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Demographic characteristics and exploitation rate of *Dormitator lebretonis* (Pisces: Eleotridae: Steindachner, 1870) from four coastal lagoons of Southern Benin, West Africa

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ABSTRACT

Dormitator lebretonis (Pisces: Eleotridae) is the dominant eleotrid in the Benin coastal waters, where this species constitutes an important fisheries component. The current fisheries survey investigates demographic parameters and the exploitation of D. lebretonis from the Benin coastal waters to contribute to species conservation and sustainable use. Individuals of *D. lebretonis* have been sampled monthly for 18 months at four locations in the Benin coastal waters. Overall, *D. lebretonis* showed moderate asymptotic length ($L\infty$) ranging between 11.55-12.08 cm. The growth rate (K) ranged between 0.74yr^{-1} and 3.1yr^{-1}. The species exhibited moderate longevity ranging between 0.968 and 4.054 years. The growth performance index (φ') varied between 1.994-2.617, indicating that *D. lebretonis* is a relatively slow-growing eleotrid. Annual mortalities dominate population growth ($Z/K>1$), and lengths at first capture ($3.80 \leq L_{50} \leq 5.05$cm) indicated that *D. lebretonis* was exploited at immature stages. Nevertheless, the exploitation rate (E) was under 0.5, showing the stock was underexploited. The species showed two peaks of recruitment, except in Lake Ahémé. Sustainable exploitation of *D. lebretonis* in the coastal waters requires a holistic management scheme that should include fisheries regulation enforcement, spawning ground protection, ecosystem restoration, and follow-up.

Keywords: Coastal waters, *Dormitator lebretonis*, Exploitation rate, Growth parameters, Lengths at first capture, Recruitment/Management

Introduction

In sub-Saharan Africa, fisheries provide low-cost proteins of high nutritional quality accessible to grassroots and urban populations, even those with limited revenues (Joly et al., 2007; Allali, 2017). Primarily, fishermen practice multi-species fisheries that improve their income and, thus, constitute an important component of their annual revenue. Belhabib et al. (2019) reported that African fishery catches increased from 2.1 million metric tons in 1950 to 16.7 million metric tons in 1988. Hence, due to overexploitation and environmental degradation, catches in 2010 were reduced to 12.4 million metric tons, estimated at 1.860.000.000 US dollars. At a country level, the role of fisheries in the economy is quite significant, and its contribution to the total Gross Domestic Product (GDP) of African countries is approximated at 1.12% (De Graaf and Garibaldi, 2014). In Benin, fisheries products remain the most accessible source of animal protein for the majority of the population, with an estimated consumption of 73 965 tons in 2020 (World Bank, 2022). The fisheries sector constitutes an important component of rural development, with about 59114 inland and marine fishermen in Benin (Direction de la Production halieutique du Bénin, 2022). Hence, it substantially contributes to reducing unemployment (JICA, 2022). In addition, fisheries play an important role in the national economy by contributing to about 2.2% of the national PIB (Gross Interior Product) (INSAE, 2019). As reported by the Benin fisheries Department (2019), though specialized inland and marine fishermen approximated 59114, more than 600 000 people (including fishermen, woman sellers, fishmongers, boat makers, boat mechanics, etc.) were directly or indirectly employed in the inland and marine fisheries sector. Hence, because of aquatic ecosystem degradation, habitat fragmentations, and overfishing, almost a quarter of fish populations are threatened worldwide, leading to changes in fish community structures and reduced fish stocks (Adite, 2013; Ifremer, 2019).

At the Benin coastal waters, a recent ichthyological survey indicated five (5) eleotrids, *Dormitator lebretonis*, *Eleotris vittata*, *Eleotris daganensis*, *Eleotris senegalensis,* and *Bostrychus africanus* inhabit the four coastal waters, Lake Nokoué, Porto-Novo Lagoon, Coastal Lagoon, and Lake Ahémé. Among them, *Dormitator lebretonis* is of high fisheries and commercial importance in these brackish waters where it constitutes the most abundant eleotrid making about 57.91% - 87.39% of the squeaker community. Fishbase (2022) states that *D. lebretonis* is only distributed in Africa and endemic to the West African coast from the Senegal River to the Cunene River in Namibia. Specifically, this eleotrid occurred in countries such as Angola, Benin, Cameroon, Côte d'Ivoire, Congo (RDC), Gambia, Ghana, Guinea, Namibia, Nigeria, Senegal, and Sierra Leone.

Benin Fisheries Department (2022) reported that annual catches of Eleotridae species in the Benin coastal waters were estimated at 47.95 metric tons. According to Sonon et al. (2021), *Dormitator lebretonis* was the dominant eleotrid in the Benin coastal waters and accounted for about 67.11% (31.87 metric tons) of the annual catches of Eleotridae. Fishing gear such as traps, cast nets, and seines were used to exploit the species. *Dormitator lebretonis* individuals were caught in aquatic vegetation in the spawning grounds at a depth of less than 50 cm. Also, the species was caught in open water with mean depths ranging between 138.8 ±36.1 5cm and 225.3 ±29.56 cm.

Babatundé (2015) and Sonon et al. (2021) reported that *D. lebretonis* was intensively exploited because when fried, this eleotrid is widely consumed with corn meal and rice. Likewise, for its great organoleptic quality and distinctive taste, *D. lebretonis* is utilized for soup seasoning in replacement with lagoon shrimps whose stock has decreased. In general, there is no prohibition against the fishing *Dormitator lebretonis* as the species is not on the list of endangered species. Nevertheless, there is a fishing regulation from the Benin Department of Fisheries that prohibits the use of cast nets and gillnets of small mesh size (≤10 mm) (Direction de la production halieutiaue, 2018). Adite et al. (2013) and Sonon et al. (2021) reported that the sizes of *D. lebretonis* individuals recorded in Beninese lagoons were moderate due to overexploitation and habitat degradation. These threats to Benin coastal waters, ichthyofauna in general, and *D. lebretonis* in particular, constitute a real obstacle to the renewal of the fish stock and the fishing industry's sustainability. An emergency plan is, therefore, necessary to anticipate the collapse of the natural stock of *D. lebretonis* populations in Benin.

Despite the fisheries and commercial importance of this small-sized eleotrid and the continuing disturbances and degradation of Benin's coastal waters, little is known about the demographic features and exploitation rate of *Dormitator lebretonis*. Efficient conservation of fish, sustainable exploitation, and better decision-making in fisheries industries require knowledge of demographic components such as exploitation rate, fishing and natural mortalities, asymptotic length, growth factors, and species recruitment (Abohwere and Falaye, 2008; Tah et al., 2010; Imorou Sidi et al., 2019).

The current fisheries research aimed to assess the demographic characteristics and exploitation rates of *Dormitator*

lebretonis to contribute to the rational management of its stock in the Benin coastal waters.

