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Pellonula leonensis Boulenger, 1916 Fishery in Taabo Lake – Fishing Areas, Fishing Effort and Catches Variability

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Abstract

Variability of production and fishing effort of *Pellonula leonensis* in Taabo Lake are evaluated from August 2014 to July 2015 in the catchment areas identified for this purpose. The enumerated fishing areas were Taabo city and Senegalegoum on the left bank, Courandjourou, Antonio, Port and Dyke on the right bank, Big island and Small island in the central part. Our study shows a spatio-temporal variation of the studied parameters. Taabo city (112.83 t), Antonio (57.64 t) and Senegalegoum (59.61 t) was the most productive and exploited catching areas with 75.87% of the fishing effort. There was, also, a seasonal negative correlation between production and fishing effort in the left and right banks. The maximum landing (70.83%) comes from the left bank during the rainy season. In the dry season, the right bank takes over with 50.70 % of production.

Keywords: *Pellonula leonensis*, fishing areas, fishing effort and production variability, Taabo Lake, Cote d'Ivoire

Introduction

Côte d'Ivoire has a network of rivers, lakes and a large number of water bodies with active fisheries. Fishing activities on Taabo lake began in 1981 ^[1]. Two types of fisheries were developed. The first one, which mainly targets on large-sized fish (*Tilapia*, *Chrysichthys* spp., catfishes, etc.) is practiced by Bozo fishermen from Mali. The second one is related to the fishery of the small pelagic fish species *Pellonula leonensis* which is commonly referred to as "Mimie la go", and exploited by autochthonous people of Taabo village ^[1]. Fishery of *P. leonensis* is very important today, and contributes nearly 250 tons per year to the fishery production of Taabo Lake. This sector of activity is a source of jobs for people of Taabo village and surrounding areas. Recorded activity levels include catching, processing (fish smoking) and commercialization ^[1]. According to Yao (2008) ^[1], 94.12% of fishermen and aids, mostly young, of whom 35.3% have fishery as their only activities, claim to live very well on their income.

However, according the considerable and permanent fishing effort on *P. leonensis* stocks (quasi-daily exploitation), the rationalization of the exploitation of this resource is necessary for the durability of this activity. Indeed, according to Garcia (1986) ^[2] fishing can be a successful activity if it is properly managed. In contrary case, stocks of the exploited Fish species may fall sharply.

With regard to *P. leonensis*, Yao (2008) ^[1] and Kone (2012) ^[3] indicate the overexploitation of its stocks in Taabo Lake. The average size of specimens caught by artisanal fishers in Taabo is 2.37 times smaller than what is observed in Kossou Lake ^[3].

Despite this situation, no rational management plan for this fishery has been put in place on Taabo reservoir. As a result, this work was aimed to characterize the determinants of this fishery, notably: to characterizing *P. leonensis* fishing areas, fishing effort on stocks, production variability by catching area in order to consolidate the scientific database acquired by CNRA to developing a co-management plan with stakeholders for the rational and durable exploitation of stocks.

2. Material and methods

2.1 Field of study

Taabo Lake is a reservoir located between 06 ° 20 'and 06 ° 40' North latitude and 5 ° and 05 ° 30 'West longitude. This hydroelectric dam built in 1978 and started working since 18 January 1979. It is located in about 110 km downstream from the confluence of the White Bandama and the Marahoué, and about 120 km downstream of the Kossou Lake [4]. This lake is the fourth largest in the country in terms of area (69 km²) and 625.106 m³ at the normal reservoir (124 m) for an average

annual flow of 128 m³/s [4,5]. Located at 160 km on Abidjan Yamoussoukro axis, Taabo reservoir is influenced by the transitional equatorial Attiean climate, which is generally observed in the southern part of the country [6]. The region is characterized by four seasons, including: a long dry season (GSS), a large rainy season (GSP), a short dry season (PSS) and a short rainy season (PSP). In this lake, *P. leonensis* stocks are exploited in the lacustrine pocket at the level of open water not occupied by floating aquatic plant mats (Fig 1).

