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# Fish Assemblages and Fishery Analysis at the Mare aux Hippopotames in Burkina Faso

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**Abstract:** Fish populations and the exploitation of water bodies data are essential for the implementation of sustainable fisheries management strategies. Thus, fish diversity, fisheries production and fishermen's income in the «Mare aux Hippopotames» located in western Burkina Faso were studied. This study aims to characterise the fish fauna and fisheries in this natural lake. From 12 to 16 May 2020, experimental fishing was conducted using gillnets with mesh sizes of 10, 20, 35 and 40 mm and cast-nets in five stations. Supplementary data were collected within 22 commercial fishing landings. In total, 1642 fish individuals belonging to 29 species were collected. Twenty-two genera and 13 families were identified. *Sarotherodon galilaeus* is the dominant species (46.83%) followed by *Oreochromis niloticus* (11.02%), *Brycinus nurse* (10.66%). The fish fauna is quite varied and reflects the characteristics of the tropical fish fauna. Length-weight relationship revealed that some fish species have allometric growth while others have isometric growth. The density of fishermen, which is between 0.18 and 0.36 fishers per hectare shows a moderate pressure on the reservoir. The total production of the lake is estimated at 47.85 tonnes per year, i.e. an average yield of 398.78 kg. $ha^{-1}$. The average annual income of the fisherman is estimated at 528,000 FCFA.

**Keywords:** Fish Fauna, Fishing, Condition Factor, Income

## 1. Introduction

Aquatic ecosystems are both diverse and sensitive to anthropogenic activities [1]. Thus, natural lakes, artificial lakes and rivers from Africa have been studied extensively [2-4]. Also, some intensive projects [5, 6] made deep researches. However, in the African continent, scientific information has remained scarce, fragmentary, difficult to access, and the statistical methodologies used are often not harmonized [7]. For fish production, as example, yields often seem to be calculated intuitively by empirical procedures or, more recently, by applying indices based on data for other similar water bodies [8].

In the fields, only part of the production is declared and recorded in official statistics [9]. The productions like those of subsistence fisheries are devoted to family consumption and are not taken into account in the statistics. The quantities caught in these fisheries are likely to be very large [10]. According to Béarez [9], the actual fish landings from running waters are about twice higher than those that appear in the catch statistics in Burkina Faso. However, the fisheries administration believes that only 1/3 of the catches are not weighed.

Burkina Faso is not provided with large natural water bodies and rivers. Nowadays, the production of capture fisheries tends to stabilize and even decrease, as the stocks are fully or over exploited to satisfy the high demand of fish products and also due to bad environmental, climatic and hydrological conditions. However, hopes of increasing production by opening new

reservoir fisheries and/or aquaculture implementation are jeopardised by the rapid deterioration of aquatic environments influencing negatively certain fisheries [7]. In Burkina, in a few exceptional water bodies, a good fishery management could lead to a further increase in local production and generate substantial income for populations.

In Burkina Faso the Hippopotamus Pond or "Mare aux Hippopotames" is one of these aquatic ecosystems. It is a natural lake opened to commercial fishing between 1955 and 1958 [11]. Actually, it is part of a multi-status conservation area. The assessment of wetland ecosystems and their vulnerability pointed out, the disappearance of vegetal and animal species as a result of climate change and human activities [12]. Hence, listing animal and plant species of this ecosystem as well as their relationships is critical for its sustainable use [12]. In order to characterize the Hippopotamus Pond as well as its fish population, several studies such as Blanc and Daget [13], Béarez [9] and Compaoré et al. [14] have been carried out. These different studies have reported the presence of several fish species, belonging to different trophic levels. However, information regarding the morpho-metric characteristics of the fish and the exploitation of the fishery were scarce. Therefore, the present study was conducted to fill this gap.

The overall objective of this study is to characterize the fishery of the Mare aux Hippopotames of Balla. The specific objectives are (i) describe the structure of the fish fauna; (ii) analyse the dynamics of the exploitation of the fish resources and (iii) estimate the production and the income from the fishery.