Material and Methods

Study Area

The study was carried out in the four (4) coastal waters of Southern Benin. These were Lake Nokoué, Porto-Novo Lagoon, Coastal Lagoon, and Lake Ahémé. Lake Nokoué (140 km^2) is located between 6°20' and 6°30'N, and between 2°20' and 2°35'E. The Salinity of Lake Nokoué was highly variable and ranged between 0 to 40 ‰ because of the permanent connection of this lake with the marine water (Atlantic Ocean) (Adité et al., 2013; Hamil et al., 2018). The average depth varied between 0.25-3.46 m, transparencies were ≤ 98.5 cm, water temperature between 27.5- 31.1ºC, pHs ranged between 5.8 et 7.55, and dissolved oxygen varied from 0.55mg/L to 8.9 mg/L (Sonon et al., 2021). In general, lower dissolved oxygen was recorded in aquatic vegetation and swamp habitats full of organic matter and mud that intensively consume dissolved oxygen. In contrast, open water is a habitat of high transparency where high photosynthesis activities generate a relatively high dissolved oxygen concentration. Porto-Novo Lagoon (35 km^2) is geographically and hydrologically connected to Lake Nokoué and situated between 6°25'and 6°30'N and between 2°30' and 2°38'E, with an average width of 35 m (Gnohossou, 2006) and salinities ≤ 18 ‰. Depth ranged between 88.5-485.3 cm, transparency between 45.3-113.5 cm, water temperature between 26.8-31.5ºC and salinity between 0.11-18 ‰. pH varied between 6.2-8.55, and dissolved oxygen ranged between 0.85-8.2 mg/L (Sonon et al., 2021). The Coastal Lagoon extends 55 km^2 and is located between 6°25' and 6°30'N and between 2°30' and 2°38 East. Depth ranged between 2.2 - 3.85 m, with transparency varying between 2.2 m and 0.92 m. The salinity at the Coastal Lagoon varied between 0.15 and 30‰, and dissolved oxygen fluctuated between 0.82 and 9.8 mg/L. The pH was neutral and ranged between 6.5 and 8.5 (Adite et al., 2013; Sonon et al., 2021). Lake Ahémé (80 km^2**)** lies between 6.20° and 6.40°N and between 1.55° and 2°E. Depth ranged between 0.72 and 4.78 m, and transparencies varied between 0.78 and 1.29 m. The salinity in Lake Ahémé varied between 0.12-22‰, and pH fluctuated from 6.1 to 7.8. The dissolved oxygen concentration ranged from 0.85 to 9.7 mg/L (Sonon et al., 2021).

The four (4) coastal waters' environment shows a sub-equatorial climate type with an annual mean rainfall ranging between 1108.1 and 1307.3 mm (Adite et al., 2013). The evaporation varied from 59.2 to 145 mm (Akouegninou et al., 1993). The soils were sandy, swampy, and red ferric (Gbaguidi and Adite, 2016). The ambient temperature varies from 25°C to 30°C (I.N.S.A.E, 2016). Vegetation species were compounded by two main groups: aquatic floating plants (*Eichornia crassipes, Pistia stratiotes*) and semi-aquatic plants (*Paspalum vaginatum, Cyperus articulenius, Penisetum polystachion, Typha australis, Phragmites australis, Cyclosorus striatus*). Dominant mangrove trees were *Rhizophora* sp and *Aviennia africana* (Chouti, 2011). Regarding aquatic animals, the dominant fish families were Cichlidae, Clariidae, Bagridae, and Claroteidae; the family was the most abundant (Sonon et al., 2021; Vodougnon, 2015). Also, mangrove shellfish such as *Crassostrea tulipa* were intensively exploited and cultured.

Fish Sampling Methods

Twelve (12) sites, five (5) in Lake Nokoué, two (2) in Porto-Novo Lagoon, three (3) in Coastal Lagoon, and two (2) in Lake Ahémé were selected for the fish sampling (Figure 1). At each sampling site, geographic coordinates were determined using a GPS (Garmin Dakota 10). *Dormitator lebretonis* individuals were sampled monthly from April 2017 to September 2018 at the open water and aquatic vegetation habitats. Traps cast net (3m diameter; 10 mm mesh) and seine (3 to 20 mm mesh) was used for *D. lebretonis* samplings. Once collected, a 10% formalin was used to preserve the fish samples transported to the LEMEA laboratory of Abomey-Calavi University (Adite et al., 2013). At the laboratory, the total length (TL) and standard length (SL) of *D. lebretonis* individuals were measured to the nearest 1mm with an ichthyometer and weights (W) were measured to the nearest 1mg with an electronic balance (Adite et al. 2013).

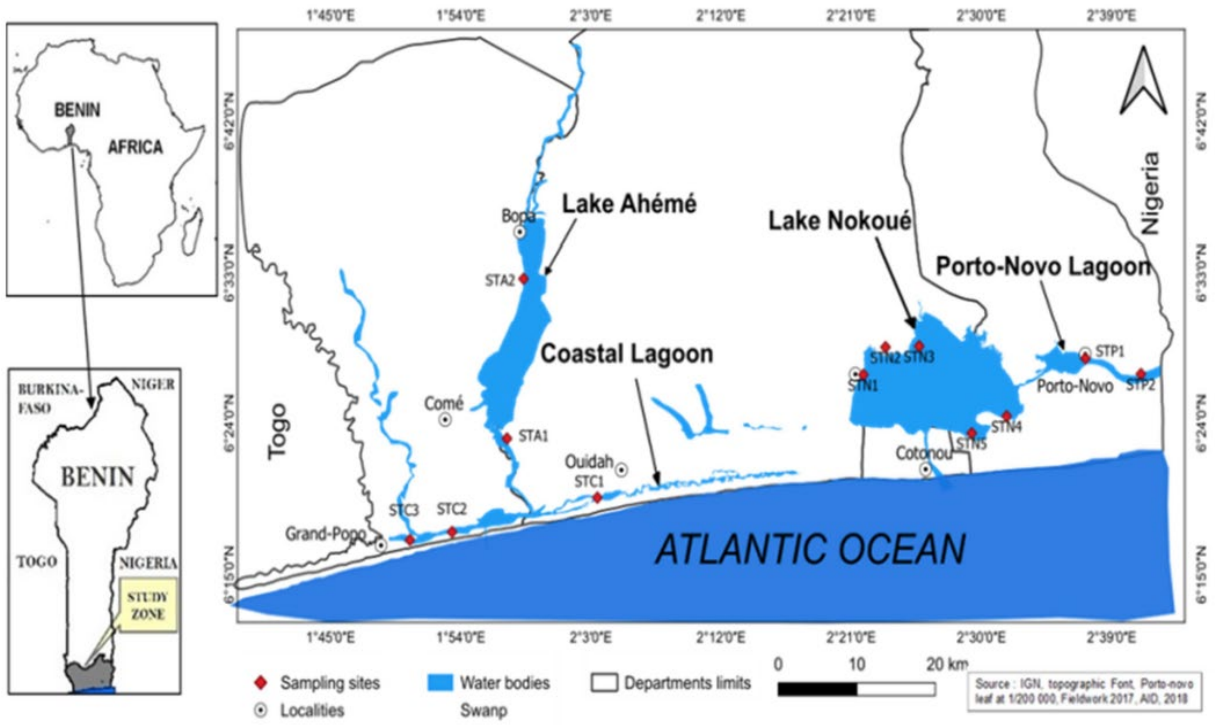
The growth parameters were computed using the VBGF fitted in FISAT II (2005).