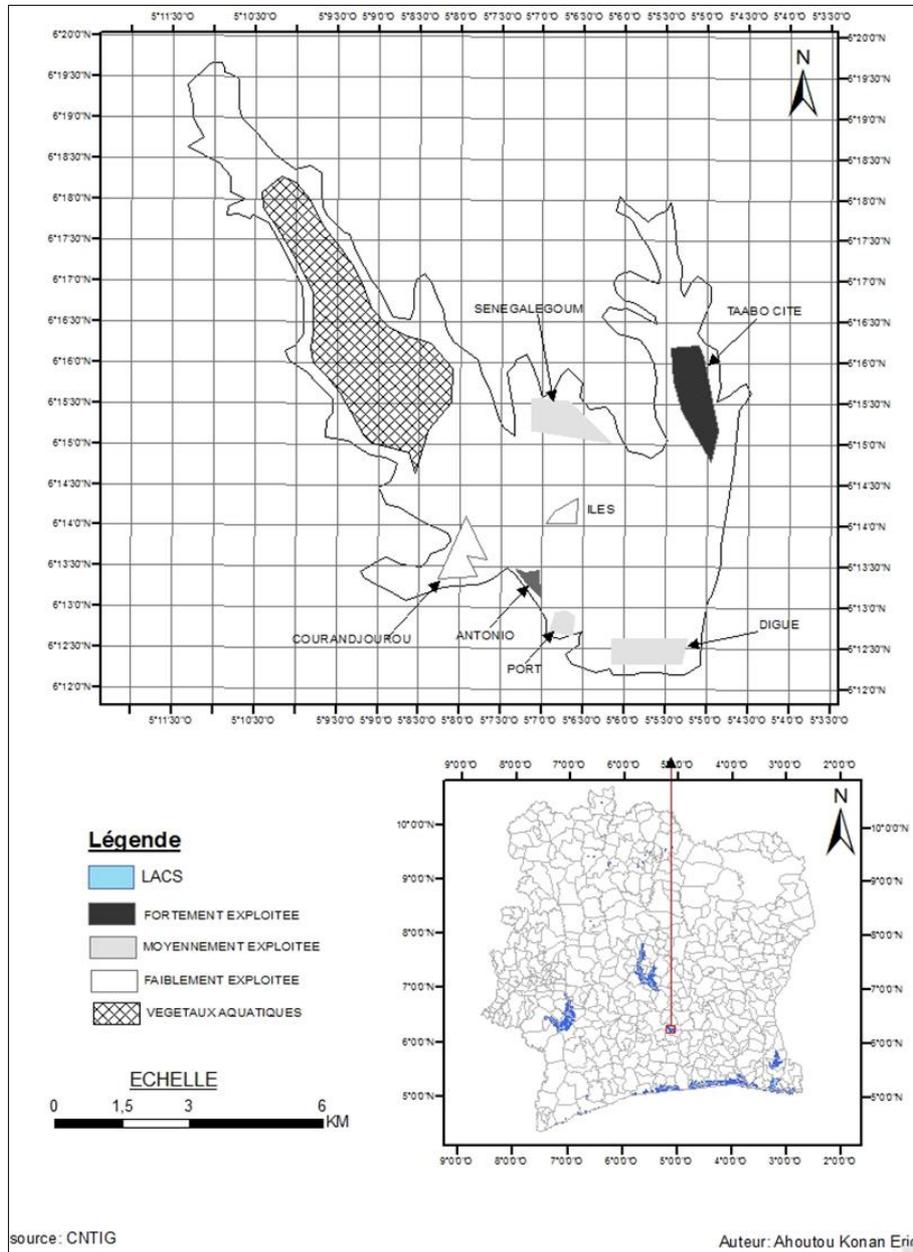


Fig 1: Map of *P. leonensis* fishing grounds at Taabo Dam

2.2 Data collection procedure

For this study, surveys of *P. leonensis* landings were conducted daily from August 2014 to July 2015. Sampling of treated fish specimens focused only on catches from the commercial fishery and on stocks from the different fishing areas in the lacustrine pocket of Taabo Lake.

2.3 Characterization of fishing areas

The characterization of the catching areas was carried out by direct observations in two phases. The first step consisted of

delimiting each fishing area by geolocation of four geographical coordinate points delimiting the different seining zones of *P. leonensis* within the fishing area surveyed. At the same time, a physical description of the fishing areas was carried out. Water temperature was, also, measured during the study cycle. In a second phase, we mapped the different *P. leonensis* fishing areas and sub-areas on Taabo Lake map.

2.4 Assessment of fishing effort and production

The fishing unit used for the exploitation of stocks of *P.*

leonensis has the following basic unit: a four-seater canoe driven by a crew of three sailors and a captain whose fishing gear is a seine net called "Mimie la go" seine^[1]. In the context of this study, the fishing effort considered is all the daily trips of the fishing units in a *P. leonensis* fishing area. It is expressed in number of fishing trips per day of registered "Mimie la go" crews.

Monthly production or monthly catch per fishing area expressed in kilograms was determined by summing the daily landings for each fishing area during the month. The annual production of fishing areas is obtained by adding the monthly catch of each area.

2.5 Statistical analysis

The Chi-square test with the Statistical version 7.1 software was used to test the significance of the fishing effort and the average production of the different fishing zones.

