considered in this study is the total daily fishing trips for all gears effectively involved in catching fish. Fishing effort by gear type was then evaluated per month and per station. Total monthly catches per unit effort (CPUE) were estimated using the following formula:

CPUE = Total catch /Total effort (Kitheka *et al*., 2011)

For each fishing gear, the monthly catches (Ci) in kg were calculated by the sum of the daily catches taken during month i.

The summation of the monthly quantities made it possible to calculate the total annual quantity (Ca) of fish caught per each gear and the fishermen. The total quantity was obtained by the following formula:

$Ca = \sum Ci$

1-4-Statistical analysis

Data analysis was carried out using Excel spreadsheet. The Kruskal Wallis and Mann Whitney tests were used to compare differences in CPUE between sampling stations and gear types. Statistical analyzes were carried out at the 5% significance level using STATISTICA version 7.1 software.

RESULTS

1-Composition of exploited fauna

The fish captured belong to 5 orders, 13 families and 41 species (Table 1). The dominant orders were Siluriformes (44%) and Perciformes (26%). The population was dominated by the families Claroteidae (59.13%) with the species *Chrysichthys nigrodigitatus*. They were followed by families Cichlidae (22.05%) with the Hybrid species (*Coptodon zillii* x *C. guineensis*) and *Oreochromis niloticus* and Mochokidae (6.82%) was represented by *Synodontis punctifer*.

The monthly distribution of fish species captured is recorded in Table (2). The highest number of fish species (25) was noted in june and the lowest number (6) was obtained in january. Some species were only observed during a single month. This is the case of the fish *Mormyrops anguilloides*, *Mormyrus rume* and *Malapterurus electricus* observed in August, *Alestes baremoze* and *Heterobranchus longifilis* recorded in November, *Enteromius ablabes* recorded in october and *Chromidotilapia guntheri* and *Hemichromis bimaculatus* observed in June. On the other hand, the species *Oreochromis niloticus*, Hybrid (*C. zillii* x *Coptodon guineensis*), *Chrysichthys nigrodigitatus*, *Synodontis schall*, *S. bastiani* and *S. punctifer* were observed every month of the sampling period.

Table 1. Composition and abundance of orders and families of fish sampled in the Bandama River at Lamto from july 2023 to june 2024

Osteoglossiformes (6%)		
Mormyridae (2.09%)	*Marcusenius*	*Marcusenius furcidens*
		Marcusenius ussheri
		Marcusenius senegalensis
	Mormyrops	*Mormyrops anguilloides*
	Mormyrus	*Mormyrus rume*
Characiformes (10%)		
Hepsetidae (0.57%)	*Hepsetus*	*Hepsetus akawo*
Alestidae (3.42%)	*Alestes*	*Alestes baremoze*
	Brycinus	*Brycinus imberi*
		Brycinus longipinnis
		Brycinus macrolepidotus
		Brycinus nurse
Distichodontidae (0.38%)	*Distichodus*	*Distichodus rostratus*
Cypriniformes (14%)		
Cyprinidae (1.52%)	*Enteromius*	*Enteromius ablabes*
	Labeo	*Labeo coubie*
		Labeo parvus
Siluriformes (44%)		
Claroteidae (59.13%)	*Chrysichthys*	*Chrysichthys maurus*
		Chrysichthys nigrodigitatus
Schilbeidae (1.14%)	*Schilbe*	*Schilbe intermedius*
		Schilbe mandibularis
	Parailia	*Parailia pellucida*
Clariidae (0.57%)	*Clarias*	*Clarias anguillaris*
	Heterobranchus	*Heterobranchus isopterus*
		Heterobranchus longifilis
Malapteruridae (0.38%)	*Malapterurus*	*Malapterurus electricus*
Mochokidae (6.82%)	*Synodontis*	*Synodontis bastiani*
		Synodontis schall
		Synodontis punctifer
Perciformes (26%)		
Channidae (0.95%)	*Parachanna*	*Parachanna obscura*
Cichlidae (22.05%)	*Chromidotilapia*	*Chromidotilapia guntheri*
	Hemichromis	*Hemichromis bimaculatus*
		Hemichromis fasciatus
	Oreochromis	*Oreochromis niloticus*
	Sarotherodon	*Sarotherodon galilaeus*
		Sarotherodon melanotheron
	Coptodon	*Coptodon guineensis*
		Coptodon zillii
		Hybride (Coptodon zillii x Coptodon guineensis)
		Coptodon sp
	Tilapia	*Tilapia mariae*
	Tylochromis	*Tylochromis jentinki*
		Tylochromis intermedius
Anabantidae (0.95%)	*Ctenopoma*	*Ctenopoma petherici*
13 families	24 genera	41 species

Table 2. Monthly distribution of fish species observed in catch samples from the Bandama River at Lamto from July 2023 to June 2024

