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Fish species, catch per unit effort (CPUE) and size structure in the lower Bandama River (Côte d'Ivoire, West Africa)

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Abstract

This study helped to fill the information gap on some characteristics of the fish and fish fishery on the Bandama River. Data were collected using the fishermen catches.

It gives information on species composition, CPUE and size structure of fish in three localities of the Lower Bandama River. 44 species belonging to 19 families were recorded during this sampling. The locality of Tiassalé is the richest with 39 species followed Singrobo (37 species) and N'Zianouan (33 species).The family of Cichlidae (20% of catches) and *Chrysichthys nigrodigitatus* (15% of species) dominate catches throughout the area. The CPUE average values varied from 6.36±2.81kg/trip at Tiassalé to 5.41±1.7kg/trip at N'Zianouan and are generally higher in all localities in the drop season. The minimum and maximum average sizes are higher at Tiassalé which has 22.59% of large individuals. Furthermore, the modal classes vary from 11.25 to 17.95cm at Tiassalé, Singrobo and N'Zianouan. This study on fishing in Lower Bandama River has provided information on the exploitation of fishes at Singrobo, N'Zianouan and Tiassalé.

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Introduction

The world's, fisheries provide important food sources for many countries (Watson and Pauly, 2001) and are extremely important to many less industrialized nations (Russ, 1991; McManus *et al.,* 2000). In Côte d'Ivoire, it contributes to income, nutrition and employment for about 23029 people (FAO, 2012).However, water course undergo various perturbations including those related to overfishing (Diouf, 1996; Albaret, 1999).

The decline in the production of fisheries, calls for new approaches to assess the implications of fishing on the ecosystem (Gislason *et al.,* 2000; Link, 2002). Although, biological indicators have been identified in fisheries management, Rochet and Trankel (2003) and Kantoussan (2007) recommend respectively size-spectra and Catch Per Unit Effort (CPUE) as prior indicators in fisheries management. In this work, fish size distribution and Catch Per Unit Effort (CPUE) were chosen as biological indicator to evaluate fish exploitation in the Lower Bandama River. Daget and Iltis (1965); Teugels *et al.* (1988) and Aboua *et al.* (2010) have reveled respectively 69; 107 and 83 species in the Bandama River. Besides, 57 species have showed by Aboua (2012) in the Lower Bandama River. Nevertheless, there is scarce information on fish size distribution and Catch Per Unit Effort in this area. It was therefore, the aim of this study to provide information on fish specific structure, size structure and CPUE in different areas from the Lower Bandama River.

Material and methods

Study area

The study was carried out in the Lower Bandama River (5°53'- 6°05 N and 4°90 - 4°55 W)in the south of Côte d'Ivoire(West Africa).The climate gives two spate periods(June to July and September to October) and two drop periods (August and December to March) (Fig. 1). Three sites were sampling: Tiassalé (5°33 N and 4°49 W); N'Zianouan (6°00 N and 4°49 W) and Singrobo (6°05 N and4°55 W) along the Lower Bandama River (Fig. 2). Singrobo and N'Zianouan are near to the Taabo hydroelectric reservoir.

Data collection

Fish were collected monthly at random from commercial landings over 3 to 4 days per site in between July 2013and June 2014. Captured fish species were identified according to Paugy *et al.* (2003). Each specimen was weighed to the nearest gram (0.1 g) and standard length (SL) was measured to the nearest millimeter (mm).Individual length of fish were recorded and used to generate length frequency distributions from length class intervals. The number of length class intervals was obtained using Sturges's rule (Scherrer, 1984) where the number of class (k) is equal to the nearest value approximately to 1+ 3.3 log10n with n as the sample size.

The formula is: $k = 1 + 3.3 \log 10n$.

Catch per unit effort (CPUE) was defined as the quantity of fish caught (kg) per fishing trip. The CPUE were every month estimated per landing site, as follows (Boguhé *et al.,* 2014):

CPUEi = Wi/Ti, where CPUEi is the weight of fish caught (kg) per fishing trip in the month i, Wi is the total weight (kg) of daily catches landed by fishermen in the month i; Ti corresponds to the number of daily fishing trip in the month i.

The Numeric abundance (N) of fish species and families was determined through the following formula: $N = (n_i \times 100)/N_t$, where n_i is the number of specimen from i specie or i family and N_t the total number of specimens.

Data analysis

ANOVA test was used to assess differences between the three zones according to average size of fish species. It relived the means of significant variables. Test was reported as significant at the alpha<0.01 level. Differences between CPUE average values were tested used Chi-Square (χ^2). Test was reported as significant at the alpha < 0.05levels. All data in this study were analyzed using *Statistica 7.1*

Results

Fish community composition

During sampling period, 44 species belonging to 19 families were identified ('Table 1').

Table 1. Distribution of the fish fauna of Lower Bandama River from July 2013 to June 2014.