3. Results

3.1 Mapping of identified *P. leonensis* fishing areas

In total, seven fishing zones were highlighted during the present study. These are large bays of Antonio, Iles, Senegalegoum, Courandjourou, Taabo city, Dike and Port (Fig 1) which were the main catching areas. These catching areas were subdivided into twenty-seven sub-fishing zones. The physical characteristics of the seven identified fishing areas were as following:

Senegalegoum - This fishing area was located on the left bank of the lake at 06 ° 14.731 'N - 005 ° 06.402' W. The canopy in this area of the lake pocket was small. Within this catchment area, there were 5 subzones which include: Kokro, Tomatekro, Synthetic, Banana, down Rhônier and Rhônier coupé. Flora observed in this place are, in particular, aquatic plants such as *Salviniamolesta*, *Eichornia crassipes*, respectively, of the families Salviniaceae and Ponderaiceae. The landscape was composed of herbaceous plants and Palmyra. A bozo fishing camp was, also, observed in the Kokro fishing sub-area. The bottom of the lake in this part was generally, sandy, except from Synthetic sub-zone level, which was characterized by the presence of dead wood stumps.

Taabo city - Located at 06 ° 15.777 'N - 005 ° 05.027' W, this fishing area on the left side of Taabo Lake has a weak canopy and is subdivided into five seining sub-areas (Papayer, Cité port, Goumba, Srabana and Fahassou). The substrate at this location was sandy and muddy in some places. The landscape around this area is marked by the presence of trees of various species. In addition, there was a sweet banana agro-industrial plantation. The landscape was also sparse with Palmyra.

Courandjourou - This fishing zone is located at 06 ° 13.778 'N - 005 ° 08.379' W and has several sub-seining areas. These were Courandjourou bay, down acacia and old cemetery (remains of the cemetery of Taabo ancient village covered by water). The vegetation in this area that shelters *P. leonensis* fishing areas in Courandjourou Bay closed to the Bozo fishermen camp, was rather shrubby with a relatively weak canopy. The bottom of the lake in this area was mostly muddy.

Dike - located on the right bank of the lake at 06 ° 12.327 'N - 005 ° 06.038' W. The name of this catching area of *P.*

leonensis results from the fact that it is closed to the dike of the dam. The recorded fishing sub-areas are, respectively, Tondjonssou, En bas de fromager and Goudron. The Dike fishing zone was marked by herbaceous vegetation and a few feet of Palmyra. We can, also, note the presence of an oil palm field. The substrate was, mostly, sandy and gravitational. The canopy was, also, relatively weak.

Port - This *P. leonensis* fishing area located at 06 ° 12.556 'N - 005 ° 06.415' W has a very low canopy. Three seining sub-zones were observed. They are Caillou and Tasso. Port was characterized by the presence of colonies of floating aquatic plants such as water hyacinth (*Eichornia crassipes*) and water fern (*Salviniamolesta*). The landscape was marked by the dominance of cassava fields and, also, the presence of a palm grove. In this fishing area, water bottom was sandy and muddy.

Antonio - This fishing area was located on the right side of Taabo Lake (06 ° 13.442 'N - 005 ° 07.001' W). Five seining sub areas were registered in this zone, notably: Déhi, Tondjonssou, Kragbe, Large and Village. In all of these sub-zones, the landscape was arboreal. Antonio area was characterized by the presence of pineapple and plantain fields, and parcels of vegetable crops on the banks. The bottom of the lake in this area was sandy with granitic and schistose elements. This catchment area was characterized, also, by many strains of wood.

Islands - Two islands were observed in this *P. leonensis* fishing area, as following: a small island and another larger located, respectively, at 06 ° 14.141 'N - 005 ° 07.088' W and 06 ° 14.673 'N - 005 ° 07.070' W. A tree vegetation is very developed in these places, translating a slightly closed canopy. The presence of animals such as monkeys was reported as the largest of the islands. The bottom of the lake near the islands was marked by the presence of chippings, stumps and dead wood.

3.2 Temperature

The temperature of the water in *P. leonensis* capture areas varied from season to season. During the long dry season (GSS), the maximum temperature (27.91 ± 0.47 ° C) was recorded in Antonio area (right bank). The lowest value (27.63) was recorded at Senegalegoum catching area (left bank). For the long rainy season, the highest value was reached in Senegalegoum area (27.79 ± 0.48 ° C) on the left bank. During the short rainy season, the waters are warmer in the areas of the right bank (Port and Dike). In these areas the temperature was respectively 27.94 ± 0.97 ° C and 27.83 ± 0.94 ° C against a lower temperature in Taabo city (27.26 ° C) and Senegalegoum (27.68 ° C) on the right bank. In the short dry season, the average temperature of all fishing areas of the left bank (26.81 ± 0.41 ° C) is relatively similar to that of the right bank (26.87 ± 0.12 ° C).