## 2. Materials and Methods

### *2.1. Study Area*

The Mare aux Hippopotames of Balla or Hippopotamus Pond of Balla is a natural lake about 60 Km far from Bobo-Dioulasso and located in the Department of Satiri. It is a depression in the floodplain of the right hand side of the Mouhoun River bank and fed by numerous phreatic resurgences [9]. The lake is about 2.6 km long (direction northwest-southeast) and 700 m wide. However different sources give different estimates of its size: 80 to 350 ha according to Béarez [9] and 120 to 660 ha according to UCFHB [15]. The last source mentions that the water is 3 m deep.

The Hippopotamus pond has several national and international conservation status. It is a classified forest since 1937, a Biosphere Reserve since 1987, a Ramsar site since 1991 and then a Wildlife Conservation Unit in 2003 [16]. It hosts a population of hippos whose protection status could be beneficial to other species dependent on the lake.

### *2.2. Fish Sampling and Fish Species Determination*

Fish were sampled from May 12 to 16, 2020 in five stations chosen according to their accessibility. We used gillnets of 10 mm, 20 mm, 30 mm, 35 mm and 40 mm mesh side and a cast net of 40 mm mesh side to catch fish. The fishes were identified to species level using Paugy et al. [17, 18]. Then, each specimen was weighed (total weight W) to the nearest 0.1 g using an electric balance (CONSTANT brand / model 14192-33) and its total length ($L_T$) was measured to the nearest mm. The names of the fish in bobo, a local language of the area, were also given by the local fishermen. Fish specimens whose determination was uncertain were sent to the Laboratory of Animal Biology and Ecology of the University Joseph Ki-Zerbo in Ouagadougou for confirmation.

We also observed the commercial landings, in search for species and fish size that we were not catching.

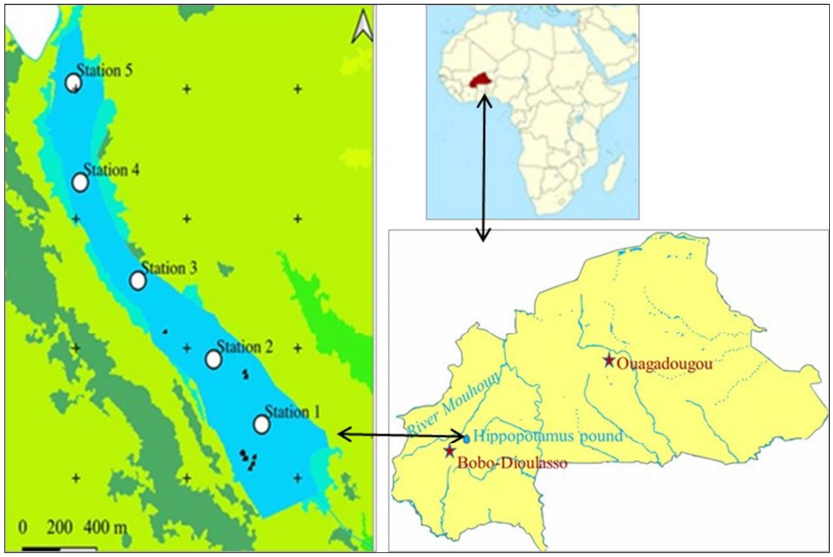


***Figure 1.*** *Localisation of the Hippopotamus Pond.*

### *2.3. Data on Fishermen's Production and Income*

A questionnaire was carried out during fish sampling period. The purpose of this survey was to collect data about the number of fishermen, the types of fishing gears, the gears cost and their lifespan, the seasonality of fishing, the prices of fish,

other income-generating activities.

### *2.4. Statistical Analysis*

The fish fauna diversity was expressed by the total specific richness (S) [19], the Shannon diversity index H' [20] and the Pielou evenness index E determined to account for this diversity. The frequency of occurrence (F) of Dajoz [21] was used to assess fish species occurrence.

$$H' = -\sum_{i=1}^{S} p_i \, lnp_i \quad (1)$$

p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), ln is the natural log, Σ is the sum of the calculations, and s is the number of species

$$E = \frac{H'}{H_{max}} \quad (2)$$

$$F = \frac{e}{E} \times 100 \quad (3)$$

e: sample where the taxon is present, E: total number of samples).

The values of F were set as:

1. F ≥ 50%, then the taxa is "very frequent";
2. 25% ≤ F <50%, then the taxon is "frequent";
3. F < 25% the taxon is "rare".