Families	Species	Tiassalé	Singrobo	N'Zianouan
Arapaimidae	*Heterotis niloticus*[1]	+		
Notopteridae	*Papyrocranus afer*	+	+	+
Mormyridae	*Mormyrops anguilloïdes*	+	+	+
	Mormyrus rume	+	+	+
	Marcusenius senegalensis	+	+	+
	Marcusenius ussheri		+	
Alestidae	*Alestes baremoze*		+	
	Brycinus nurse	+	+	+
	Brycinus macrolepidotus	+	+	+
	Brycinus imberi		+	+
	Hydrocynus forskalii	+		+
Distichodontidae	*Distichodus rostratus*	+	+	+
Cyprinidae	*Labeo parvus*	+	+	+
	Labeo coubie	+	+	+
	Barbus bynni waldroni	+	+	+
	Barbus bynni occidentalis	+	+	
Claroteidae	*Chrysichthys maurus*	+	+	
	Chrysichthys nigrodigitatus	+	+	+
	Auchenoglanis occidentalis	+	+	+
Schilbeidae	*Schilbe intermedius*	+	+	+
	Schilbe mandibularis	+	+	+
Clariidae	*Clarias anguillaris*	+	+	
	Heterobranchus isopterus	+	+	+
	Heterobranchus longifilis	+		
Malapteruridae	*Malapterurus electricus*	+	+	+
Mochokidae	*Synodontis bastiani*	+	+	+
	Synodontis schall	+	+	+
	Synodontis punctifer	+		
Channidae	*Parachanna obscura*	+	+	+
Latidae	*Lates niloticus*	+	+	+
Carangidae	*Trachinotus teraia*[2]	+		+
Cichlidae	*Chromidotilapia guntheri*	+	+	+
	Hemichromis bimaculatus		+	
	Hemichromis fasciatus	+	+	+
	Oreochromis niloticus[1]	+	+	+
	Sarotherodon galilaeus[2]	+	+	+
	Sarotherodon melanotheron[2]	+		+
	Tilapia mariae[2]	+		
	Tilapia zillii	+	+	+
	Tylochromis jentinki[2]	+	+	+
Mugilidae	*Liza falcipinnis*[2]	+	+	+
Gobiidae	*Awaous lateristriga*[2]	+	+	+
Anabantidae	*Ctenopoma petherici*	+	+	+
Mastacembelidae	*Mastacembelus nigromarginatus*		+	
19	44	39	37	33

Note: + = presence ; 1= introduce species ; 2= marine and/or brackish species

The family of Cichlidae (20%) had the highest numeric abundance in the catches. It was followed by six families: Alestidae (11%), Mormyridae and Cyprinidae (9% each), Claroteidae, Clariidae and Mochokidae (7% each).

The others families represented 30% (Fig. 3) of catches from the three localities. The specie *Chrysichthys nigrodigitatus* had the highest numeric abundance with (15%) of the catches. It followed five species: *Tilapia zillii* (10%), *Labeo coubie* and *Synodontis bastiani* (9% each) and *Synodontis schall* (7%). The others species (n=38) represented 50% of total catches (Fig. 4**).** The locality of Tiassalé had the highest species richness 39 species (89%) and 19 families. 37 species (82%) and 17 families were identified at Singrobo and 33 species (74%) belonging 17 families at N'Zianouan**.**

Table 2. Percentage and mean of individuals larger than 50 cm (Nb = number) recorded between July 2013 and June 2014 on the Lower Bandama River.

Localities	Percentage (%)	mean	Standard deviation
Tiassalé	22.59	114.83	± 120.91
Singrobo	0.39	1.67	± 3.17
N'Zianouan	13.96	51.67	± 76.50

(F = 5.65; *P* = 0.0077).

Structure size of catches

The small size measured varied from 5 cm at Tiassalé and N'Zianouan to 6 cm at Singrobo. The maximum size observed in the study area was 90.7 cm at Tiassalé; 85 cm at Singrobo and 92 cm to N'Zianouan. The Fig. 5 gives length frequency distribution of fish species at Tiassalé, Singrobo and N'Zianouan. The results of this study showed the same modal class (11.25 to 17.95 cm) at Tiassalé (35.36% of specimens), Singrobo (43.37% of specimens) and N'Zianouan (42.17% of specimens).

Table 3. Test of Khi-square (X^2) applied to mean values of Units of Effort (PUE) recorded from July 2013 to June 2014 on the Lower Bandama River.

Localities	PUE (kg/trips)	X^2	*P*
Tiassalé	6,36 ± 2,81	0,234	0,628
Singrobo	5,75 ±1,64		
Tiassalé	6,36 ± 2,81	0,405	0,524
N'Zianouan	5,41 ± 1,70		
Singrobo	5,75 ± 1,64	0,024	0,877
N'Zianouan	5,41 ± 1,70		

The minimum and maximum average sizes were largest at Tiassalé (14.3 cm and 34.1 cm) than Singrobo (12.6 cm and 26.2 cm) and N'Zianouan (12.9 cm and 29 cm)**.** Otherwise, the average size of the total catches is higher at Tiassalé (24.2 cm) than N'Zianouan (20.95 cm) and Singrobo (19.42 cm). The analysis showed a highest proportion of large specimens (over 50 cm) at Tiassalé (22.59%; mean=114.83) than N'Zianouan (13.96%; mean=51.67) and Singrobo (0.39%; mean=1.67). Those values differed significantly at $p < 0.05$ (ANOVA) ('Table 2') (Fig. 6).