3.3 Fishing effort in the catchment areas of *P. leonensis* in Taabo Lake

The number of fishing trips during the study period in all the fishing areas was 3713. Moreover, this annual fishing effort made by *P. leonensis* fishermen is different from one area of capture to another. This overall trend is also observed monthly. Annually, it appears that three catching areas namely Taabo city, Antonio and Senegalegoum record alone

75.87% of fishing trips with, respectively, 1078; 999 and 740 trips. The other catching areas distribute one another the remaining 24.13%. These were the areas of Dike, Port, Courandjourou and Islands. Fishermen of *P. leonensis* carried out 396 and 274 fishing trips, respectively in Dike and Port. In addition, the lowest trips were obtained in Courandjourou (193 trips) and Islands (33 trips).

Taabo city was the most exploited area during the short dry season (PSS) with 176 fishing trips accounting for 45.13% of all observed trips. During this climatic season, the fishing effort was of 96 (24.62%) and 84 trips (21.54%), respectively, for Senegalegoum and Antonio. The smallest number of fishing trips is observed during this period in Dike, Courandjourou and Port. The fishing trip rate was less than 4%. No fishing trips were observed in the islands area during the short dry season.

In the short rainy season (PSP), the fishermen of *P. leonensis* focus mainly on two areas. These are Taabo City and Senegalegoum with, respectively, 341 and 299 fishing trips. These spaces record at this period almost 86.60% of the fishing effort. In the other catching areas and, particularly in Antonio, our surveys indicate a decline of activity. 16 fishing trips representing 2.17% of the fishing effort was observed in Antonio against 21.54% in PSS. The number of fishing trips noted at Dike and Courandjourou were, respectively, 27 (3.65%) and 16 (2.03%) fishing trips.

Moreover, during the long dry season (GSS), fishing activities were more concentrated at Antonio with 28.40% (418 trips) of the fishing effort. An increase in fishing effort was also observed, although, at Dike (225 trips), Courandjourou (132 trips) and Port (224 trips) during this season. From a spatial point of view, all these catching areas were located into the right side of Taabo Lake. In contrast, a drop in fishing effort was observed in the fishing areas of the left bank of the lake, namely Taabo city and Senegalegoum. In this season, these places recorded respectively 177 and 280 fishing trips. With regard to the long rainy season, the largest number of fishing trips was observed in Antonio catching areas. In this period, 43.23% of the fishing effort on Lake Taabo was deployed in this area. However, Taabo city shows an almost similar fishing effort with 384 fishing trips (34.53%). In the other listed fishing zones (Senegalegoum, Dike, Courandjourou, Port and Islands), a drop in fishing effort was also recorded in the long dry season. The areas of Dike and Courandjourou record the lowest values of the fishing effort with respectively 137 and 31 fishing trips. From this acquired data, the exploitation diagram of the fishing zones of *P. leonensis* in Taabo lake can be established as following: Of all the climatic seasons, the long rainy season (GSP), remains a period during which Senegalegoum zone was less exploited by "Mimie la

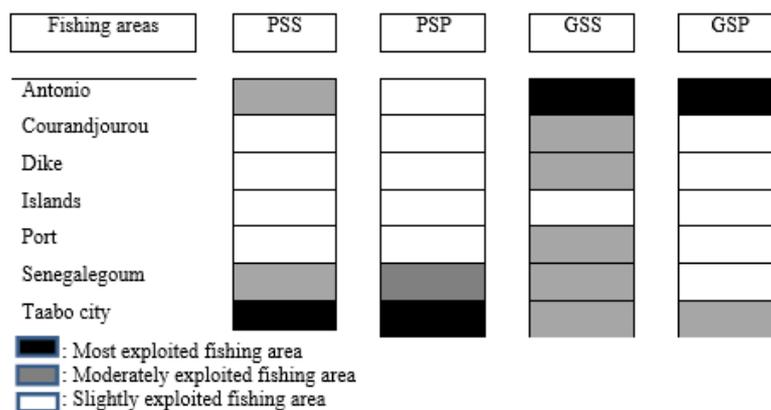
go" fishermen. Overall, the ranking of fishing areas according to the importance of the deployed fishing effort (number of fishing trips) over an annual cycle was as following: 1- Taabo city (1078); 2- Antonio (999); 3- Senegalegoum (740); 4- Dyke (396); 5- Port (274); 6- Courandjourou (193); 7- Islands (33).

3.4 Production of *P. leonensis* in catchment areas of Taabo Lake

The production of *P. leonensis* from the different catch areas was 279.16 tons. In addition, 40.42% of this production comes from the zone of Taabo city for an annual quantity of 112.83 tons. The landing from Senegalegoum and Antonio fish was 59.61 and 57.64 tons, respectively. The other catching areas of less production were Courandjourou, Dike, Port and Islands. In these sectors, annual production was between 2.55 tons (Islands) and 22.02 tons (Dike). It was noted, however, that 9.43 tons of *P. leonensis* landed in the Port area (Fig 2).