The length-weight relation $W = a * L^b{}_T$ [22] was used to estimate the relationship between the weight (g) and the total length (cm) of the fish. The parameters a and b representing respectively the intercept and the slope of the relationship were deduced using the linear regression of the log-transformed equation: log (W) = log (a)+blog ($L_T$).

The condition factor K was established to assess the degree of wellbeing of fish species. The statement is that heavier fishes are in better condition than lean ones. So, Good growth condition of the fish is deduced when K≥1, while the fish is in poor growth when K<1. K was calculated based on the following formula: $K = \frac{W}{L_S^b} \, x \, 100$, [23] W is the total weight, $L_S$ is the standard length.

In order to have valid result, only fish species having relative abundances greater or equal to 1%, and/or having a frequency of occurrence greater or equal to 10% were taken into account for the analysis of the relationship.

We also estimated the net revenue generated by fishing after collecting data on the investment, the running costs and the gross revenue.

## 3. Results

### *3.1. Fish Fauna Characterisation*

A total of 655 cast net throws and 3 gillnet fishing were carried out and 13 commercial landings searched. As a results, 1642 fish specimens were observed. These included 974 specimens for experimental fishing and 668 specimens for commercial fisheries. Twenty-nine (29) species of fish were identified. They were dominated by *Sarotherodon galileaus* (46.83%) followed by *Oreochromis niloticus* (11.02%) and *Brycinus nurse* (10.66%) (Table 1). Very low frequencies were observed for some fish species, such as *Synodontis clarias* (0.06%), *Auchenoglanis occidentalis* (0.06%) and *Mormyrus rume* (0.06%).

The interview with the fishermen showed that several species or families of fish have the same vernacular name in the Bobo language. These names are given by the fishermen according to the biology, morphology and ethology of the species. However, the names in bobo of some species have not been found yet (Table 1).

***Table 1.*** *List, frequencies and species names in Bobo, the locale language.*

| | Species | Relative frequencies | Names in Bobo language | |
|---|---|---|---|---|
| | | | Name | Meaning of the name |
| 1 | *Sarotherodon galilaeus* | 46.83% | Pagale fourou | Jump in the water |
| 2 | *Oreochromis niloticus* | 11.02% | Pagale Gjoun | Jump in the water |
| 3 | *Brycinus nurse* | 10.66% | Kôlnon | Fish of clear water |
| 4 | *Synodontis nigrita* | 7.49% | Kikônon | Fish with spine |
| 5 | *Hemichromis fasciatus* | 6.88% | Sougoudienon | --- |
| 6 | *Coptodon zillii* | 2.92% | Pagale pènè | --- |
| 7 | *Hemichromis. bimaculatus* | 2.68% | Sougoudiénon | --- |
| 8 | *Enteromius macrops* | 1.77% | --- | --- |
| 9 | *Schilbe intermedius* | 1.52% | Yilénon | Fish poisonous spine |
| 10 | *Synodontis membranaceus* | 1.04% | Kikônon | Fish with spine |
| 11 | *Gymnarchus niloticus* | 0.85% | Gnini | Silly or stubborn fish |
| 12 | *Synodontis schall* | 0.85% | Kikônon | Fish with spine |
| 13 | *Heterotis niloticus* | 0.79% | Zonkiè | --- |
| 14 | *Clarias anguillaris* | 0.73% | Makèlè | Slipping fish |
| 15 | *Hyperopisus bebe* | 0.73% | Bôrônon | Fish with reproduction |
| 16 | *Polypterus senegalus* | 0.67% | Kalga | Spine |
| 17 | *Ctenopoma kingsleyae* | 0.49% | --- | --- |
| 18 | *Parachanna obscura* | 0.37% | Tianon | Sleeper fish |
| 19 | *Coptodon dageti* | 0.30% | Pagale pènè | --- |
| 20 | *Chrysichthis sp* | 0.24% | Kpirèdotalé | Powerful venom fish |
| 21 | *Synodontis punctifer* | 0.24% | Kikônon | Fish with spine |
| 22 | *Labeo coubie* | 0.18% | Dayagabou | Fish with a lot of bones in the boby |
| 23 | *Marcusenius senegalensis* | 0.18% | Bôrônon | Fish with reproduction |

| | Species | Relative frequencies | Names in Bobo language | |
|---|---|---|---|---|
| | | | Name | Meaning of the name |
| 24 | *Chromidotilapia guntheri* | 0.12% | --- | --- |
| 25 | *Siluranodon auritus* | 0.12% | Yilénon | Poisonous spine |
| 26 | *Synodontis ansorgii* | 0.12% | Kikônon | Fish spine |
| 27 | *Auchenoglanis occidentalis* | 0.06% | Sobarikikonon | Donkey fish |
| 28 | *Mormyrus rume* | 0.06% | Bôrônon | Fish with reproduction |
| 29 | *Synodontis clarias* | 0.06% | Kikônon | Fish with spine |