Families	Fish species	Ju	Au	Se	Oc	No	De	Ja	Fe	Mr	Ap	My	Jn
Mormyridae	*Marcusenius furcidens*				+								+
	Marcusenius ussheri				+								+
	Marcusenius senegalensis				+								+
	Mormyrops anguilloides		+										
	Mormyrus rume		+										
Hepsetidae	*Hepsetus akawo*	+			+	+							+
Alestidae	*Alestes baremoze*					+							
	Brycinus imberi	+			+								+
	Brycinus longipinnis	+			+	+							
	Brycinus macrolepidotus					+							+
	Brycinus nurse	+	+			+							
Distichodontidae	*Distichodus rostratus*				+	+							
Cyprinidae	*Enteromius ablabes*				+								
	Labeo coubie		+			+							
	Labeo parvus		+			+							
Claroteidae	*Chrysichthys maurus*	+	+	+	+	+	+				+	+	+
	Chrysichthys nigrodigitatus	+	+	+	+	+	+	+	+	+	+	+	+
Schilbeidae	*Parailia pellucida*	+	+										
	Schilbe intermedius	+	+			+	+						+
	Schilbe mandibularis	+	+			+							+
Clariidae	*Clarias anguillaris*	+	+			+	+				+	+	+
	Heterobranchus isopterus	+											+
	Heterobranchus longifilis					+							
Malapteruridae	*Malapterurus electricus*		+										
Mochokidae	*Synodontis bastiani*	+	+	+	+	+	+	+	+	+	+	+	+
	Synodontis schall	+	+	+	+	+	+	+	+	+	+	+	+
	Synodontis punctifer	+	+	+	+	+	+	+	+	+	+	+	+
Channidae	*Parachanna obscura*	+				+							+
Cichlidae	*Chromidotilapia guntheri*												+
	Hemichromis bimaculatus												+
	Hemichromis fasciatus	+	+	+							+	+	+
	Oreochromis niloticus	+	+	+	+	+	+	+	+	+	+	+	+
	Sarotherodon galilaeus		+			+	+						+
	Sarotherodon melanotheron	+	+	+	+	+	+		+		+		+
	Coptodon guineensis		+	+		+							+
	Coptodon zillii		+	+	+	+	+			+			+
	Hybrid (Coptodon zillii x Coptodon guineensis)	+	+	+	+	+	+	+	+	+	+	+	+
	Coptodon sp												
	Tilapia mariae					+	+						
	Tylochromis jentinki					+	+						
	Tylochromis intermedius		+										
Anabantidae	*Ctenopoma petherici*					+	+						
TOTAL	**41**	**19**	**23**	**11**	**17**	**27**	**15**	**6**	**7**	**7**	**10**	**9**	**25**

2-Production (number and mass) of fish by type of catching gear

Monthly variations in the number and mass (Kg) of fish by fishing gear are illustrated in Figures (2, 3). The five main fishing gears used on the Bandama river in Lamto during the study period are gillnets, cast nets, papolo traps, mesh traps and hooks. In general, total monthly gillnet catches increase and reach their maximum in the months of June (12697 fish for 1598.25 kg) and October (10365 fish for 1304.71 kg) during the rainy season. Likewise, the optimal total monthly catches of papolo traps (7563 fish for 910.21 kg), mesh traps (4231 fish for 532.58 kg) and hooks (2062 fish for 259.56 kg) were reached in October and June. However, cast net catches decline with rising water levels. The highest values (9236 fish for 1162.60 Kg and 3356 fish for 422.54 Kg) were noted respectively in August and January.

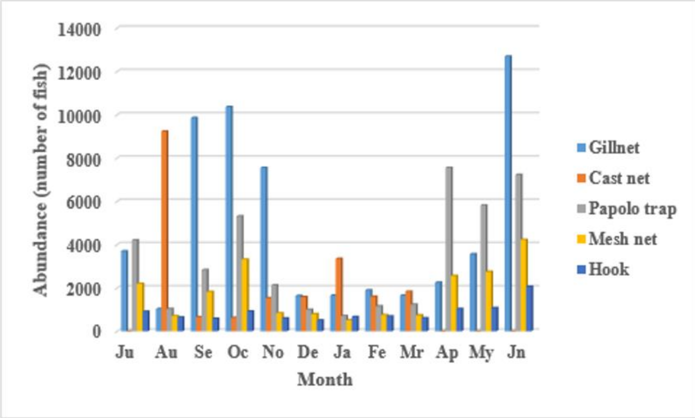

Fig. 2. Fish abundance (number) of the Bandama River at Lamto from July 2023 to June 2024