This spatial variability in the production of this Clupeidae in Taabo Lake was also observed at the different climatic and zone seasons. Thus, our surveys indicate, that the Taabo city production is the largest during the two rainy seasons (PSP and GSP) with 83.38 tons. During these seasons, the smallest productions are recorded in Iles, Port and Courandjourou with, respectively, 1.45 tons, 1.9 tons and 2.06 tons. Furthermore, in the dry season, our study data shows a decline in the production of *P. leonensis* in the area of Taabo city against an increase in the tonnage of this fish species in the areas of Courandjourou and Port. Production increases from 13.01 tons in the dry season to 2.06 tons in the rainy season at Courandjourou. This trend was also observed in Port whose quantity of fish landed was 7.53 tons in rainy season and 1.90 tons in dry season. In Senegalegoum and Antonio, the weight of *P. leonensis* catches reached 36 and 34.10 tons, respectively, in the rainy season and just over 23.50 tons in these two areas. Dike and Island areas show less variation in seasonal fish production. In fact, landings of *P. leonensis* rise from 10.93 tons in the dry season to 11.09 tons in the rainy season in the Dike area. The quantity of fish weighed in the dry season was 1.09 tons, while it reached 1.46 tons in the rainy season in the Islands area.

Of all the climatic seasons, the most important landing of *P. leonensis* was noted in the short rainy season and is observed in the area of Taabo city for 45.49 tons. During the long rainy season, 81.48% of the quantity of fish landed comes from the fishing areas of Taabo city (left side) and Antonio (right side). In the areas of Taabo city, Courandjourou and Port, a very marked seasonal production differential (rainy season and dry season) was recorded compared to other catching areas.



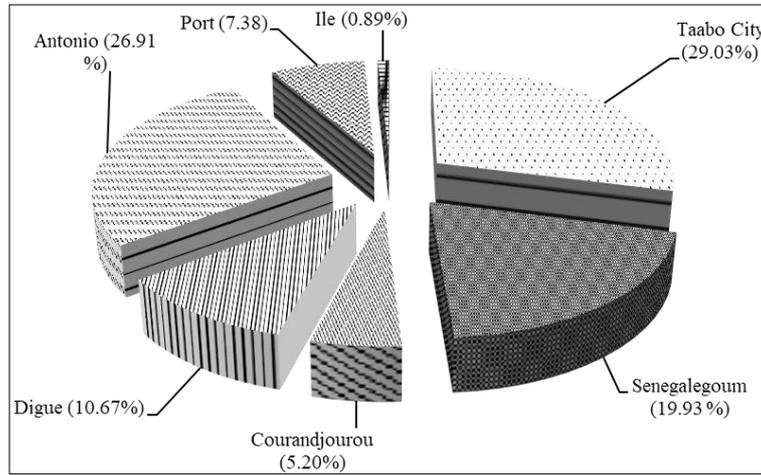


Fig 2: Fishery Area Log (A) and Annual Fishing Effort Frequency by Fishing Area (B)

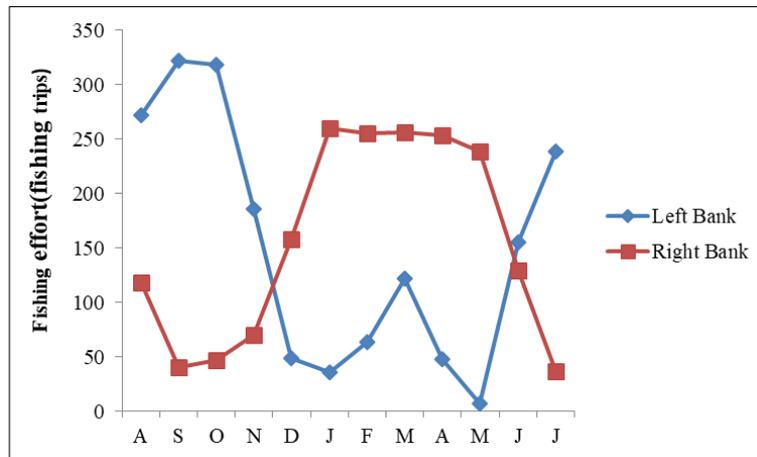


Fig 3: Annual variation in fishing effort on the left and right banks of Lake Taabo

Table 1: Seasonal variations in fishing effort of different fishing areas

	Taabo city	Senegalegoum	Digue	Antonio	Courandjourou	Port	Ile
PSS	176	96	7	84	15	12	0
PSP	341	299	27	16	15	29	12
GSS	177	280	225	418	132	224	16
GSP	384	65	137	481	31	9	5
SS	353	376	232	502	147	236	16
SP	725	364	164	497	46	38	17
Mean ± Ecartype	269,5 ± 108,81	185 ± 121,58	99 ± 101,6	249,75 ± 233,74	48,25 ± 56,34	68,5 ± 104,04	8,25 ± 7,14