Seven fish species were found at station 1, near the source, 12 twelve at station 2 and 17 at stations 3 and 4. The Shannon diversity and Pielou Evenness indices followed the same trend as the species richness. From upstream to downstream, the Shannon index ranged from 1 to 1.81 and the Pielou Evenness ranged from 0.52 to 0.64 (Figure 2).

***Table 2I.*** *Occurrence of fish species in the Mare aux Hippopotames.*

| Species | Occurrence frequencies (%) | Frequencies signification |
|---|---|---|
| *Sarotherodon galilaeus* | 100.00 | Very frequent species |
| *Oreochromis niloticus* | 85.71 | Very frequent species |
| *Coptodon zillii* | 52.38 | Very frequent species |
| *Hemichromis fasciatus* | 47.62 | Frequent species |
| *Heterotis niloticus* | 38.10 | Frequent species |
| *Gymnarchus niloticus* | 38.10 | Frequent species |
| *Clarias anguillaris* | 38.10 | Frequent species |
| *Brycinus nurse* | 38.10 | Frequent species |
| *Synodontis schall* | 28.57 | Frequent species |
| *Synodontis nigrita* | 28.57 | Frequent species |
| *Synodontis membranaceus* | 23.81 | Rare species |
| *Parachanna obscura* | 23.81 | Rare species |
| *Schilbe intermedius* | 19.05 | Rare species |
| *Polypterus senegalus* | 19.05 | Rare species |
| *Hemichromis bimaculatus* | 19.05 | Rare species |
| *Ctenopoma kingsleyae* | 19.05 | Rare species |
| *Synodontis punctifer* | 14.29 | Rare species |
| *Marcusenius senegalensis* | 14.29 | Rare species |
| *Hyperopisus bebe* | 14.29 | Rare species |
| *Enteromius macrops* | 14.29 | Rare species |
| *Chrysichthis sp* | 9.52 | Rare species |
| *Chromidotilapia guntheri* | 9.52 | Rare species |
| *Synodontis clarias* | 4.76 | Rare species |
| *Synodontis ansorgii* | 4.76 | Rare species |
| *Siluranodon auritus* | 4.76 | Rare species |
| *Mormyrus rume* | 4.76 | Rare species |
| *Labeo coubie* | 4.76 | Rare species |
| *Coptodon dageti* | 4.76 | Rare species |
| *Auchenoglanis occidentalis* | 4.76 | Rare species |

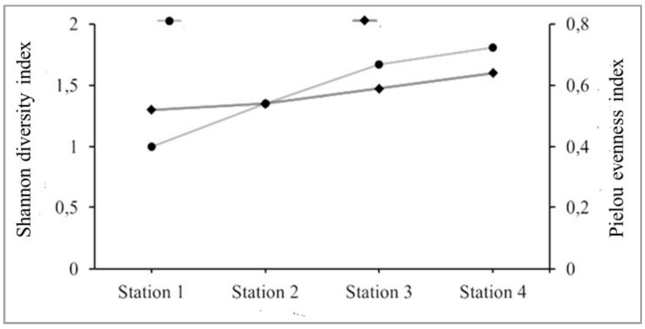


***Figure 2.*** *Diversity indices along the sampling stations.*

Regarding fish species occurrences, 10.34% of the recorded species were very frequent. These species belong to the Cichlidae family and listed as *C. zillii, O. niloticus and S. galilaeus*. Frequent species represented 24.14% of species; they were *B. nurse, C. anguillaris, G. niloticus, H. fasciatus, H. niloticus, S. nigrita and S. schall*. During this study, 65.52% of the species caught were rare. Species with lowest frequencies of occurrence (4.76% each one) included *S. clarias, A. occidentalis and M. rume* (figure 3).