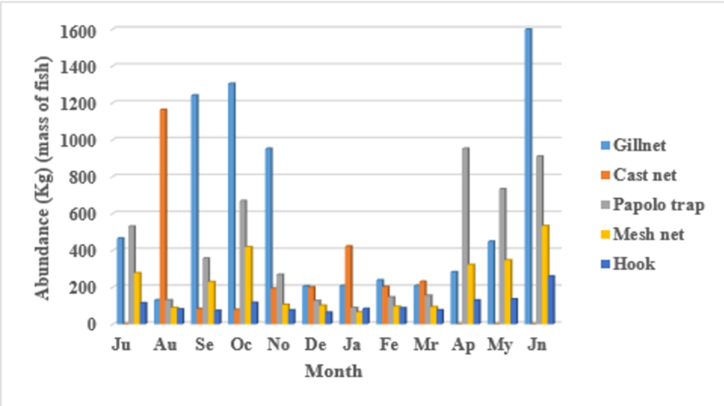

Fig. 3. Fish abundance (mass) of the Bandama River at Lamto from July 2023 to June 2024

3-Fishing effort in the Bandama River at Lamto

The spatio-temporal variations in fishing effort for catching gear were represented by Figures (4, 5, 6). For gillnets, the highest value (7.3 trips/day) was noted at station LB in May. No fishing trips were observed during December to January for this gear in the three stations. The fishing effort for cast nets varied and reached its maximum in January (8.7 trips/day) corresponding to the dry season at the LB station. The maximum value (8 trips/day) of the fishing effort of the papolo trap gear was obtained at the GB station and in June. Likewise, concerning mesh traps the highest value (6.8 trips/day) was recorded in june at the GB station. The spatio-temporal variations of fishing effort presented significant differences (Kruskal Wallis test, p = 0.001 < 0.05).

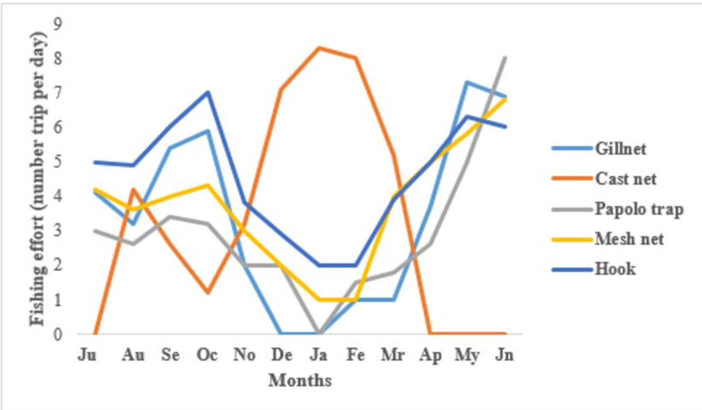

Fig. 4. Fishing effort of capture gear at Loumboussou station (LB) from July 2023 to June 2024

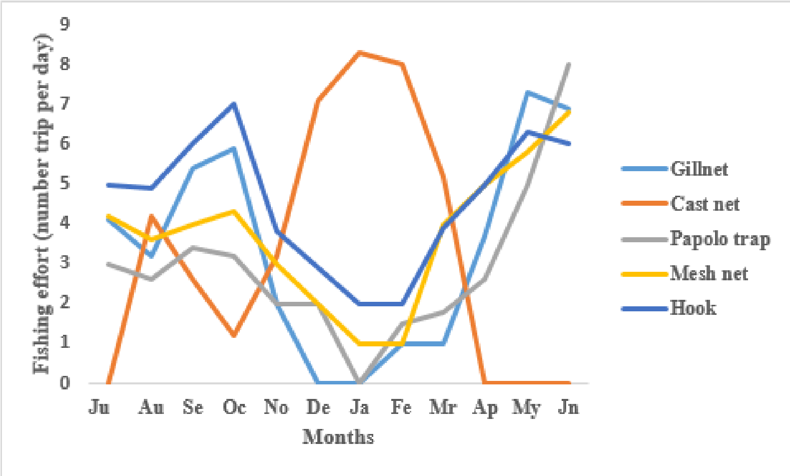

Fig. 5. Fishing effort of capture gear at Yoboué station (YB) from July 2023 to June 2024

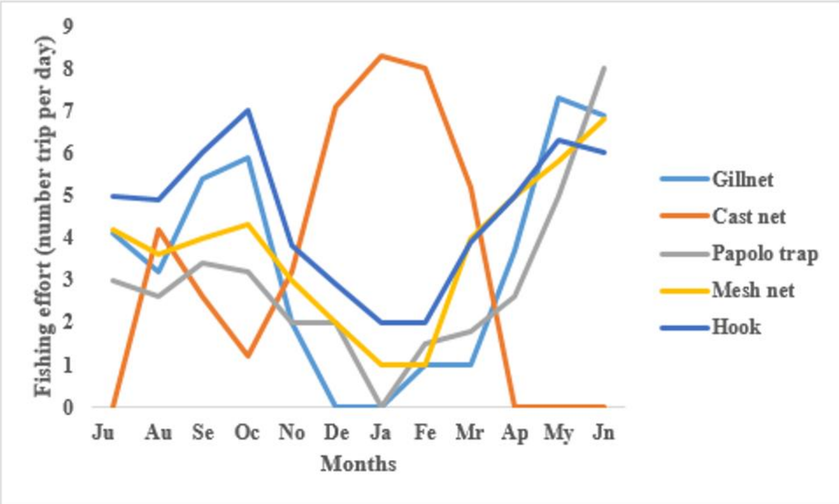

Fig. 6. Fishing effort of capture gear at Gbahan station (GB) from July 2023 to June 2024