Table 2: Seasonal variation of *P. leonensis* production in the different catchment areas of Taabo Lake

	Taabo City	Senegalegoum	Courandjourou	Digue	Antonio	Port	Ile
PSS	13,2	5,54	0,93	0,1	2,99	0,24	0
PSP	45,49	30,93	0,68	2,04	1,178	1,79	0,964
GSS	16,24	18,05	12,084	10,83	20,54	7,28	1,095
GSP	37,89	5,07	1,38	9,04	32,92	0,11	0,49
SS	29,44	23,59	13,014	10,93	23,53	7,52	1,095
SP	83,38	36	2,06	11,08	34,098	1,9	1,454
Mean ± Ecartype	28,205 ± 15,93	14,897 ± 12,26	3,768 ± 5,55	5,502 ± 5,23	14,407 ± 15,12	2,355 ± 3,37	0,637 ± 0,50

4. Discussion

The total fishing effort recorded in all *P. leonensis* catching areas in Taabo Lake is of 3713 fishing trips. This value is higher than that obtained by Kone (2012) [3] which indicates 3547 fishing trips. This result reflects sustained and increasing exploitation of this fish species stocks. According to Khoufi (2015) [7], the increase in fishing effort has a negative impact on exploited stocks. For this author, an increase in fishing effort of 50% would lead to a loss of

biomass of 19 to 56%.

Fishing trips recorded at Taabo Lake were unequally distributed over the entire lake. A total of 1078 trips were made in the area of Taabo city, 999 in Antonio and 740 in the Senegalegoum area. In these three catching areas, 75.87% of the fishing effort by *P. leonensis* fishermen was recorded. The contribution of other fishing areas was 24.13% of fishing trips. We can deduce from these indications, that areas of Taabo city, Antonio and Senegalegoum were the most

important fishing areas of *P. leonensis* at Lake Taabo. As a result, they represent a privileged area of migration for this fish species in this waterbody. This fishing effort differential in the different catching areas of *P. leonensis* in Taabo Lake was, also, observed at the Fae Lake (San Pedro river Basin; Cote d'Ivoire) with regard to the exploited fish species. According to Da Costa *et al.* (2008)^[8], the maximum fishing effort in this reservoir was deployed, especially, in catching areas with numerous bays and floodplains. This was the case of the fishing areas of Taabo city, Antonio and Senegalegoum.

This zonation in the exploitation of fishing areas is, also, observed in the Aby Lagoon (Côte d'Ivoire)^[9]. Indeed, N'goran (1990)^[9], indicates a difference in fishing effort between the northern and southern parts of Aby lagoon for the exploitation of *Ethmalosa fimbriata* stocks. The total fishing effort for beach seines recorded in this lagoon were 2392 fishing trips to Aby North and 3713 to Aby South. According to the fishing effort deployed per catching area, the maximum cumulative fishing trips during the short dry season (PSS) and the long dry season are recorded at Antonio on the right bank (502 trips) against 353 trips in Taabo city and 376 trips in Senegalegoum. In contrast, the maximum number of fishing trips during the small and large rainy seasons was observed in Taabo city on the left bank, e.g. 725 trips. From these observations, there was a seasonal shift in fishing effort in the different catching areas depending on the availability of *P. leonensis* stocks.

This dynamic of fishing effort in the fishery of *P. leonensis* may be characteristic of Taabo Lake trophy in the lacustrine pocket. Indeed, Martyn *et al.* (2001)^[10] indicate that fish migration in several spatio-temporal scales is likely to be a response to fluctuations in prey availability. For Charnov (1976)^[11], this is also due to the fact that fish must conform to food foraging patterns in an unevenly distributed food environment. This situation could, also, be due to the physico-chemical regime of the waters in the different catching areas. Concerning the physicochemical parameters at Lake Taabo, our temperature data indicate a relative variability of the temperature in the fishing areas. Indeed, during the long rainy season, the waters are warmer in the catching areas in the left bank of Taabo Lake. Comparatively, at this season, the temperature was lower in the right bank. During the short rainy season, we observe an inversion of this situation. Temperature of the waters is higher (27.94 ± 0.97 °C) on the right bank than in the left. Gropa (2012)^[12] observes, also a difference of this parameter in the different areas Taabo Lake. In terms of temperature, this author noted a larger value (29.18 ± 0.53 °C) in Taabo city (left bank) compared with Dike (29.15 ± 0.48 °C) and Port (28.89 ± 0.31 °C) located on the right bank of the lake.