Catch Per Unit Effort (CPUE)

The average values of CPUE calculated monthly showed 5.41±1.7kg/trip at N'Zianouan, 5.75±1.64kg/trip at Singrobo and 6.36±2.81kg/trip at Tiassalé (Fig. 7). Those values were not significantly different between the three areas used for sampling (Khi - Square; $p > 0.05$) ('Table 3').

However, monthly changes of the CPUE showed that the maximum value was recorded in drop period on March (11.48 kg/trip) (dry season) and the minimum values in spate period on October (3.52 kg/trip) and November (3.86 kg/trip) (rainy season) at Tiassalé. Concerning Singrobo, the maximum and the minimum values were respectively noted on December (8.17 kg/trip) in drop period (dry season) and November (3.26 kg/trip) in spite period (rainy season). N'Zianouan presented the maximum value in drop period (March, 8.94 kg/trip) (dry season) and the minimum value in spate period (October, 3.51 kg/trip) (rainy season).

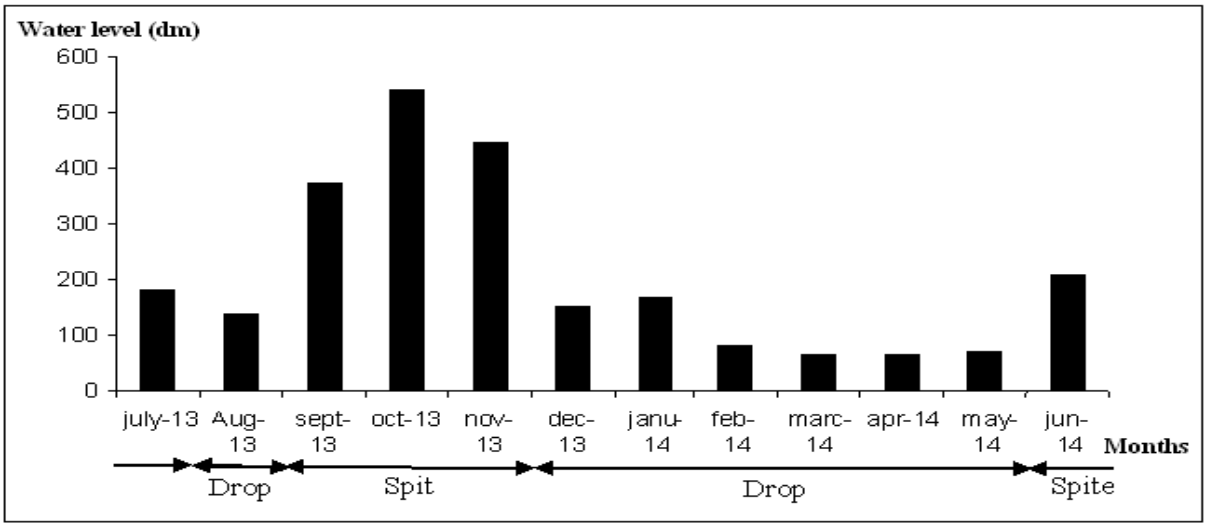

Fig. 1. Water-level Variations from July 2013 to June 2014 in the lower Bandama River. Data source: the direction of Hydrology of the Ministry of Economic Infrastructure.