Data Analysis

Growth parameters

The growth parameters of *D. lebretonis* individuals were computed using the von Bertalanffy growth function model (VBGF) (1938) of the ELEFAN I program in FiSAT II. The following growth formula was applied to the total length (TL) of *D. lebretonis*:

$$\mathbf{TL = L\infty \{1 - exp [-K(t - t0)]\}}$$



STN= Lake Nokoué sites; STP=Lagoon of Porto-Novo' sites; STC= Coastal Lagoon sites; STA= Lake Ahémé sites.

Figure 1. Map of *D. lebretonis* sampling sites

Where TL (cm) is the fish's total length; L∞ (cm) is the asymptotic length of the fish. L∞ is the maximum size that fish can reach after several years of life; K (yr^{-1}) is the growth coefficient of fish; t_0 (yr) is the theoretical age of fish when its length is zero. t_0 is obtained from the equation of Pauly (1979):

Log 10 ($-t_0$) = -0.392- 0.275 Log10L∞- 1.038 Log10K

Where t_0 (yr) is the inverse of the Bertalanffy growth equation. It represents the age of fish of different sizes. The Growth Performance Index was assessed using Pauly and Munro's (1984) formula:

φ'= Log10K+ 2Log10 L∞

Mortalities and level of exploitation

The total instantaneous mortality rate (Z) was directly estimated in FiSAT II software (FAO, 2005) using a Length-converted Catch Curve that integrates both the asymptotic length (L∞) and the growth coefficient (K) of the species in each of the four (4) coastal waters.

Natural mortality rate (M) was estimated using Pauly's (1980) in FiSAT II software (FAO, 2005) using the following empirical relationship:

$$\log_{10} M = -0.0066 - 0.279 \log_{10} L\infty + 0.6543 \log_{10} K + 0.463 \log_{10} T$$

Where T is the annual temperature of the water body.

The fishing mortality coefficient (F) was estimated by the formula: **F = Z-M**

The longevity was determined by Anato's (1999) formula: **Tmax = 3/K**

The exploitation rate (E) was used to determine whether or not *D. lebretonis* stock is overexploited (Pauly, 1983). was evaluated from the length linearity curve converted into a catch curve: **E = F/Z**

F is the fishing mortality rate, and Z is the annual mortality rate. According to Francis and Sikoki (2007), the maximum level of exploitation of a resource is reached when the exploitation rate is greater than or equal to 0.5 or when fishing mortality (F) is equal to natural mortality (M).

Probability of capture and first capture size

FiSAT software was used to generate the catch curve to assess both the size of the first capture (L_{50}) and the probability of capture.

Recruitment of *Dormitator lebretonis*

Recruitment is the relative abundance of new young fish stages that enter yearly in adult sub-population. The recruitment patterns of *D. lebretonis* in each of the four (4) coastal lagoons were assessed through a recruitment curve generated by FiSAT software based on total length (TL) frequency data (Pauly, 1985).

Results and Discussion

Estimation of the von Bertalanffy Growth Parameters (L∞, K, t) and the Growth Performance Index (φ')

Table 1 presents values of the von Bertalanffy growth parameters generated by FiSAT software. The asymptotic length (L∞) values vary from 11.55 cm (Lake Nokoué, Lake Ahémé, and Coastal Lagoon) to 12.08 cm in the Lagoon of Porto-Novo. Growth rate (K) values ranged between 0.74 yr^{-1} (Coastal Lagoon) to 3.100 yr^{-1} (Lake Ahémé). The highest growth performance index Φ' was recorded in Lake Ahémé (Φ'=2.204), and the lowest performance index was recorded in Coastal Lagoon (Φ'=1.994). Theoretical age at length 0 varied from -0.58 years recorded in the Lagoon of Porto-Novo and the Coastal Lagoon to -0.30 years in Lake Ahémé (Table 1).

Table 1: Growth parameters of *Dormitator lebretonis* from the coastal waters of Benin

Parameter	Lake Nokoué	Lagoon of Porto-Novo	Coastal Lagoon	Lake Ahémé
L∞ (cm)	11.55	12.08	11.55	11.55
K	1.200	0.780	0.740	3.100
t (an)	-0.46	-0.58	-0.58	-0.30
φ’	2.204	2.058	1.994	2.617

Estimation of Mortality Parameters, Exploitation Rate, and Longevity

Table 2 and Figure 2 showed trends of mortality parameters and exploitation rate (E) for *D. lebretonis* from Benin’s four (4) coastal waters investigated. Overall, the total mortality (Z) ranged between 2.21 and 8.29, while the natural mortality (M) recorded varied from 1.93 (Coastal Lagoon) to 4.93 (Lake Ahémé) (Table 2). Also, the exploitation rate (E) varied from 0.13 (Coastal Lagoon) to 0.41 (Lake Ahémé). The longevity of *D. lebretonis* was moderate and ranged between 0.968 years (Lake Ahémé) and 4.054 years (Coastal Lagoon). Values of ratio Z/K were superior to 1 and ranged from 2.67 (Lake Ahémé) to 3.47 (Porto Novo Lagoon). The ratio (L_{50}/L∞) of the size of the first capture and asymptotic length showed low variations and fluctuated between 0.33 (Lake Ahémé) and 0.44 (Lake Nokoué) (table 2).

Probability of Capture and First Capture Size

The size of the first capture (L_{50}) of *D. lebretonis* was moderate in all four (4) lagoons. The lowest value (L_{50} =3.80 cm) was recorded in Lake Ahémé, whereas the highest value (L_{50}=5.05 cm) was recorded in Lake Nokoué (Figures 3-A, B, C, and D).