4-Capture per unit effort (CPUE) per gear and sampling station production

Table (3) summarizes the catches per unit effort (CPUE) of the gear at the study stations. The highest CPUE for the gillnet in the three stations were obtained in June during the main rainy season. The values were 16 Kg/gear/day and 3.20 Kg/day/person at LB station, 3.64 Kg/gear/day and 0.73 Kg/day/person at YB station and 23.14 Kg/gear/day and 4.63 Kg/day/person at GB station. Conversely, the CPUE for this fishing gear decreases during dry periods in all surveyed stations. The values were 3.11 Kg/gear/day and 0.62 Kg/day/person, 1.11 Kg/gear/day and 0.22 Kg/day/person and 10.25 Kg/gear/day and 2.05 Kg/day/person at LB, YB and GB station respectively. A significant difference was noted in monthly and in sampling production station CPUE (Kruskal Wallis test, $p = 0.00001$ and $0.0002 < 0.05$). With cast nets, the highest CPUE values (4.96 Kg/gear/day and 1.65 Kg/day/person) were recorded at LB station in February. At stations YB and GB, the values were 1.64 Kg/gear/day and 0.55 Kg/day/person and 10.79 Kg/gear/day and 3.60 Kg/day/person and recorded respectively in January and February. These values were zero in rainy seasons for all stations. The Kruskal Wallis test performed established a significant difference in CPUE ($p = 0.001$ and $0.002 < 0.05$). The highest CPUE values for papolo traps in LB and GB stations were respectively 10.21 Kg/gear/day and 2.04 Kg/day/person then 17.39 Kg/gear/day and 3.48 Kg/day/person and were obtained in October. The CPUE were 3.18 Kg/gear/day and 0.64 Kg/day/person for YB station and were noted in June. The lowest corresponding values were recorded in dry seasons. They are 2 Kg/gear/day and 0.4 Kg/day/person, 3.64 Kg/gear/day and 0.73 Kg/day/person and 1 Kg/gear/day and 0.2 Kg/day/person. A significant difference was noted in monthly and station CPUEs (Kruskal Wallis test, $p = 0.002$ and $0.001 < 0.05$). The highest CPUE for mesh traps at all three stations was obtained in june. The values were 5.54 Kg/gear/day and 1.85 Kg/day/person, 1.71 Kg/gear/day and 0.57 Kg/day/person and 9.68 Kg/gear/day and 3.23 Kg/day/person respectively at LB, YB and GB stations.

The lowest corresponding values for these station recorded in dry seasons were 1.11 Kg/gear/day and 0.37 Kg/day/person, 0.29 Kg/gear/day and 0.1 Kg/day/person and 2.36 Kg/gear/day and 0.79 Kg/day/person. A significant difference was noted in monthly and station CPUEs (Kruskal Wallis test, p = 0.00002 and 0.00001 < 0.05). Similarly, the month of june recorded the highest values of CPUE for hook fishing gear at all stations. They were 2.89 Kg/gear/day and 0.72 Kg/day/person at LB, 0.71 Kg/gear/day and 0.18 Kg/day/person at YB and 5.29 Kg/gear/day and 1.32 Kg/day/person at the GB station. For this fishing gear, the lowest values were also recorded in dry seasons. They are 0.43 Kg/gear/day and 0.11 Kg/day/person, 0.25 Kg/gear/day and 0.06 Kg/day/person and 1 Kg/gear/day and 0.25 Kg/day/person at LB, YB and GB stations respectively. The Kruskal Wallis test performed indicated a significant difference in CPUE (p = 0.003; 0.001and 0.0001 < 0.05).

Table 3. Station based CPUE for every net during the study period (July 2023 - June 2024)