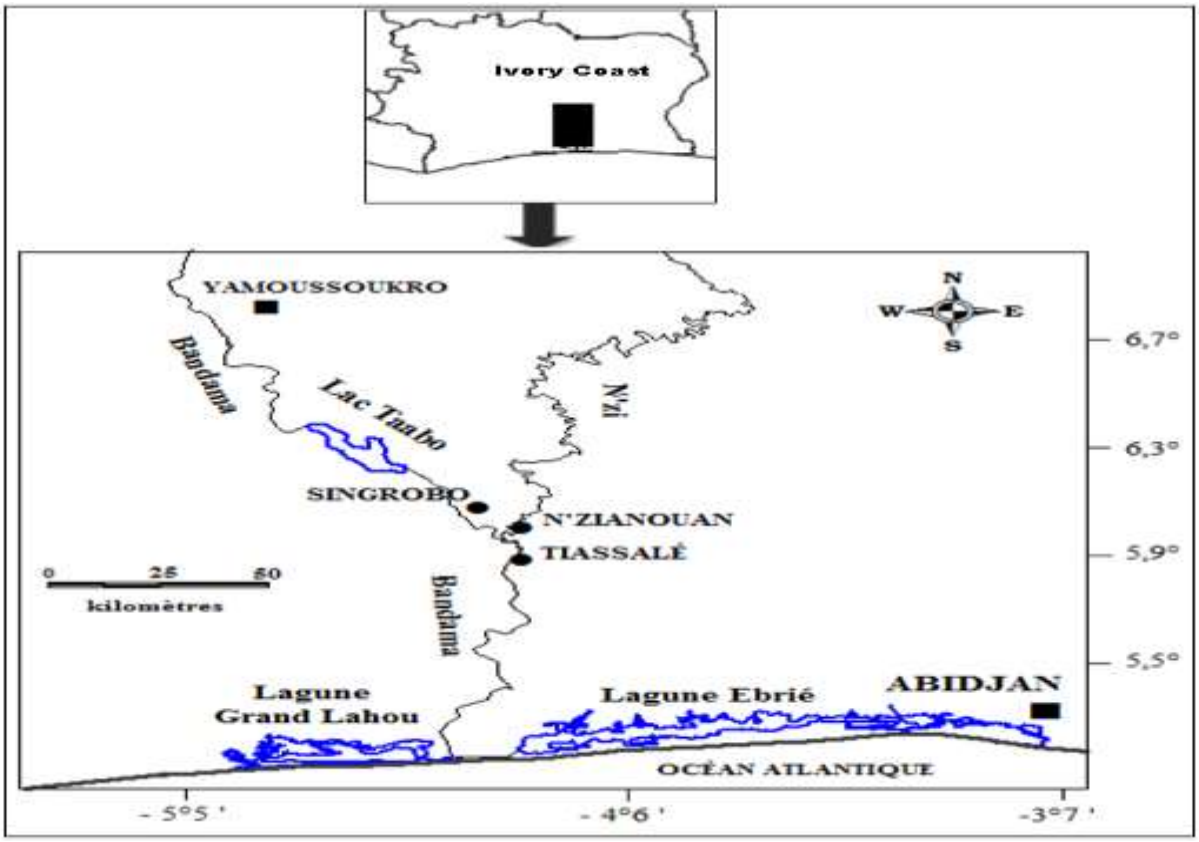

Fig. 2. Map of Lower Bandama River and location of sampling sites.

Discussion

In the present study, according to the numeric abundance, families of Cichlidae, Alestidae, Mormyridae, Cyprinidae, Claroteidae, Clariidae and Mochokidae dominated in order the catches in the Lower Bandama River. This order is opposite to this established by Aboua (2012) during her sampling on this part of Bandama River. According to this author, Alestidae; Mormyridae and Cichlidae were the most important families in order in the Lower Bandama River. One part of this difference may be related to the sampling methods. Indeed, its data were from experimental fishing in addition to commercial fishing. Besides, the works of Aboua (2012) looked other sites in addition to our sampling areas.

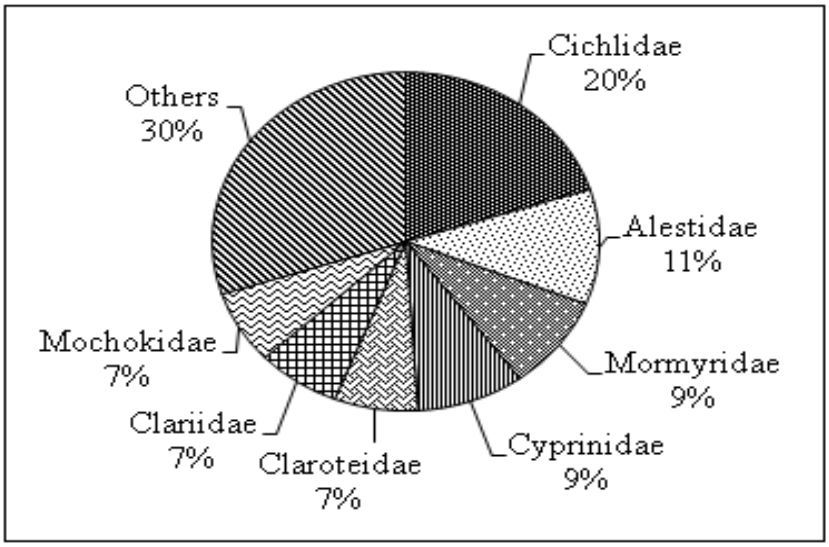

Fig. 3. Main fish families on the lower Bandama River at July 2013 to June 2014.

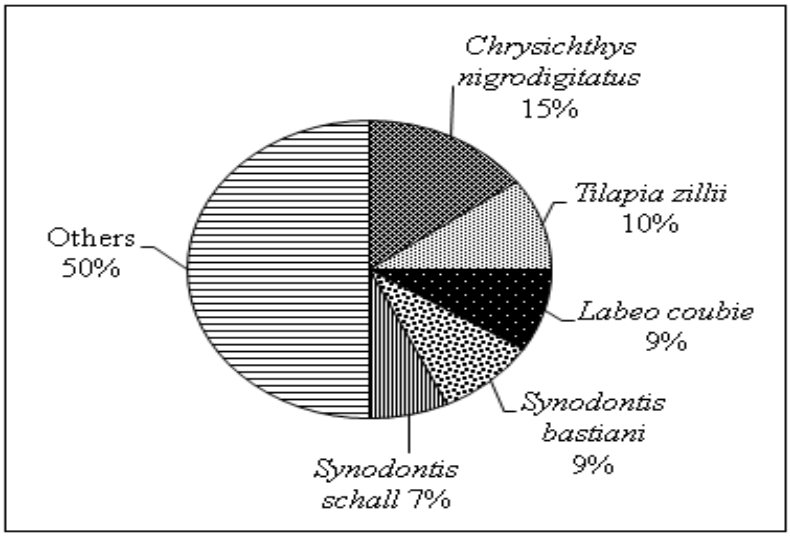

Fig. 4. Main fish species on the lower Bandama River at July 2013 to June 2014.