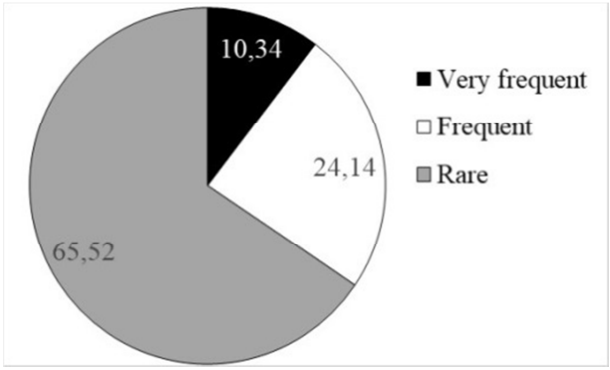


***Figure 3.*** *Fish species distribution according to their occurrence (%) in the Hippopotamus Pond.*

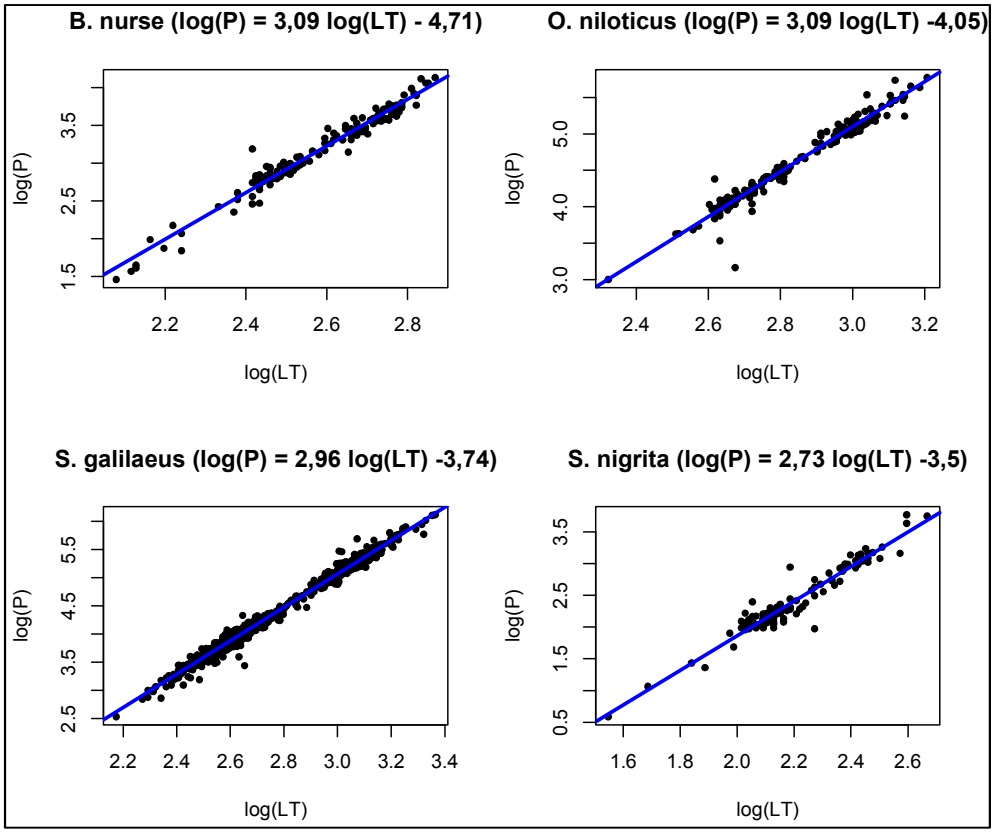


***Figure 4.*** *Length-weight relationship of four dominant fish species.*

***Table 3.*** *Descriptive parameters and Length-weight relationship parameters of fishes.*

| N° | Species | Abundance | a | b | $R^2$ | Growth type | $K_{means}$ | K Standard deviation | Growth condition |
|---|---|---|---|---|---|---|---|---|---|
| *1* | *Brycinus nurse* | 175 | 0.008 | 3.087 | 0.97 | I | 0.826 | 0.08 | Poor |
| *2* | *Clarias anguillaris* | 12 | 0.003 | 3.191 | 0.99 | A+ | 0.343 | 0.027 | Poor |
| *3* | *Coptodon zillii* | 48 | 0.012 | 3.184 | 0.97 | A+ | 1.182 | 0.183 | Good |
| *4* | *Ctenopoma kingsleyae* | 8 | 0.021 | 2.986 | 0.99 | I | 2.096 | 0.079 | Good |
| *5* | *Enteromius macrops* | 29 | 0.022 | 2.615 | 0.65 | A- | 2.239 | 0.283 | Good |
| *6* | *Gymnarchus niloticus* | 14 | 0.05 | 2.202 | 0.80 | A- | 5.395 | 2.119 | Good |
| *7* | *Hemichromis bimaculatus* | 44 | 0.137 | 2 | 0.77 | A- | 13.685 | 1.025 | Good |
| *8* | *Hemichromis fasciatus* | 113 | 0.015 | 2.998 | 0.97 | I | 3.122 | 6.559 | Good |
| *9* | *Heterotis niloticus* | 13 | 0.321 | 2.101 | 0.78 | A- | 35.198 | 19.435 | Good |
| *10* | *Hyperopisus bebe* | 12 | 0.033 | 2.508 | 0.99 | A- | 3.274 | 0.199 | Good |
| *11* | *Oreochromis niloticus* | 181 | 0.016 | 3.088 | 0.96 | I | 1.462 | 0.393 | Good |
| *12* | *Parachanna obscura* | 6 | 0.009 | 3.072 | 0.77 | I | 1.037 | 0.62 | Good |
| *13* | *Polypterus senegalus* | 11 | 0.0007 | 3.622 | 0.94 | A+ | 0.069 | 0.006 | Poor |
| *14* | *Sarotherodon galilaeus* | 769 | 0.022 | 2.96 | 0.99 | I | 2.154 | 0.36 | Good |
| *15* | *Schilbe intermedius* | 25 | 0.002 | 3.433 | 0.98 | A+ | 0.226 | 0.023 | Poor |
| *16* | *Synodontis membranaceus* | 17 | 0.032 | 2.64 | 0.81 | A- | 3.219 | 0.368 | Good |
| *17* | *Synodontis nigrita* | 123 | 0.028 | 2.725 | 0.93 | A- | 2.699 | 0.456 | Good |