		CPUE									
		Gillnet		Cast net		Papolo trap		Mesh net		Hook	
Months	Stations	Kg/gear/day	Kg/ gear/ person	Kg/gear/day	Kg/ Gear /person	Kg/gear/day	Kg /gear /person	Kg/gear/day	Kg/ gear/ person	Kg/gear/day	Kg / Gear /person
Ju	LB	6.18	1.24	0.82	0.27	4	0.8	1.54	0.51	1.25	0.31
	YB	2.64	0.52	0.93	0.31	1.32	0.26	0.82	0.27	0.36	0.09
	GB	13	2.6	5.54	1.85	9.5	1.9	3.43	1.14	1.46	0.37
Au	LB	3.5	0.7	3.68	3.68	3.54	0.71	1.5	0.5	0.82	0.21
	YB	1.96	0.39	1.46	0.49	1.14	0.23	0.5	0.17	0.32	0.08
	GB	10.79	2.16	7.36	2.45	3.64	0.73	3.18	1.06	1.39	0.35
Se	LB	7,46	1.49	0	0	6.68	1.34	1.86	0.62	0.57	0.14
	YB	2.64	0.53	0	0	1.14	0.23	1.04	0.35	0.5	0.13
	GB	16.75	3.35	0	0	9.57	1.91	3.64	1.21	1.75	0.44
Oc	LB	14.54	2.91	0	0	10.21	2.04	2.93	0.98	2.43	0.61
	YB	3.54	0.71	0	0	2.46	0.49	1.25	0.42	0.54	0.06
	GB	17.89	3.58	0	0	17.39	3.48	6.14	2.05	2.82	0.71
No	LB	5.04	1.01	4	1.3	3.04	0.61	1.11	0.37	0.54	0.13
	YB	1.5	0.3	1.29	0.43	1	0.2	0.39	0.13	0.25	0.08
	GB	15.32	3.06	5.57	1.86	4.29	0.86	2.36	0.79	1	0.25
De	LB	4.14	0.83	3.54	1.18	2.64	0.53	1.64	0.55	0.64	0.16
	YB	1.11	0.22	1.14	0.38	1.18	0.24	0.39	0.13	0.32	0.07
	GB	14.36	2.87	8.86	2.95	4.11	0.82	3.64	1.21	1.54	0.38
Ja	LB	3.54	0.71	4.39	1.46	2.07	0.41	1.57	0.52	0.46	0.12
	YB	1.04	0.21	1.64	0.55	1.04	0.21	0.43	0.14	0.29	0.06
	GB	10.25	2.05	5.93	1.98	3.68	0.74	3.14	1.05	1.39	0.35
Fe	LB	3.11	0.62	4.96	1.65	2	0.4	1.39	0.46	0.43	0.11
	YB	1.29	0.26	1.43	0.48	1.04	0.21	0.32	0.11	0.25	0.06
	GB	10.61	2.12	10.32	3.44	7.5	1.5	2.79	0.93	1.5	0.38
Mr	LB	3.18	0.64	4.39	1.46	2.43	0.49	1.89	0.63	0.64	0.16
	YB	1.57	0.31	1.14	0.38	1.11	0.22	0.29	0.1	0.25	0.06
	GB	13.5	2.7	10.79	3.6	8.11	1.62	4	1.33	2.	0.5
Ap	LB	5.5	1.1	0	0	4.07	0.81	3.29	1.1	1.14	0.29
	YB	2.36	0.47	0.14	0.05	1.71	0.34	1.04	0.35	0.36	0.09
	GB	15	3	0.79	0.26	10.79	2.16	6.68	2.23	3.43	0.86
My	LB	5.89	1.18	0	0	4.54	0.91	4.39	1.46	2.07	0.52
	YB	2.79	0.56	0	0	1.82	0.36	1.32	0.44	0.5	0.13
	GB	21.54	4.31	0	0	13.89	2.78	8.61	2.87	4.21	1.05
Jn	LB	16	3.2	0	0	9.07	1.81	5.54	1.85	2.89	0.72
	YB	3.64	0.73	0	0	3.18	0.64	1.71	0.57	0.71	0.18
	GB	23.14	4.63	0	0	16.11	3.22	9.68	3.23	5.29	1.32

5-Seasonal variation of the CPUE for each fishing gear

Seasonal variations of catches per unit effort (CPUE) per gear were illustrated in Table (4). The highest gillnet CPUE values for the three stations were recorded in rainy seasons which correspond to rising water levels. They are 4.38 Kg/gear/trip, 1.38 Kg/gear/trip, 8.99 Kg/gear/trip respectively at LB, YB and BG stations. There was a significant difference in seasonal CPUE at the station (Mann Whitney U test, p = 0.001, 0.003 and 0.002 < 0.05). This trend has been observed with papolo traps, mesh traps and hooks. For papolo traps, the CPUE values were 3.08 Kg/gear/trip at LB station, 0.65 Kg/gear/trip at YB station and 6.32 Kg/gear/trip at GB station. The observed seasonal variations in CPUE were significant (Mann Whitney U test, p = 0.0002, 0.0001 and 0.0004 < 0.05). With mesh traps the CPUE values were respectively 1.66 Kg/gear/trip, 0.56 Kg/gear/trip and 3.23 Kg/gear/trip at LB, YB and GB station. The Mann-Whitney U test applied to the CPUE data revealed a significant difference between seasons (p = 0.03, 0.001 and 0.002 < 0.05). The CPUE values for the hook fishing gear were 0.81 Kg/gear/trip at LB, 0.24 Kg/gear/trip at YB station and 1.63 Kg/gear/trip at GB station. There was a significant difference was noted in the seasonal CPUE at the station level (Mann whitney U test, p = 0.0001, 0.0004 and 0.0002 < 0.05). On the other hand, the high CPUE values of the cast nets over the seasons were obtained during the dry seasons which correspond to the low water level. The values noted were 1.78 Kg/gear/trip, 0.66 Kg/gear/trip and 4.53 Kg/gear/trip at LB, YB and GB station respectively. The seasonal variations in CPUE observed for cast nets were significant (Mann Whitney U test, p = 0.004, 0.002 and 0.001 < 0.05).