As concern the production of *P. leonensis* from the catching areas during the study period, its total value is of 279.16 tons. This production is higher than that obtained by Yao *et al.* (2015)^[13] and Kone (2012)^[3], which report annual production of 250 and 211.86 tons, respectively. These data show, moreover, from 2007 to 2015, an increase in the production of *P. leonensis* of the order of 30%. This reflects fishing pressure on this fish species stocks. For comparison, the production of *P. leonensis* in Kossou Lake using gillnets is much lower and is equivalent to 9,008 tons^[3].

In addition to the increase of fishing pressure, the use of *P. leonensis* seines, often lined with mosquito nets (1 mm mesh) by fishermen on Taabo Lake, may be responsible of the

increase in fishing production of the considered Fish species. In Africa, according to Laë (1997)^[14], the increase in demography, the introduction of nylon net and the conjunction of subsistence activity have led to an increase of fishing effort in lake environments. This has the direct consequence of increasing and stabilizing landings at a high level. Moreover, the distribution of catches of *P. leonensis* by lake sector shows, that the catching areas of Taabo city, Senegalegoum and Antonio are the most productive (82.42%) compared to Courandjourou, Port, Dyke and Islands (17, 58%). This trend was, also, observed in Fae Lake. Indeed, Da Costa *et al.*, (2008)^[8] indicate an inequality of catches for the three main fishing zones. According to these authors, the analysis of catches by fishing zone in Fae Lake shows that the most productive fishing sectors are in order of importance sectors 2 and 1 compared to sector 3 contiguous to the dyke and which makes a small contribution to the production of Fish. As for Clupeidae *Ethmalosa fimbriata* captured by beach seine in Aby lagoon, the same dynamics are observed (N'goran, 1990)^[9]. Production of this fish species is of 1534.4 tons in the northern sector and 1111.5 tons in the southern part. This seasonality or difference in the landings of *P. leonensis* with respect to the different catching areas would, thus, be linked, on the one hand, to the seasonality of the activity of the fishing units of "Mimie la go" and, on the other hand, to the availability of this resource. By similarity, blue Fish species travel at sea level in searching of spawning grounds and optimal conditions of the environment^[15-25]. Consequently, part of the biomass usually composed of large individuals adults become, outside the breeding season, inaccessible to fishermen, who fish in traditional catching areas (shallow coastal fringes).

5. Conclusion

This study of the spatio-temporal variability of the production and fishing effort of *P. leonensis* in Taabo Lake shows the indicators determining the evolution of this fishery. We can conclude, that the fishing of *Pellonula leonensis* currently named "Mimie la go" in Taabo Lake is, mainly, carried out in seven fishing areas characterized by zones with trees and some without tree stumps. These identified fishing areas are, on the one hand, Taabo city, Senegalegoum on the left side of the lake and, on the other hand, Courandjourou, Port, Antonio and Dyke on the right bank, and, finally, the zone of big and Little islands in the central zone. The annual fishing effort on this waterbody is deployed mainly on three areas that are Taabo city, Antonio and Senegalegoum. Also, in the rainy season, fishing is concentrated on the catching areas of the left side of Taabo Lake. At the opposite, during the dry season, there is an increase in fishing effort in the catching areas on the right side of this reservoir.

On the basis of these results, effective and sustainable co-management measures of *P. leonensis* stock are essential for the long-term preservation of this resource in Taabo Lake. These should consist, on the one hand, of reducing the fishing effort and, on the other hand, of the periodic closure of *P. leonensis* fishery on the basis of the scientific results relative to the ecology and the fishing biology of the considered fish species. In perspective, the closure of the catching areas of *P. leonensis* in Taabo Lake can be considered in the light of our study. In this context, the reduction of the fishing effort requires, among other things, the reduction of the fishing time for the capture of *P. leonensis*.