| *18* | *Synodontis schall* | 14 | 0.019 | 2.673 | 0.98 | A- | 1.956 | 0.245 | Good |

$R^2$ = Coefficient of determination; a = Intercept of regression; b = Slope of regression; Kmeans= Condition factor; I= Isometric growth; A- = Negative allometric growth, A+ = Positive allometric growth.

### *3.2. Length-weight Relationships*

The weight-length relationship showed a strong correlation between these two variables ($p < 0.05$) with $R^2$ values greater than 0.90 in twelve species, $0.70 \leq R^2 \leq 0.9$ in five species and $R^2 = 0.65$ for one species (figure 4, Table 3). The values of the constant b revealed three types of growth in the species encountered in Mare aux Hippopotames. The growth trend for four species, namely *C. anguillaris, C. zillii, S. intermedius* and *P. senegalus* is positive allometric growth (Table 3), while *B. nurse, C kingsleyae, H. fasciatus, O. niloticus, P. obscura* and *S. galilaeus* showed isometric pattern. Conversely, eight species including *G. niloticus, E. macrops, H. bimaculatus, H. niloticus, H. bebe, S. membranaceus, S. nigrita and S. schall*

presented a negative allometric growth.

The values of the condition factor are shown in the table 3, fourteen of the 18 fish species showed well-being with the recorded mean values of K greater than 1, while the other 4 showed poor shape (Table 3).

### *3.3. Number of Fishermen and Fish Production*

A focus group was held with 11 fishermen, and was implemented with individual interviews with 8 fishermen. They indicated that the total number of fishermen is 61, but on average 22 fishermen are active every day. They are all from villages bordering the lake. The survey showed that agriculture and livestock are the primarily activities, fishing being the third most important economic activity. The fishermen tend to reduce fishing in order to go for farming during the rainy season (June to and October). Anyhow they fish less from July to September that corresponds to the maximum level of water in the lake, because the production of fishing is low.