The predominance of Cichlidae in this study could be explained by the successful adaptation of this family over time to adverse conditions as water releases from the Taabo hydroelectric reservoir. The high species richness at Tiassalé may be related to his wide fishing surface comparatively to Singrobo and N'Zianouan. It is recognized that fish diversity is correlated to habitat diversity and the highest of the living area (Bachmann *et al.*, 1996; Irz *et al.*, 2002). Moreover, Worm and Duffy (2003) showed a reciprocal influence between the productivity of an ecosystem, his stability and his biodiversity.

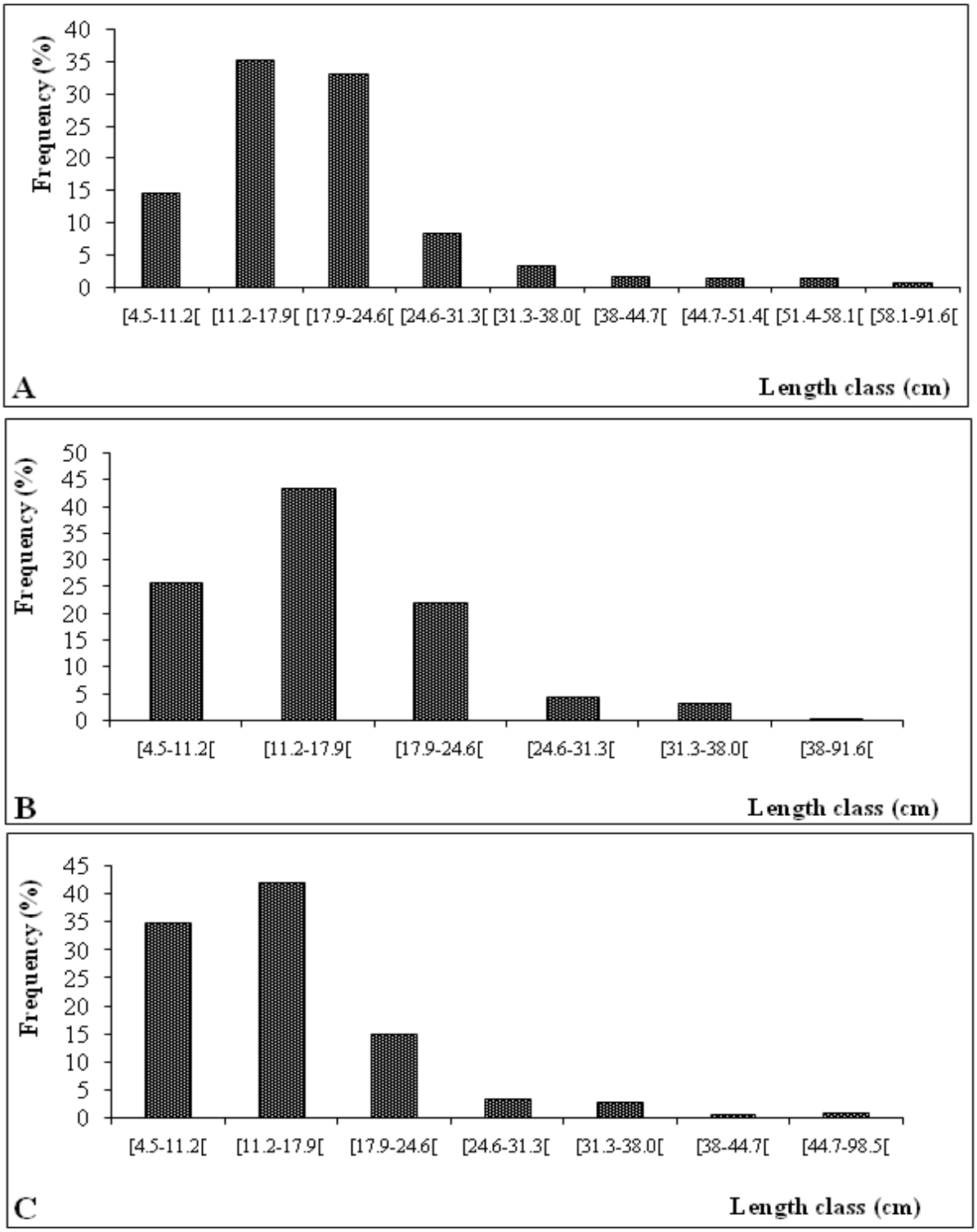

Fig. 5. Frequency distribution of sizes observed in the three localities: Tiassalé (A), Singrobo (B) and N'Zianouan (C) on the Lower Bandama River from July 2013 to June 2014.

This second observation seems plausible for this study because Singrobo (n=37) and N'Zianouan (n=33) less diversified than Tiassalé (n=39) are more influenced by the abusive opening of man-made lake of Taabo than Tiassalé.