Table 4. Seasonal variation of CPUE of fishing gear during the surveys period from July 2023 and June 2024

		CPUE (Kg/gear/trip)		
		LB	YB	GB
Gillnet	RS	1,83	0,63	6,19
	DS	4,38	1,38	8,99
Cast net	RS	1,78	0,66	4,53
	DS	0,36	0,07	0,07
Papolo trap	RS	1,44	0,56	2,73
	DS	3,08	0,65	6,32
Mesh net	RS	0,73	0,24	1,88
	DS	1,66	0,56	3,23
Hook	RS	0,35	0,15	0,69
	DS	0,81	0,24	1,63

RS = Rainy season ; DS = Dry season

6-Total annual catch of exploited fish

The total annual catches from the Bandama River in Lamto are 7285.74 Kg for the gill net, 2573.67 Kg with the cast net, 5066.53 and 2672.99 Kg for the papolo and mesh traps respectively and 1296.65 Kg with the hook fishing gear.

DISCUSSION

The ichthyological fauna found in this study consists mainly of Siluriformes represented by Claroteidae and Mochokidae and Perciformes represented by Cichlidae. This is similar to the composition and distribution of the fish fauna of African rivers (Paugy, 1994; Lévêque and Paugy, 2006; Kantoussan, 2007 and Montchowui *et al*., 2007). The species richness (41) noted is similar to Adou *et al*., (2017) which had listed 40 species in the Ayamé 2 dam lake and to Kien *et al*., 2021 which had indicated 44 fish species in the lower course of the Bandama river. This variability in the specific richness of the ichthyological population of these environments could be explained either by the surface area of these courses and bodies of water which have various dimensions, or by the nutrients availability which is one of the main parameters of attraction of living organisms capable of mobility, or by the environmental parameters which regulate density and specific diversity (Montchowui *et al*., 2007). The dominance of species *Oreochromis niloticus*, Hybrid (*C. zillii* x *Coptodon guineensis*), *Chrysichthys nigrodigitatus* and *Synodontis punctifer* as well as their presence in the catches in all months of the year would be due to the fact that these fish find there a habitat conducive to their development and reproduction as pointed out by Phillipart and Ruwet

(1982). In addition, these species are well known for their great adaptability to wide variations in ecological factors of the aquatic environment (Fishelson and Yaron, 1983; Plisnier *et al*., 1988).

Overall, production, fishing effort, CPUE of gill nets, papolo traps, mesh traps and hooks obtained in this study are high during rainy seasons which more or less favor rising water levels. The results are similar to those of Da Costa *et al*., (1998), Ouattara *et al*., (2006) and Tah *et al*., (2009). On the other hand, these results are different from those of Cissé *et al*., (2019) and Bédia *et al*., (2017; 2021) who obtained high values in the dry season as for most large rivers in Africa (Welcomme, 1985, Levêque, 1995). These authors explained that the flooded plain is the preferred place for fish during the rainy season. Indeed, Floods lead to an increase in the average level of aquatic ecosystems and flooding of adjacent plains. The fish then disperse in the water column as well as in flooded environments where they will feed and/or reproduce. During this period, the development of vegetation and the large body of water make fish less vulnerable to fishing gear and leading to lower catches per unit effort (CPUE). This situation ceases with the drop in water levels and the return of fish that lived in the flooded plains to the river beds. This process is accentuated during low water when all the fish are concentrated in a small water volume. Thus, the fish become more accessible and more vulnerable, which is taken advantage of by fishermen. Concerning the results of this study, the rainy seasons which lead to the rise in the water level of the Bandama river in Lamto are periods of maximum fishing (big catches). Indeed, according to the fishermen, this dead arm of the river being made up of several rocks in the various surveyed stations which emerge in the dry season does not allow the installation of gillnets and traps making fishing impossible. They therefore resort to to fishing gear such us cast nets and hooks which are used more when the water level becomes low. Next, these fishing techniques are easily practiced with rising water levels, hence the increase in fishing effort in this season. In addition, during the rainy seasons, the use of traps and hooks is not very restrictive since they are generally placed in the bordering parts of the river where many adult fish come to feed and reproduce as suggested by Levêque (1995). The usability of these capture devices during high water periods intensifies fishing due to the influx of numerous fishermen. The high production values obtained with gill nets and traps are due to the appreciation of these catching devices by fishermen and their ease of use, hence their great use. According to fishermen, the use of these devices for the most part is not very restrictive, requires little investment, very low operating costs, and does not great physical strength and can be used without any real specialized training.

The results of fishing efforts and CPUE obtained in this study are generally below the standards indicated by FAO (2012) for watercourses in the UEMOA area during the best seasons, thus indicating that the fish fauna of the Bandama river in Lamto is overexploited. Production remains low compared to the catches mentioned by the FAO (2012).