Recruitment

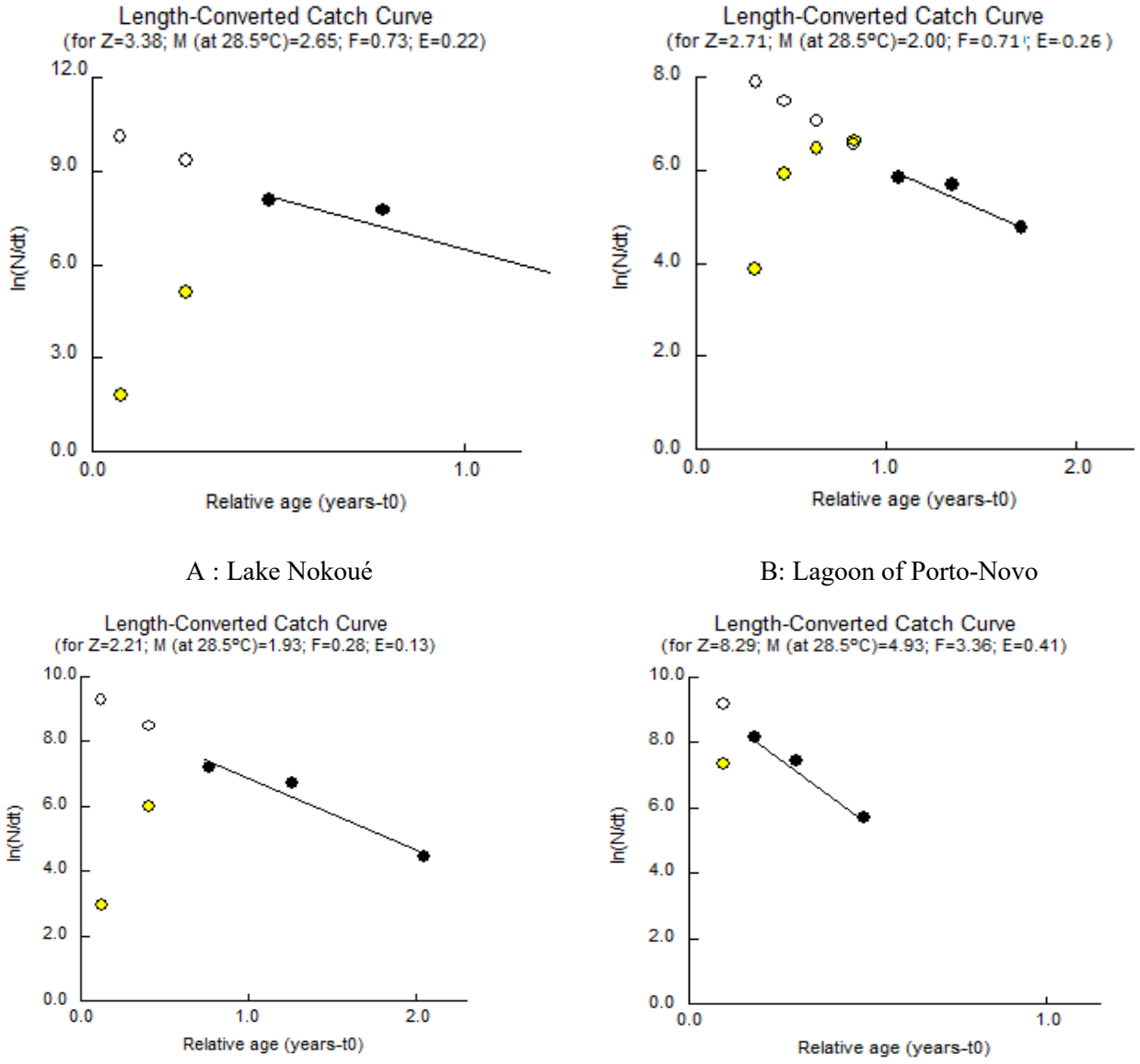
Lake Nokoué, Coastal Lagoon, and Lagoon of Porto-Novo, *D. lebretonis* population exhibited two peaks of recruitment (Figures 4 A, B, and C). Percentages of recruitment significantly varied not only between coastal waters but also between peaks of the same coastal water. In contrast, in Lake Ahémé, *D. lebretonis* showed one recruitment peak during the year, with a higher percentage reaching 20% (Figure 4-D).

Overall, growth parameters and performance indices are efficient tools most fisheries biologists use to assess the status of fish population stocks. In the current fisheries survey of *D. lebretonis*, the asymptotic lengths (11.55< L∞ <12.08) recorded, that is, the maximum total length fish individuals can reach in their population, were moderate and almost similar in the four (4) coastal water studied. These results agreed with that Fishbase (2022) reported in Western Africa (Senegal, Gambia, Guinea, Cote d’Ivoire, Ghana, Nigeria), where the maximum total length recorded for *D. lebretonis* was 12.4 cm. In this study, the relatively lower value (L∞=11.55 cm) recorded in Lake Nokoué, Lake Ahémé, and Coastal Lagoon and even in Lagoon of Porto-Novo (L∞=12.08 cm) may be the result of environmental disturbances such as dumping of domestic wastes, mangrove degradation, the proliferation of floating plants that negatively affect water parameters and water quality (Barro, 1968; Adite, 2013). Also, using sophisticated fishing gear leads to overfishing, with fishery increasingly oriented towards small individuals. Nevertheless, Sonon et al. (2021) records of physicochemical parameters indicated that the water quality of the four (4) coastal waters studied was within the required standards for the survival and growth of *D. lebretonis*. Indeed, the presence of air-breathing accessory organs helps to cope with the harsh conditions (mainly dissolved oxygen: 4.5 ±0.42 mg/L) in swamps and aquatic vegetation habitats. These ecological trends agreed with those reported by Okyere et al. (2011) in the coastal wetland of Ghana, where dissolved oxygen was reduced and averaged 4.2 ±0.9 mg/L.

Table 2: Mortality, longevity, and exploitation rate of *Dormitator lebretonis* from the Benin coastal waters

Ecosystems	M	F	Z	E	Z/K	L_{50}	Tmax	$L_{50}/L\infty$
Lake Nokoué	2.65	0.73	3.38	0.22	2.82	5.05	2.5	0.44
Lagoon of Porto-Novo	2.00	0.71	2.71	0.26	3.47	4.17	3.846	0.34
Coastal Lagoon	1.93	0.28	2.21	0.13	2.98	4.20	4.054	0.36
Lake Ahémé	4.93	3.36	8.29	0.41	2.67	3.80	0.968	0.33

M: Natural mortality; F: Fishing mortality; Z: Total mortality; K: Growth coefficient; E: Exploitation rate; L_{50}: Size of first capture; Tmax: Longevity.