According to Tah *et al.* (2009) fishing altered the size structure of fish community. Kantoussan *et al.* (2009) said that these changes made through direct effects (the selection of larger fish) and indirect effects (the proliferation of small species).

Thus, the size structure of fish populations is commonly used in fisheries as suitable indicators of fishing effects (Bianchi *et al.*, 2000; Shin *et al.*, 2005). The analysis of size distribution in this study showed a difference between the three study zones. The maximum and minimum averages sizes higher at Tiassalé may be related to the abundance of large specimens (22.59%) in catches in this locality than Singrobo and N'Zianouan.

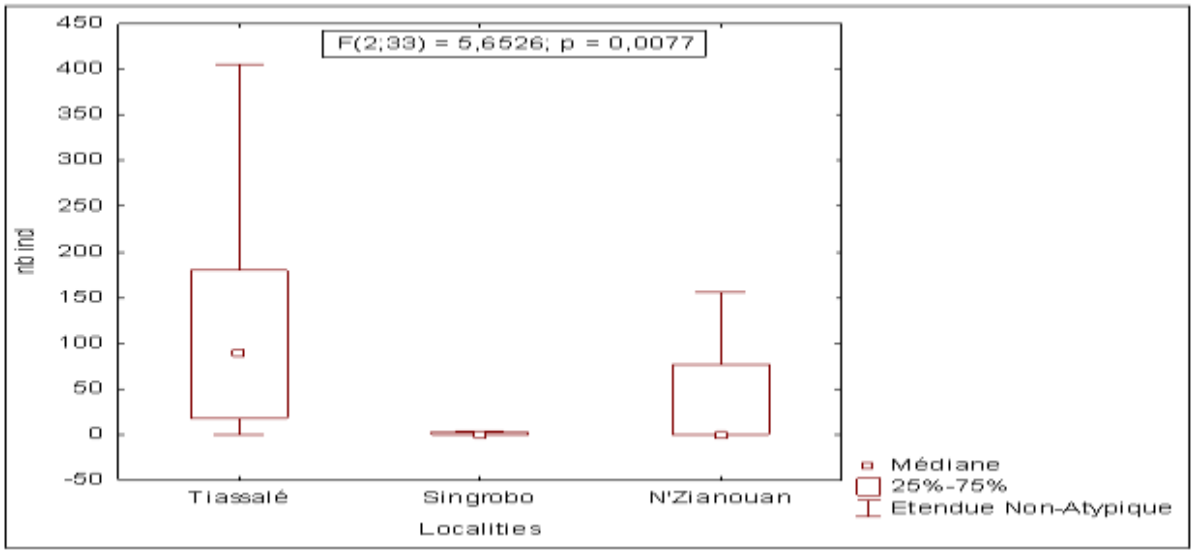

Fig. 6. Variation of catches of large size specimens (over 50 cm) in localities on the Lower Bandama River from July 2013 to June 2014.

The analysis of size structure landed by commercial fishing showed that the small specimens in all localities dominated the fish population on the Lower Bandama River.

This could be explained by a more intense exploitation of the resource on all the Lower Bandama River.

The catch per unit would help to better describe the dynamics of exploited ecosystems (Lelleu, 2012). Overall, in the three zones, the highest catches per unit effort were obtained in drop periods (dry season) and lowest in spite periods (rainy season).

According to this author, CPUE in weight is a suitable operating indicator. CPUE decreased sharply during high water and gradually increase during the low water (Tah *et al.,* 2009).

In this study, the highest values of CPUE during the drop periods and lowest during the spate time could be attributed to hydrological variations in downstream of the lake of Taabo.

Indeed, the spite periods of the lake Taabo causes the abusive opening of its gates.

Thus, the strong current of water followed in the Lower Bandama River makes fishing activity difficult and trained the dispersion of fish in the water column which makes them less vulnerable to fishing gear.

Vanga (2001) linked also this decline to the behavior of the native fishermen which not having a long tradition of fishing, abandon fishing activity at this period for fear of drowning.

In drop time, the few opening of the gates of man-made lake of Taabo led lower water levels in the Lower Bandama River.

Thus, fish specimens tend to concentrate in a small volume of water and become more accessible and vulnerable to high catches.

This period also coincides with farm work diminished as mentioned Vanga (2001) and Tah *et al.* (2009) and fishing activity became more intense.