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7. Références

1. Yao A. Données préliminaires sur la pêche du petit pélagique *Pellonula leonensis* Boulenger, 1916 (Pisces ; Clupeidae) dans le lac de barrage de Taabo (Bassin du Bandama, Côte d'Ivoire). Mémoire de D.A.A., ESA/INPHB/CNRA, Yamoussoukro, 2008, 87.
2. Garcia S, Demetropoulos A. L'aménagement de la pêche à Chypre. FAO. Document technique sur les pêches. 1986; 250 :43.
3. Koné N. 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 Taabo (fleuve Bandama Côte d'Ivoire), 2012, 174.
4. Kouassi K. Hydrologie, transport solide et modélisation de la sédimentation dans les lacs de barrage hydrologiques de Côte d'Ivoire: Cas du lac de Taabo. Thèse unique, Université Nangui Abrogoua d'Abobo, 2007, 209.
5. Aliko N, Da Costa KS, Konan KF, Ouattara A, Gourène G. Fish diversity along the longitudinal gradient in a man-made lake of west africa, Taabo hydroelectric reservoir, Ivory Coast. Rbarstvo. 2010; (2) :47-60.
6. Issiaka S, Aboudramane K. Principaux facteurs environnementaux de la Côte d'Ivoire in Atlas de la Biodiversité de l'Afrique de l'Ouest, Côte d'Ivoire Tome III. 2010, 560.
7. Khouffi W. Biologie, dynamique des populations et gestion des pêcheries (*Merluccius merluccius*, 1810) en Tunisie. Thèse de Doctorat, Institut National des sciences et technologies de la mer, 2015, 225.
8. Da Costa KS, Dietoa Y. Production halieutique du lac Fae (Bassin de san pedro) en region sud ouest de la Côte d'Ivoire. Agronomie Africaine. 2008; 20(3):313-329.
9. N'Goran Y. La pêche artisanale en lagune Aby (Côte d'Ivoire), Analyse des captures en 1988 et 1989. Arch. Sci. cent. Rech. Oceanogr. Abidj, 1990; XIII(1):11-41.
10. Martyn C, Etienne B, Timothy J, Annie D, Ondrey S. Migration of freshwater Fisher. 2001, 441.
11. Charnov E. Optimal foraging: the marginal value theorem. Theorem population Biology. 1976; 114:67-76.
12. Grogga N. Structure, Fonctionnement et Dynamique du phytoplancton dans le lac de Taabo (Côte d'Ivoire). Thèse de Doctorat, Université de Toulouse, France, 2012, 224.
13. Yao A, Costa DAKS, Dietoa Y. Small pelagic fish *Pellonula leonensis* Boulenger, 1916 (Piscès ; Clupeidae) fishery in Taabo Lake: Typology, yield and socio-economic characteristics. International Journal of Fisheries and Aquatic Studies. 2015; 3(1):392-399.
14. Laê R. Estimation des rendements de pêche des lacs Africains au moyen de modèles empiriques. Aquat. Living Resour. 1997; 10:83-92.
15. Rijavec L, Zaara Y. Distribution et abondance relative des stocks de poissons pélagiques dans les eaux tunisiennes en 1972. Bull. Pêche, 1974; 1:86-132.
16. Rijavec L, Gueblaoui M. Distribution, abondance relative et identification des stocks au large de la Tunisie en 1973. Bull. Pêches. 1975; 2:1-68.
17. Boely T. Biologie de deux espèces de Sardinelle (*Sardinella aurita* Valenciennes 1847 et *Sardinella maderensis* Lowe, 1841). Thèse de Doctorat d'état de l'Université de Paris VI et Museum National d'Histoire Naturelle, Paris. 1979, 219.
18. Belvèze H. Biologie et dynamique des populations de sardine (*Sardina pilchardus* Walbaum) peuplant les côtes atlantiques marocaines et propositions pour un aménagement des pêcheries. Thèse de Doctorat d'Etat de l'Université de Bretagne Occidentale, 1984, 532.
19. Cury P, Fontana A. Compétition et stratégie démographiques comparées de deux espèces de sardinelle (*Sardinella aurita* et *Sardinella maderensis*) des côtes ouest Africaines. Aquat. Liv. Resour. 1988; 1:165-180.
20. Fréon P. Réponses et adaptations des stocks de clupeidés d'Afrique de l'Ouest à la variabilité du milieu et de l'exploitation : Analyse et réflexion à partir de l'exemple du Sénégal. Collection Etudes et Thèse. ORSTOM. 1988; 287.
21. Marchal E. Nanisme et sédentarité chez certaines espèces de poissons pélagiques: deux aspects d'une même réponse à des conditions défavorables. Dans : Pêcheries ouest-africaines. Variabilité, instabilité et changement. Cury P. et Roy C. (eds). Colloque et Séminaire. ORSTOM, Paris. 1991, 201-207.
22. Roy C. Réponses des stocks de poissons pélagiques à la dynamique des upwelling en Afrique de l'ouest: Analyse et modélisation. Etude et Thèse, ORSTOM, Paris. 1992, 146.
23. Csirke J. Fluctuation in abundance of small and mid-size pelagics. SCI. Mar. 1995; 59(3-4):481-490.
24. Binet D. Hypotheses accounting for the variability of sardinella abundance in the northern Gulf of Guinea in: Dynamique et usage des ressources en sardinelles de l'upwelling côtier du Ghana et de la Côte d'Ivoire. Bard, F.X et Koranteg, K.A. (eds). ORSTOM: Paris. 1995, 98-133.
25. Pauly DP. Méthodes pour l'évaluation des ressources halieutiques. Adaptation française Moraue J Cepadues, Paris. 1997, 288.