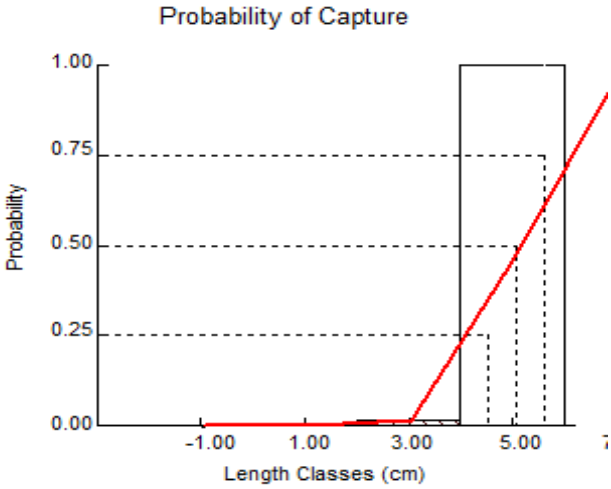
A : Lake Nokoué

B: Lagoon of Porto-Novo

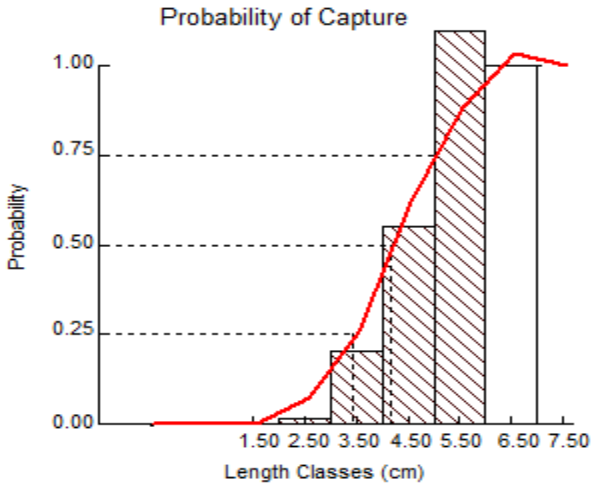
C: Coastal Lagoon

D: Lake Ahémé

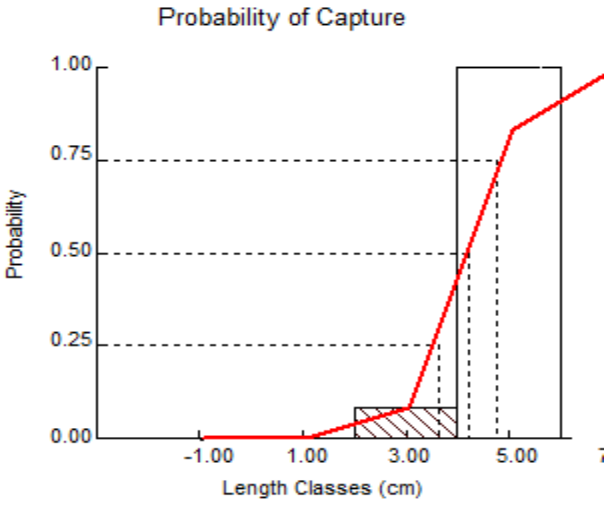
Figure 2 (A, B, C, and D). length converted catch curves of *Dormitaor lebretonis* from the coastal waters of Benin



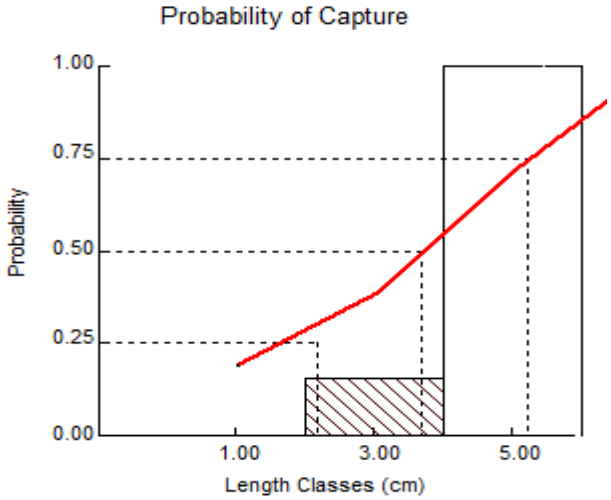
A : Lake Nokoué



B : Lagoon of Porto Novo

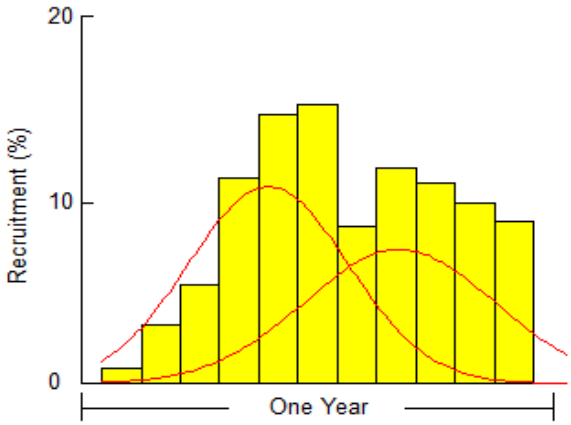


C: Coastal Lagoon

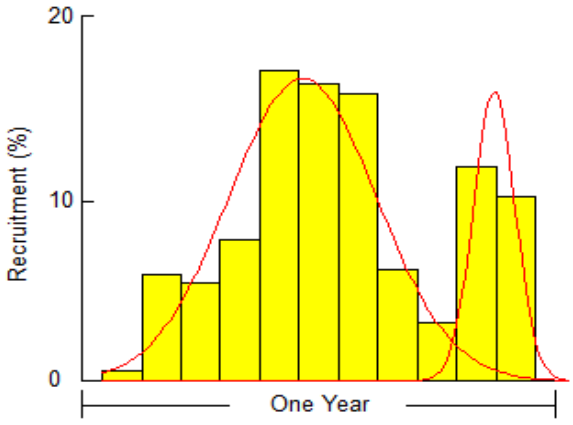


D: Lake Ahémé

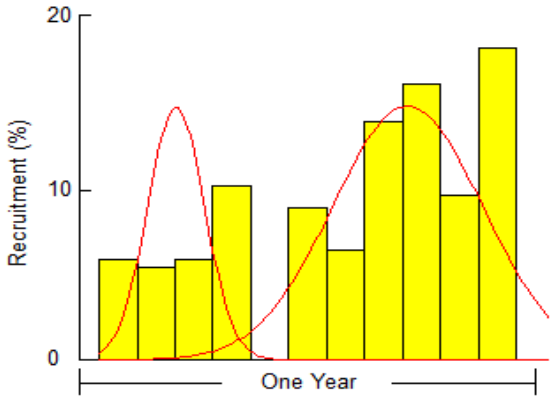
Figure 3 (A, B, C, and D). Probability of capture and length of the first capture of *Dormitator lebretonis* from the Coastal waters of Benin