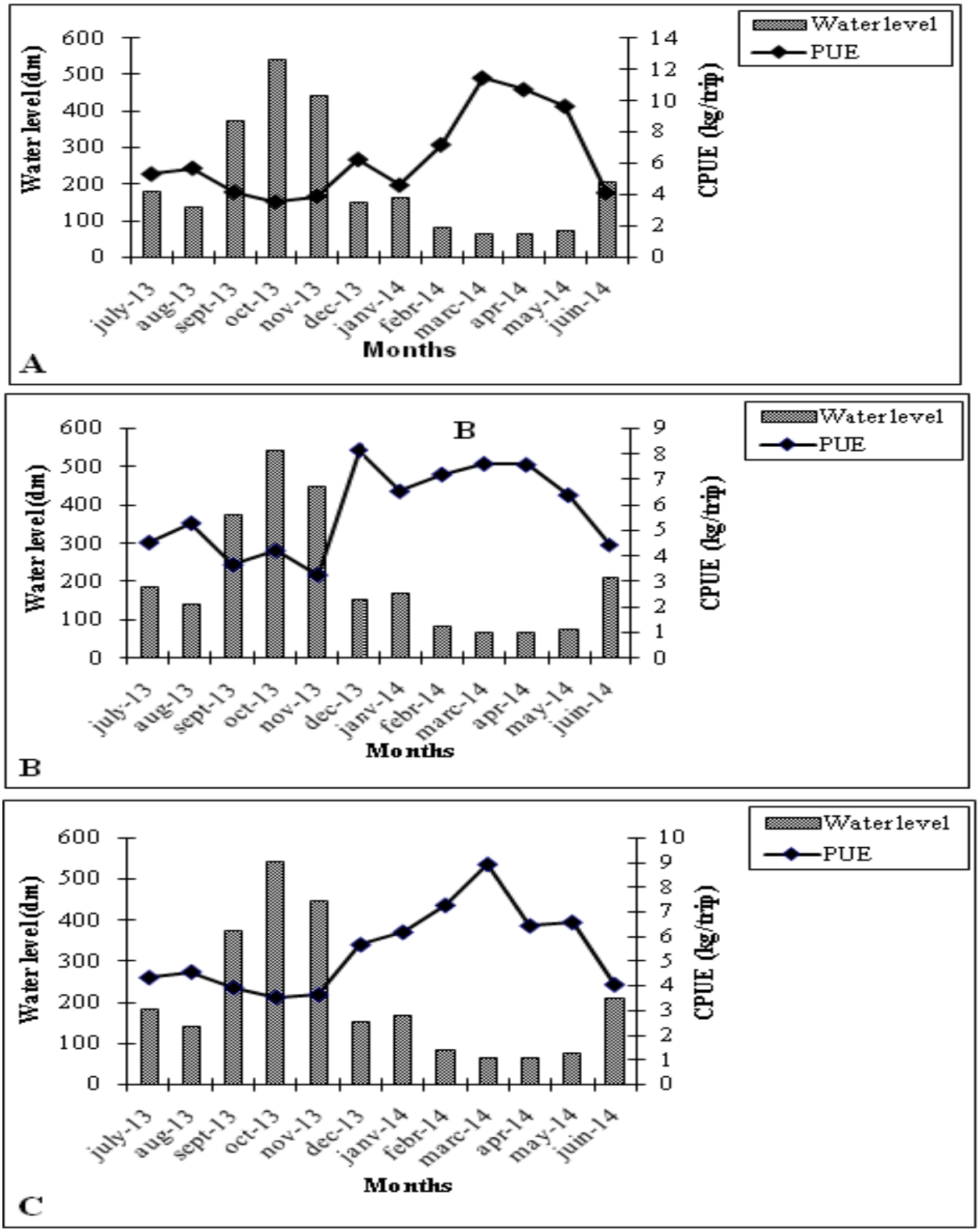

Fig. 7. Monthly variation of catch per unit effort (CPUE) in Tiassalé (A), Singrobo (B) and N'Zianouan (C) on the Lower Bandama River from July 2013 to June 2014.

Conclusion

This study on fishing in Lower Bandama River has provided information on the exploitation of fishes at Singrobo, N'Zianouan and Tiassalé. The size of distribution presents the same modal class in these localities. However, it is observed at Tiassalé the biggest catch per unit effort. Cichlidae and *Chrysichthys nigrodigitatus* are respectively the family and the species of fish most represented within the study area.

Seen the economic interest attaching to the fish in the study area, the present study helps to make seen light on the fishery in the Lower Bandama River for authorities to avoid a possible risk of a collapse stocks.

Acknowledgment

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References

Aboua BRD. 2012. Développement d'un indice d'intégrité biotique piscicole pour la préservation de la biodiversité du fleuve Bandama. Thèse de doctorat, Université Félix HOUPHOUET-BOIGNY, 227 p.

Aboua BRD, N'Zi KG, Kouamélan EP, Berté S, Bamba M. 2010. Organisation spatiale du peuplement de poissons dans le Bandama. International Journal of Biological and Chemical Sciences **4(5),** 1480-1493.

Albaret JJ. 1999. Les peuplements des estuaires et des lagunes. *In* Lévêque C. and Paugy D. eds. Les poissons des eaux continentales africaines. Diversité, écologie, utilisation par l'homme. Paris, Edition IRD: 325-349.

Bachmann RW, Jones BR, Fox DD, Hoyer M, Bull LA, Canfield JDE. 1996. Relations between trophic state indicators and fish in Florida (U.S.A.) lakes. Canadian Journal of Fisheries and Aquatic Sciences **53**, 842-855.

Bianchi G, Gislason H, Graham K, Hill L, Jin X, Koranteng K, Manickchand-Heileman S, Pay I, Sainsbury K, Sanchez F, Zwanenburg K. 2000. Impact of fishing on size composition and diversity of demersal fish communities. ICES Journal of Marine Science **57,** 558-571.