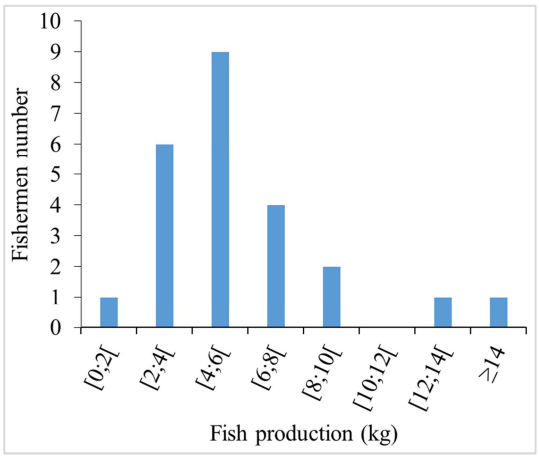


***Figure 5.*** *Daily production of fish in the Hippopotamus Pond.*

Four types of fishing gear are used: gillnet, cast net, traps and longlines. All fishermen (100%) use the gillnet in combination with the longlines, traps or harpoon. The cast net is occasionally used in shallow waters free of vegetation. It appears that 12.5% of the fishermen combine a maximum of three gears. Some fishermen use harpoons to handle large size fishes caught by the gillnet, but still alive.

The fishing gears can be used from 2 to 12 months. The minimum investment for gears that was recorded was 12000 FCFA and the maximum 74000 FCFA. Some fishermen have canoes which individually costs at least 75000 FCFA.

No species is particularly targeted, but the most expensive ones and large size specimen are simply preferred.

On average, the fisherman works 240 days a year, and the mean catches per day is 5.96 kg (Min. 3; Max. 14) as illustrated by figure 5.

The annual production of the Mare aux Hippopotames is estimated at 30.94.85 tonnes per year, i.e. an average yield of 257.84 $kg.ha^{-1}$ if we consider that the water surface is 120 ha [9] and 51.568 $kg.ha^{-1}$ if we consider an area of 600 ha.

### *3.4. Income from Fishing*

The cost of a ready-to-use gillnet is estimated at 39,468.75 FCFA. To make a longline, the packet of hooks is purchased at 1500 FCFA and the assembly cost varies according to the size and number of the hooks. The canoe costs 35,000 to 100,000 FCFA. Operational expenses per fishing day include fuel costs to reach the lake, food and hot drinks and other miscellaneous (cola nuts, cigarettes, …) cost 1,081.25 FCFA.

After being landed, the catches are all immediately bought by fishmongers from the village of Satiri or the town of Bobo-Dioulasso. The most expensive fishes are sold at 1,500 FCFA/kg and include *G. niloticus*, *L. niloticus* and *H. niloticus* (i.e. 9% of catches). Any other species is sold at 700 FCFA/kg. Self-consumption is estimated at 3.40% of catches. Thus, on average the daily gross income of the fisherman is around 4044.40 FCFA. The fisherman must save FCFA 1,795.36 per fishing day for the amortisation of his fishing equipment. The fishing license and all taxes that the fisherman faces cost 10,500 FCFA per year. By deducting all the expenses, the net daily income of the fisherman is 2200 FCFA. The survey revealed that fisherman works 240 days a year and so his annual net income is 528,000 FCFA.

## 4. Discussion

The 29 fish species that we recorded contribute for less than 25% of total diversity of Mouhoun sub-catchment compiled by Minoungou [24]. Although this compilation has to be improved, this suggests that the Hippopotamus Pond probably hosts more many species of fish. Actually, the present study took place during season only, but more many species could have been found if the fish were sampled during the rainy season as stated by Baijot et al. [11] and Ouédraogo [6]. However, more often the differences of species richness between these two seasons are not significant after statistical test [25].

Some former studies already conduced in the Mare aux Hippopotames revealed different species richness. Among which the maximum diversity was recorded by Blanc and Daget [13] who identified 42 species. However, in these study many species names are invalid, therefore the reliability of the result is questionable. Recently, Sanon [26], Béarez [9] and Compaoré et al. [14] studied fish diversity of the lake and came respectively to a list of 34, 30 and 24 species, which is not significantly different to our findings.