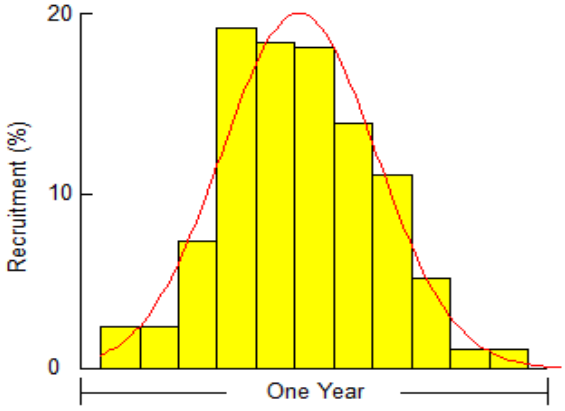
A : Lake Nokoué



B : Lagoon of Porto-Novo



C: Coastal Lagoon



D: Lake Ahémé

Figure 4 (A, B, C, D): Recruitment patterns of *Dormitator lebretonis* from the coastal waters

In the current study, when considering the whole abundance of *D. lebretonis* in the four coastal waters, One-way Analyses of Variance (ANOVA) on the length of this eleotric showed significant ($F_{3,4848} = 21.42$, $P = 0.002$) variations of SL across the four coastal waters. However, physicochemical parameters exhibited insignificant ($p>0.05$) variations across the four coastal waters, indicating that mean physicochemical parameters were nearly identical across the 4 coastal waters (Sonon et al., 2023). These records were probably due to different fishing pressures in each of the four coastal waters and generating different sizes of *D. lebretonis* in each ecosystem.

Among the four (4) coastal waters, Lake Ahémé showed the highest growth rate reaching $K=3.1$ yr^{-1}, whereas those recorded from Lake Nokoué, Lagoon of Porto-Novo, and coastal lagoon were relatively low and ranged between $K=0.74$ yr^{-1} and $K=1.20$ yr^{-1}. As Sidi Imorou et al. (2019) reported, the relatively low abundance of *D. lebretonis* in Lake Ahémé could have reduced intraspecific food competition, enhancing the growth rate of this eleotrid. Also, the presence of suitable habitats for *D. lebretonis* in Lake Ahémé, exempt from floating plants at some sites, could have increased the availability of dissolved oxygen and minerals that made greater the quality of habitats and hence, the growth rate. Likewise, the intensive reinforcement of fishing regulation by the Benin Department of Fisheries in Lake Ahémé compared to Lake Nokoué, Lagoon of Porto-Novo, and Coastal Lagoon could have positively impacted the growth rate of *D. lebretonis.* Also, the value of K recorded in Lake Ahémé was higher than those obtained from some other five (5) teleost fishes *Hemi-*

chromis fasciatus, Marcusenius senegalensis, Shilbe intermedius, Oreochromis niloticus, Brycinus macrolepidotus from the Okpara river in Northern Benin where K ranged between 0.66 yr^{-1} (*Shilbe intermedius*) and 1.2 yr^{-1} (*Marcusenius senegalensis*). However, in the current study, the growth rate range (K=0.74 yr^{-1} - K=1.20 yr^{-1}) recorded for *D. lebretonis* in Lake Nokoué, Lagoon of Porto-Novo and Coastal Lagoon were relatively low and rather agreed with those reported for *H. fasciatus, M. senegalensis, S. intermedius, O. niloticus, B. macrolepidotus* from the Okpara river. Identical trends of low K were recorded in Lake Ayame in Cote d'Ivoire for *Brycinus macrolepidotus* (K= 0.46), *Hemichromis fasciatus* (K=0.57) and *Oreochromis niloticus* (K=0.48). Combined effects of habitat degradations and fragmentations, species tolerance to disturbances, niche breadth, and level of ecosystem productivity could act for spatial and temporal variations of K. (Al-Nadhi et al., 2009).

Longevity depends not only on the species but also on the habitat's ecological status. In the Benin coastal water, *D. lebretonis* exhibited moderate longevity that varied between 0.968 yr (Lake Nokoué) and 4.054 yr (Coastal Lagoon). Though species-dependent, the moderate longevity recorded in Lake Nokoué is probably the result of mangrove destruction, the proliferation of invasive floating vegetation such as water hyacinth, the dumping of domestic and industrial wastes, and overall habitat degradation. In contrast, at the Coastal Lagoon, some mangrove forests are under protection through the reinforcement of Benin fisheries regulation. These findings nearly agreed with those Sidi Imorou et al. (2019) reported for some teleost fishes such as *M. senegalensis*, *S. intermedius B. macrolepidotus,* and *H. fasciatus* from the Okpara river in Northern Benin, where longevity ranged between 1.88 yr and 4.55 yr. Also, these results agreed with those reported for *Chrysicthys nigrodigitatus* in Lake Akata in Benue State in Nigeria, where longevity varied from 1 to 3 yr (Ikongbeh et al., 2015). However, on the Sô River, where ecological disturbances were moderate, Hazoume et al. (2017) reported higher longevity (11.66 yr) for the Claroteidae *Chrysichthys auratus*.

The growth performance index (φ') values recorded on all the water bodies were relatively low and varied from 1.994 (Coastal Lagoon) to 2.617 (Lake Ahémé). This result indicates that *D. lebretonis* is a very slow-growing fish species (Baijot and Moreau, 1997). The various degradations of the aquatic environment due mainly to anthropogenic activities may negatively influence the growth performance of the fish (Sidi Imorou *et al.*, 2019). In this survey, the exploitation rate (E) was under 0.5 in all four (4) coastal waters suggesting that the stocks of *D. lebretonis* were underexploited. This result is similar to those Francis et al. (2007) reported in Andoni River System, Niger Delta in Nigeria, who found many underexploited fish species with an exploitation ratio (E) below 0.50. Some of these underexploited fish species reported were *Galeoides decadactylus* with E =0.20, *Chrysichthys nigrodigitatus* (E= 0.25), *Sarotherodon melanotheron* (E=0.31), *Eucinostomus melanoptenus* (E= 0.45), *Liza grandisquamis* (E= 0.45), *Tilapia guinensis* (E= 0.48).

In the current fisheries survey, the ratio Z/K was greater than 1 and ranged between 2.67 and 3.47. As reported by Barry & Tegner (1989) and Sidi Imorou (2019), these results indicate that annual mortalities (Z) dominate population growth (K). According to Lederoun *et al.* (2015), a ratio Z/K under 2 indicates that mortality predominates overgrowth. Hence, the population of *D. lebretonis* in the Benin coastal waters is threatened. Similar trends of disturbances have been recorded for species such as *Brycinus macrolepidotus, Hemichromis fasciatus, Marcusenius senegalensis, Shilbe intermedius, Oreochromis niloticus* from the Ouémé river in northern Benin where fisheries regulations are underway (Sidi Imorou et al., 2019; Ahouansou Montcho et al., 2011; Welcome and De Merona 1988; Pauly, 1982).