Boguhé GFDH, N'ZI KG, Goore BiG, Kouamélan EP. 2014. Characterization of shrimp fishery in the Bandama River, Côte d'Ivoire. International Journal of Biosciences **4(8),** 23-35.

Daget J, Iltis A. 1965. Poissons de Côte d'Ivoire (eaux douces et eaux saumâtres). Mémoires de l'Institut Fondamental de l'Afrique Noire **74**, 385 p.

Diouf PS. 1996. Les peuplements de poissons des milieux estuariens de l'Afrique de l'Ouest: l'exemple de l'estuaire hyperhalin du Sine Saloum. Thèse de Doctorat de l'Université de Montpellier II, France: 267.

FAO. 2012. Situation mondiale des pêches et de l'aquaculture. http://www.fao.org/docrep.

Fox WWJr. 1970. An exponential surplus yield model for optimizing exploited fish populations. Transactions of the American Fisheries Society 99, 80-88. Challenged by environmental and ecosystem changes: A review. Bulletin of Marine Science **76(2),** 385-462.

Gislason H, Sinclair M, Sainsbury K, O'Boyle R. 2000. Symposium overview :incorporating ecosystem objectives within fisheries management. ICES Journal of Marine Science **57**, 468–475.

Irz P, Laurent A, Messad S, Pronier O, Argillier C. 2002. Influence of site characteristics on fish community patterns in French reservoirs. Ecology of Freshwater Fish **11**, 123-136.

Kantoussan J. 2007. Impact de la pression de pêche sur l'organisation des peuplements de poissons: Applications aux retenues artificielles de Sélingué et de Manantali, Mali Afrique de l'Ouest. Thèse de Doctorat: Mention halieutique Agrocampus de Rennes, France, 195 p.

Kantoussan J, Colla C, Tito de Morais L, Laë R, Dhaussya AL, Simierb M, Guillard J, Erwan J, Ecoutin JM, Albaret JJ, Raffray J. 2009. Use and limits of three methods for assessing fish size spectra and fish abundance in two tropical man-made lakes. Fisheries Research **83(2007),** 306-318.

Leleu K. 2012. Suivi et évaluation de la pêche professionnelle au sein d'une Aire Marine Protégée : protocoles d'enquêtes, et indicateurs de pression et d'impact. Application au Parc Marin de la Côte Bleue. Thèse de Doctorat, spécialité Océanographie, Aix Marseille. Université de Marseille, 298 p.

Link JS. 2002. What does ecosystem-based fisheries management mean? Fisheries **27**, 18–21.

McManus JW, Menez LAB, Kesner-Reyes KN, Vergara SG, Ablan MC. 2000. Coralreef fishing and coral-algal phase shifts: implications for global reef status. ICES Journal of Marine Science **57**, 572–578.

Paugy D, Lévêque C, Teugels GG. 2003. Faune des poissons d eaux douces et saumâtres de l'Afrique de l'Ouest (The Fresh and Brackish Water Fishes of West Africa). Tome, Vol. II. Collection Faune et Flore tropicales 40. MRAC Tervuren, MNHN Paris, IRD Paris-Editions, Paris, 815 p.

Rochet MJ, Trenkel VM. 2003. Which community indicators can measure the impact of fishing? A review and proposals. Canadian Journal Fishing Aquatic Science **60,** 86-99.

Russ GR. 1991. Coral reef fisheries: effects and yields. In: Sale P. F. (ed) The ecology of fishes on coral reefs. Academic, San Diego, 601–635 p.

Schaefer MB. 1967. Fishery dynamics and present status of the yellow fin tuna population of the eastern Pacific Ocean. Inter-American Tropical Tuna Commission, Bulletin **12**, 89-136.

Scherrer B. 1984. Biostatistique. Gaëtan-Morin Montréal, Paris.

Shin YJ, Rochet MJ, Jennings S, Field JG, Gislason H. 2005. Using size-based indicators to evaluate the ecosystem effects of fishing. ICES Journal of Marine Science **62,** 384-396.

Tah L, Da Costa KS, Kouassi NJ, Moreau J. 2009. Preliminary assessment of Major Tilapiine Fishes exploited by artisanal Gillnet Fishery in lake Ayamé I (Bia basin, Côte d'Ivoire). Journal of Fisheries International **4(4),** 83-90.

Teugels GG, Lévêque C, Paugy D, Traoré K. 1988. État des connaissances sur la faune ichtyologique des bassins côtiers de Côte d'Ivoire et de l'Ouest du Ghana. Revue d'Hydrobiologie Tropicale **21(3),** 221-237.

Vanga AF. 2001. Conséquences socio-économiques de la gestion des ressources naturelles : cas des pêcheries dans les lacs d'Ayamé et de Buyo (Côte d'Ivoire).Thèse de Doctorat, Université d'Abobo-Adjamé, Abidjan, 210 p.

Watson R, Pauly D. 2001. Systematic distortions in world fisheries catch trends. Nature **414,** 534–536.

Worm B, Duffy JE. 2003. Biodiversity, productivity and stability in real food webs. TRENDS in Ecology and Evolution **18(12),** 628-632.