The recorded fishes included species with various ecological guilds among others ubiquitous species from continental African waters (*Synodontis schall, Labeo coubie, Synodontis membranaceus*), species from wetlands and swamps (*Clarias anguillaris, Ctenopoma kingsleyae, Synodontis nigrita*), fluvial species (*Siluranodon auritus*), *Polypterus senegalus*) and especially ubiquitous species swarming aquatic systems of Burkina Faso (*Oreochromis niloticus, Sarotherodon galilaeus, Brycinus nurse*). These large ecological guilds combined to the presence of intolerant species such as *G. niloticus, H. niloticus, H. fasciatus, P.*

*obscura* and Mormyrid species (*M. rume and H. bebe*) suggests that the aquatic ecosystem is somehow healthy as explained by Ouédraogo [6] and Mano [27], and this is confirmed by the good values of Shannon index.

Diversity increased from upstream to downstream, which is in accordance with the results of several authors including Minoungou et al. [28] in the new Samandéni reservoir, Burkina Faso.

Regarding the investigation of length-weight relationship, some of our results are in agreement with other national findings, others are not. Furthermore, the positive allometric growth recorded in the genus Clarias was in agreement with the results observed in the fisheries of Lake Bam and the Kompienga reservoir by Da et al. [29] and in the Sourou reservoir by Coulibaly [30]. However, Sirima et al. [31] obtained an isometric growth for *C. gariepinus* in the Comoe River. The isometric growth obtained for *Oreochromis niloticus* is in accordance with the results of a former study already conducted in the lake [32]. The positive allometric growth observed for *S. galilaeus* in this study is not in accordance with the results of previous studies carried out in Lake Bam [29], Lake Higa [33], Samandéni Reservoir and in Bama Pond [32]. Finally, the negative allometry observed in *H. niloticus* is consistent with the results obtained by Coulibaly [34].

The condition factor is influenced by many factors, the main ones being the individual's own morphology, the state of fattening, the sexual stage of the gonads, the specific density and the state of fullness of the digestive tract [35]. The condition factor $K \geq 1$ for the majority of the species studied clearly showed the 'well-being' of the fish and therefore a relatively good quality of the aquatic ecosystem of the Hippopotamus Pond [36, 37]. If we consider the number of 61 fishermen in the lake, we have a density of 10.17 to 76.25 fishermen per $km^2$. This number is very high in comparison to the recommendation of FAO [38] and may compromise the sustainability of the fishery in the lake. It urges to take effective management and development measures in the near future to avoid the depletion of the fishery as it happened in Lac Bam, which is currently undergoing rehabilitation [6]. However, since only 21 of the 61 fishermen fish each day due to other occupations, our statement is slightly moderated.

Most of the fish in Mare aux Hippopotames have a name in local language. However, these names are not specific for one species. More often they refer to a group of species, genus or even families with common traits as reported by previous studies [6, 30]. These findings revealed that local actors pay an attention to fish ecological guilds.

The average annual net income of fisherman observed in this study is 528,000 FCFA or 44,000 FCFA per month. This amount is well above the guaranteed minimum monthly inter-professional of 32,218 FCFA in Burkina Faso [39], the poverty threshold of 153530 FCFA in 2014 [39]. Referring to Ouédraogo [6], which reported that fishing brings about 37% of the total annual income earned by the fisherman practicing agriculture and breeding as priority activities, each fisherman would have a net annual income of 1427027.03 FCFA. Analysing this findings, one can say that theoretically, even considering fishing as their sole income-generating activity, the fishermen of Balla are not poor, even if in Burkina, INSD [40] considers fishermen to be the second socio-professional category, which has the highest proportion of poor people (48.3%) after subsistence farmers (50.1%).

# 5. Conclusions

The Hippopotamus Pond has an appreciable diversity of fish species. Although three species (*S. galileaus, O. niloticus* and *B. nurse*) highly dominate the fish fauna, the presence of intolerant species and many large size specimens suggests that the environment is not greatly impacted compared to other fisheries in Burkina Faso. The values of the diversity indices and the conditions factor also tend to confirm this.

The number of active fishermen seems quite high, but access to the fishery is regulated due to the practice of other activities, mainly agriculture and livestock breeding. So every day, the lake is frequented by 22 fishermen. Fishing provides an annual net income of 528,000 FCFA, which is consistent and suggests that fishermen are not poor but further studies can establish the profile of poverty.

# Conflict of Interests

The authors declare that they have no competing interests.

# Authors' Contribution

OR, DV and SYMF conceived, designed and performed the fieldwork. DV and SYMF participated in the data analysis and manuscript editing. OR, MK and OA participate to the manuscript editing and revision.

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