Overall, in this survey, the lengths at first capture (L50) of *D. lebretonis* were relatively small and ranged between 3.80 cm (Lake Ahémé) and 5.05 cm (Lake Nokoué). This indicates that in the four (4) coastal waters, individuals of *D. lebretonis* were practically exploited at immature or early stages. This fishing pressure on juveniles is a threat to the population and could jeopardize the sustainability of the exploitation and the extinction of this eleotrid in the future if nothing is done to restore the fishable stock (Okyere et al. 201).

Except in Lake Ahémé, *D. lebretonis* showed two peaks of recruitment in Lake Nokoué, Lagoon of Porto-Novo, and Coastal Lagoon. Probably, these two peaks originated from two different spawning seasons in the year. Indeed, in general, two rainy seasons occur in Southern Benin. In addition, annual floodplains caused by the Mono River (case of Lake Ahémé, Coastal Lagoon) and by the Ouémé River (case of Lake Nokoue, Porto-Novo Lagoon) could act to affect the breeding periods and hence, the recruitment peaks. As reported by Pauly (1982), Adité et al. (2006), and Ahouansou Montcho et al. (2011), these spawning and recruitment trends are similar for most tropical fishes, and in general, match with rainy and flooding seasons.

In terms of exploitation, fish and shellfish resources from the four coastal waters were intensively and permanently exploited by local professional fishermen for sales and food. The main fishing gear used by fishermen were cast nets, gill-

nets, seines, traps, hooks, longlines, etc. In particular, a fishing/aquaculture method called "Acadja" is mainly utilized in Lake Nokoue. The "Acadja" fishery is a site ranging between 10 m^2 – 10 hectares delimited at the shallower (0.5-1.5 m - depth) parts of the lake where tree or/and palm tree branches are planted in the mud to cover the space. These branches decompose and generate a huge amount of food leading to a high abundance of fish in the "Acadja" that finally serves as growing, spawning, and nursery grounds. Regarding management, a fishery regulation is implemented by the Benin Department of Fisheries. Thus, government fisheries agents remove prohibited fishing gears and mesh sizes. Besides, some traditional regulations, such as fishing prohibited days, are implemented by the grassroots and local population.

Conclusion

The current fisheries survey gives valuable and helpful information on the demographic characteristics of *Dormitator lebretonis* from the four (4) coastal waters of Southern Benin. The coastal waters surveyed were under severe ecological disturbances that negatively impacted demographic traits. This small squeaker generally exhibited moderate asymptotic length ($L\infty$) ranging between 11.55 and 12.08 cm in the four (4) coastal waters studied. In Lake Ahémé, *D. lebretonis* exhibited a higher growth rate (K) that was reduced in Lake Nokoué, Lagoon of Porto-Novo, and Coastal Lagoon. In these coastal ecosystems, the species showed moderate longevity but higher in the Coastal Lagoon. The growth performance index (φ') was relatively low, indicating that *D. lebretonis* is a relatively slow-growing eleotrid. In the four coastal waters, annual mortalities dominate population growth (Z/K >1), and the low lengths at first capture indicated that individuals of *D. lebretonis* were exploited at immature and early stages. Nevertheless, the exploitation rate (E) was under 0.5, indicating that the stock of *D. lebretonis* was underexploited, probably because of the two peaks of recruitment. The current results on the demographic characteristics and exploitation rate of *D. lebretonis* from the Benin coastal waters give valuable information that could serve as reference data for the efficient management of this squeaker. Sustainable exploitation *of D. lebretonis* in the four coastal waters requires a holistic management scheme that should include enforcement of fisheries regulation, spawning ground protection, and ecosystem restoration and follow-up.

Compliance with Ethical Standards

Conflict of interest: The authors declare that they have no actual, potential, or perceived conflict of interest for this article.

Ethics committee approval: Ethics committee approval is not required.

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References

Adite, A., Abou, Y., Sossoukpe, E., Fiogbe, E.D. (2013). The oyster farming in the coastal ecosystem of southern Benin (West Africa): Environment, growth and contribution to sustainable coastal fisheries management. *International Journal of Development Research*, 3(10), 087-094.

Adite, A., Imorou toko, I., Gbankoto, A. (2013). Fish assemblages in the degraded mangrove ecosystems of the coastal zone, Benin, West Africa: Implications for ecosystem restoration and resources conservation. *Journal of Environmental Protection*, 4, 1461-1475. https://doi.org/10.4236/jep.2013.412168

Ahouansou Montcho, S., Chikou, A., Lalèyè, P.A., Linsenmair, K.E. (2011). Population structure and reproductive biology of Schilbe intermedius (Teleostei: Schilbeidae) in the Pendjari River, Benin. *African, Journal of Aquatic Science*, 36(2), 139-145. https://doi.org/10.2989/16085914.2011.589111

Akoegninou, A., Oyede, L.M., Toffi, M. (1993). La mangrove du Benin: Environnement physique, végétation, et essais de gestion. Technical report, Faculté des Sciences et Techniques, Université d'Abomey-calavi, Benin,186p.

Allali, F. (2017). Evolution des pratiques alimentaires au Maroc. *Integrative Journal of Medical Sciences*, 4(1), 1-70. https://doi.org/10.15342/ijms.v4is.145

Al-Nahdi, A.A., Al-Marzouqi, E., Al-Rasadi Groeneveld, J.C. (2009). The size composition, reproductive biology, age and growth of large head cutlassfish, *Trichiurus lepturus*

from the Arabian Sea coast of Oman. *Indian Journal of Fisheries*, 56(2),73-79.

Anato, C.B. (1999). Les Sparidae des côtes béninoises: Milieu de vie, pêche, présentation des espèces et biologie de *Dentex angolensis* Poll et Maul, 1953. Thèse de Doctorat d'État des Sciences, Faculte des Sciences 1060 Tunis, Tunisie. 277 p.

Baijot, E., Moreau, J. (1997). Biology and demographic status of the main fish species in the reservoirs of Burkina Faso. In: E. Baijot, J. Moreau, S. Bouda (Eds). Hydrological Aspects of Fisheries in Small Reservoirs in Sahel Region. Technical Center for Agricultural and Rural Cooperation, Commission of the European Communities, Wageningen, Netherlands. pp: 79-109.

Barro, M. (1968). Première estimation sur la croissance des *Brachydeuterus auratus* (Val. 1834) en Côte d'Ivoire. Doc. Sei. Provis. Cent. Rech. Océanogr. Abidjan, 3, 18 p.

Barry, J.P., Tegner, M.J. (1989). Inferring demographic processes from size-frequency distributions: simple models indicate specific patterns of growth and mortality. *Fishery Bulletin*, 88, 13-19.