Regarding total production, the highest value was obtained during the rainy season. This result is linked to the fact that this period presents the highest fishing effort and CPUE values. According to Diaby *et al*., (2010) and Koné (2012), there is a positive correlation between fishing effort and production. Furthermore, this period is the one favored by fishermen for the use of gillnets and traps which are the most efficient devices on the Bandama River in Lamto. This result is consistent with the findings of Da Costa *et al*., (1998), Ouattara *et al*., (2006) and those of Tah *et al*., (2009) on Ivorian rivers.

CONCLUSION

The fish production assessment from the Bandama River at Lamto represents the first information about fishing effort, CPUE and production of gears used. The ichthyological fauna is dominated by the Siluriformes and Perciformes represented by the Claroteidae and the Cichlidae. Fishing effort and CPUE were high with gillnets and papolo traps and in the rainy season. The fish fauna in the Bandama River in Lamto is overexploited.The study showed that the Lamto reserve is subject to many human activity. It is imperative to take stepes to ensure that it retains its status as a protected area for the renewal and conservation of biodiversity in general and specifically that of fish fauna.

ACKNOWLEDGMENTS

This study is part of a vast programme to set up a multidisciplinary and multi-institutional research and training platform on Biodiversity, its conservation and its use for ecological engineering of anthropised ecosystems (in rural and urban environments). This work was funded by the « Laboratoires Mixtes Internationaux (LMI) » through the « Institut de Recherche pour le Développement (IRD) ». The authors would like to thank the co-sponsors of the project, Mr KONATE Souleymane, Professor at the Nangui Abrogoua University of Côte d'Ivoire, and Mr BAROT Sebastien, Director of Research at IRD, Sorbonne University, UMR 7618 IEES-Paris (IRD, CNRS, University of Paris Diderot, UPEC, INRA). They thank the students Kouamé Cédrick and Amani Koffi Joseph from the Félix Houphouët-Boigny University and the fisherman Mr N'Guessan who helped with the data collection.

REFERENCES

- Adou, Y. E., Blahoua, K. G., Bamba, M., Yao, S. S., Kouamélan, E. P., & N'Douba, V. (2017). Premières données sur l'inventaire du peuplement ichtyologique d'un lac ouest Africain situé entre deux barrages hydroélectriques : Lac d'Ayamé 2 (Côte d'Ivoire). Journal of Applied Biosciences, 110 : 10808-10818. http://dx.doi.org/10.4314/jab.v110i1.11