Chouti, W.K., (2011). Etude de la pollution chimique d'une Lagune tropicale (eaux, sédiments, poissons); cas de la Lagune de Porto-Novo (Sud-Bénin).Thèse de doctorat. 100p.

Direction de la production Halieutique du Bénin (2018). Statistiques des Pêches Continentales, Année 2018. Base de données de la DPH, Cotonou, Bénin.

Direction de la production Halieutique du Bénin (2019). Statistiques des Pêches Continentales, Année 2019. Base de données de la DPH, Cotonou, Bénin.

Direction de la production Halieutique du Bénin (2022). Statistiques des Pêches Continentales, Année 2022. Base de données de la DPH, Cotonou, Bénin.

Francis, A., Sikoki, F.D., Ansa, E.J., (2007). Exploitation of Fishes from the Andoni River System, Niger Delta, Nigeria and Conservation Strategies. *International Journal of Fisheries*, 2(1), 17-21.

FAO (2005). FISAT II- FAO-ICLARM fish stock assessment tools, computer programs, Food and Agriculture Organization of United Nations, Rome.

Froese, R., Pauly, D. (2022). Fish Base, World Wide Web electronic publication. https://www.fishbase.se/country/CountryList.php?ID=10008&GenusName=Dormitator&SpeciesName=lebretonis (accessed on 21/02/2023).

Gnohossou, M.P. (2006). La faune benthique d'une Lagune Ouest Africaine (le Lac Nokoué au Bénin), diversité, abondance, variations temporelles et spatiales, place dans la chaîne trophique. Thèse de doctorat. 169 p.

Hamil, S., Arab, S., Arab, A. (2018). Assessment of surface water quality using multivariate statistical analysis techniques: a case study from Ghrib dam, Algeria. *Arabian Journal of Geosciences*, 11, 1-14. https://doi.org/10.1007/s12517-018-4102-5

Hazoume, R.U.S. (2017). Diversité, organisation trophique et exploitation des poissons de la rivière Sô au Benin (Afrique de l'Ouest). PhD Thesis, University of Abomey-Calavi, Benin, 162p.

I.N.S.A.E. (2016). Cahier des villages et quartiers de ville du département de l'Ouémé (RGPH-4, 2013). Bénin, 39p.

I.N.S.A.E. (2019). Enquête Régionale Intégré sur l'emploi et le secteur informel (ERI-ESI) Bénin, 2018, Rapport final. Cotonou: Institut National de la Statistique et de l'Analyse Economique, AFRISTAT, UEMOA.

IFREMER (2020). État des stocks de poissons en 2019: alerte sur les cabillauds et les sardines. Consulté le 17/02/2022. https://www.franceinter.fr/environnement/etat-des-stocks-de-poissons-en-2019-alerte-sur-les-cabillauds-et-les-sardines

Ikongbeh, O.A., Gobe, F.G., Solomon, S.G., Ataguba, G.A. (2015). Age, growth, and mortality of *Chrysicthyes nigroditatus* (Lacepede, 1803) from Lake Akata Benue state, Nigeria. *Asian Journal of Conservation Biology*, 4(1), 81-88.

JICA (Japan International Cooperation Agency). (2022). The study on the promotion of inland Aquaculture for rural development. Available at https://www.jica.go.jp/benin/english/activities/development.html (accessed on 21/02/2023).

Laleye, P., Niyonkuru, C., Moreau, J., Teugels, G.G. (2003). Spatial and seasonal distribution of the ichthyofauna of Lake Nokoué, Benin, West Africa. *African Journal of Aquatic Science*, 28(2), 151-161.

https://doi.org/10.2989/16085910309503779

Lederoun, D., Chikou, A., Vreven, E. Snoeks, J., Moreau, J., Vandewalle, P., Lalèyè, P. (2015). Population parameters and exploitation rate of *Sarotherodon melanotheron melanotheron* rüppell, 1852 (Cichlidae) in Lake Toho, Benin. *Journal of Biodiversity and Environmental Sciences,* 6(2), 259-271.

Okyere I., Blay J., Aggrey-Fynn J., Aheto D.W. (2011). Composition, diversity and food habits of the fish community of a coastal wetland in Ghana. *Journal of Environment and Ecology*, 2(1), 1-17.
https://doi.org/10.5296/jee.v2i1.683

Pauly, D. (1979). Theory and management of tropical multispecies stocks: A review, with emphasis on the Southeast Asian demersal fisheries. ICLARM Studies and Reviews. International Center for Living Aquatic Resources Management, Manila. No.1, 35 p.

Pauly, D. (1982). Studying single-species dynamics in a tropical multispecies context. Theory and Management of Tropical Fisheries. /CLARM Conference Process, 9, 33-70.

Pauly D. (1983). Some Simple methods for the assessment of tropical fish Stock. FAO Fisheries Technical Paper No. 234. 52 p.

Pauly, D., Munro J.L. (1984). Once more on the comparison of growth in fishes and invertebrates. Fishbyte, 2: 21-

Pauly, D. (1985). Quelques méthodes simples pour l'estimation des stocks de poissons tropicaux. FAO Doc. Tech. Pêches, (234), 56p.

Sidi Imorou, R., Adite, A., Sossoukpe, E., Adjibade, K.N., Arame, H., Sonon, S.P. (2019). Demographic parameters and exploitation rate of five key fishes of Okpara stream, Oueme Rive, Benin, West Africa. *International Journal of Aquatic Biology*, 7(6), 332-341.

Sonon, P.S., Sossoukpe, E., Adite, A., Gbankoto, A. and Abou, Y. (2021). Diversity and community characteristics of Eleotridae (Pisces: Actinopterygii: Perciformes) from the coastal waters of Benin (West Africa). *Journal of Biological and Environmental Sciences,*1-16.

Sonon, P.S., Sidi Imorou, R., Arame, H., Adjibade, K.N., Adite, A. (2023). Assessment of size structures, length-weight models and condition factors of Eleotridae (Pisces: Perciformes: Gobiodei) from the coastal waters of Benin (West Africa). *International Journal of Forest, Animal and Fisheries Research*, 7(1), Jan-Feb, 2023.
https://doi.org/10.22161/ijfaf.7.1.1

The World Bank (2022). Production de la pêche de capture -Bénin. Available at:
https://donnees.banquesmondiale.org/indicator/ER.FSH.AQUA.MT?locations=BJ
(accessed on 21/02/2023).

Von Bertalanffy, L. (1938). A quantitative theory of organic growth. *Human Biology*, 10(1), 181-213.

Welcomme, R.I., De Merona, B. (1988). Fish communities of rivers. In: C. Leveque, M.N. Bruton, G.W. Ssentongo (Eds). *Biology and ecology of African freshwater fishes.* ORSTOM, Paris. pp: 251-272.