- Adou, Y. E., Blahoua, K. G., Yeo, K., Konate, S., Tiho, S. & Barrot, S. (2023). First Data of the ichthyological fauna in the Bandama river at the Lamto scientific nature reserve (Côte d'Ivoire, West Africa). European Scientific Journal, 19(18) 1857-7881. https://doi.org/10.19044/esj.2023.v19n18p190
- Albaret, J. J., & Laë, R. (2003). Aquatic Living Resources, 16 1 -9.
- Bédia, A. T., Etilé, R. N., Blahoua, G. K., & N'douba, V. (2017). Diversité, structure du peuplement ichtyologique et production d'une lagune tropicale ouest Africaine: Lagune Potou (Côte d'Ivoire). International Journal of Innovation and Applied Studies, 19(2) : 449-462.
- Bédia, A. T., Kien, K. B., & N'Guessan, K. R. (2021). Caractérisation des facteurs de production et de la production de la filière pêche sur la lagune Potou, Côte d'Ivoire. Afrique Science, 19(6) : 60 – 75.
- Cissé, M., Kamelan, T. M., Kien, K. B. & Kouamelan, E. P. (2019). Fish assemblage composition and fishery production in the man-made lake, West Africa. Journal of fisheries and life Sciences. 4(1) 9-14.
- Coulibaly B., Tah, L., Joanny-Tapé, G. T., Koné, T. & Kouamelan. P. E. (2016). Fish assemblage structure in the Tropical Coastal Lagoon of Grand-Lahou (Côte D'Ivoire, West Africa). International Journal of Fisheries and Aquaculture. 8(1) : 1-13, 2016.
- Da Costa, K. S., Traore, K., &Tito de Morais, L. (1998). Effort de pêche et production exploitée dans les petites retenues du Nord de la Côte d'Ivoire. Bulletin France Pêche Pisciculture, 348 : 65-78.
- Diaby, M., K., N'Da & Konan, K. S. (2010). La pêche des poissons Mugilidae dans la lagune de Grand-Lahou (Côte d'Ivoire): analyse de l'organisation de la pêche, des captures et de l'effort de pêche, Tropicultura, 30 (3): 173-179.
- Fishelson, L., & Yaron, Z. (1983). The First International Symposium on tilapia in Aquaculture, Nazareth, Israel, 8-13 May 1983. Tel Aviv University, Tel Aviv, Israel, 624p.
- Kamélan, T. M., Yao, S. S., Kouamé, K. A., N'Zi, K. G., & Kouamélan, E. P. (2013). Ichtyofaune de la rivière Dodo, Côte d'Ivoire : mise à jour et influence des variables environnementales sur la distribution des espèces. Journal of Applied Biosciences 71: 5773-5785. https://dx.doi.org/10.4314/jab.v71i1.98824
- Kantoussan, J. (2007). Impacts de la pression de pêche sur l'organisation des peuplements de poissons : application aux retenues artificielles de Sélingué et de Manantali, Mali, Afrique de l'Ouest. Thèse de doctorat, Agrocampus Rennes, 195 p.
- Karr, J. R (1981). Assessment of biotic integrity using fish communities. Fisheries of Bethesda. 7: 2-8.
  Kien, K. B., Ndiaye, A. & Aboua, B. R. D. (2021). Caractérisation de la diversité, de la structure des tailles et du stress écologique au niveau du peuplement des poissons sur le fleuve Bandama (Côte d'Ivoire, Afrique De l'Ouest). European Scientific Journal, 17 (21). 260-281. https://doi.org/10.19044/esj.2021.v17n43p260
- Kitheka, J., Mkumbo, J., Nyamweya, D. & Shivoga, W. (2011). Spatiotemporal variations in catch per unit effort (CPUE) of the Nile perch in Lake Victoria: insights into resource management. Journal of Applied Ichthyology. 27(4), 829-835.
- Koné, N. (2012). Etude de la pêche, des paramètres des populations et de la biologie de la reproduction du Clupeidae *Pellonula leonensis* Boulenger, 1916 dans les lacs de barrages de Kossou et de Taabo (fleuve Bandama, Côte d'Ivoire).Thèse de Doctorat, Université Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire, 194p.
- Lalèyè, P., Chikou, A., Philippart, J.C., Teugels, G. & Vandewalle, P. (2004). Étude de la diversité ichtyologique du bassin du fleuve Ouémé au Bénin (Afrique de l'ouest). Cybium, 28 (4): 330 339.
  Lévêque, C., Dejoux, C. & Iltis, A. (1983). Limnologie du fleuve Bandama, Côte d'Ivoire. Hydrobiologia, 100: 113-141.
- Montchowui, E., Niyonkuru, C., Montcho, S. A. & Chikou, A. (2007). L'ichtyofaune de la rivière Hlan au Bénin (Afrique de l'Ouest) Cybium: International Journal of Ichthyology. 31 (2) :173-176.
- Montchowui, E., Chikou, A., Kogbeto, M. J., & Lalèyè, P. (2008). Biodiversité et structure des communautés de poissons du lac Hlan au Benin. International Journal Biological Chemical Science, 2 (2): 196-206.
- Ouattara M., Gourène, G., & Vanga, A. F. (2006). Proposition de fermeture saisonnière de la pêche en vue d'une exploitation durable du poisson au lac d'Ayamé (Côte d'Ivoire).Tropicultura, 24 (1) : 7-13.
  Paugy, D. (1994). Ecologie des poissons tropicaux d'un cours d'eau temporaire (Baoulé, haut bassin du fleuve Sénégal au Mali) : adaptation au milieu et plasticité du régime alimentaire". Revue hydrobiology tropical. 27 (2), 157-172.
- Paugy, D., Lévêque, C., & Teugels G. G. (2003a). Faune des poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest. Tome 1. IRD (Paris), MNHN (Paris), MRAC (Tervuren), 457 p.
- Paugy, D., Lévêque, C., & Teugels, G. G. (2003b). Faune des poissons d'eaux douces et saumâtres de

l’Afrique de l’Ouest. Tome 2. IRD (Paris), MNHN (Paris), MRAC (Tervuren), 815 p.

- Philippart, J. C., & Ruwet, J. C., (1982). Ecology and distribution of tilapias. Proceedings of the International Conference on the Biology and Culture of Tilapias 1: 15-59, 1982.
- Plisnier, P. D., Micha, J. C., & Frank, V. (1988). Biologie et exploitation des poissons du lac Ihema (Bassin de l'Akagera, Rwanda). Presses Universitaires de Namur, Namur, Belgique, 212 p.
- Tah, L., Da Costa., K. S., Kouassi, N. J. & Moreau, J. (2009). Effort de pêche et production exploitée au lac d’Ayamé 1 (Bassin de la Bia ; Côte d’Ivoire) après le départ des pêcheurs « Bozos ». Agronomie Africaine, 21 (1) : 103-115.
- Traoré, K. (1996). Etat des connaissances sur les pêcheries continentales ivoiriennes.Rapport de consultation. PROJET FAOTCP/IVC/4553, IDESSA, Bouaké, Côte d’Ivoire.
- Welcomme, R. L. (1985). River fisheries. FAO fisheries technical paper 262. Rome, 330 p.
- Wu, J., Wang, J., He, Y., & Cao, W. (2011). Fish assemblage structure in the Chishui River, a protected tributary of the Yangtze River. Knowledge and Management of Aquatic Ecosystems 400 (11):1-14.