E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2018; 6(3): 344-350

www.fisheriesjournal.com
Received: 05-03-2018
Accepted: 08-04-2018

Mardochée Ephraïm Achoh
Laboratory of Hydrobiology and Aquaculture (LHA), Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 Box 526 Cotonou, Benin

Hyppolite Agadjohouede
(A). Laboratory of Hydrobiology and Aquaculture (LHA), Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 Box 526 Cotonou, Benin
(B). Laboratory of Research in Aquaculture and Aquatic Biology and Ecology (LaRABEA), School of Aquaculture of the Valley, National University of Agriculture, Box 43 Kétou, Benin

Luc Gangbe
(A). Laboratory of Hydrobiology and Aquaculture (LHA), Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 Box 526 Cotonou, Benin
(B). National Institute of Agricultural Research of Benin, 03 Box 884 Cotonou, Benin

Kolawolé Romaric Bertrand Laleye
Laboratory of Hydrobiology and Aquaculture (LHA), Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 Box 526 Cotonou, Benin

Mahugnon Hamil Vodougnon
Laboratory of Hydrobiology and Aquaculture (LHA), Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 Box 526 Cotonou, Benin

Philippe Laleye
Laboratory of Hydrobiology and Aquaculture (LHA), Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 Box 526 Cotonou, Benin

Correspondence
Mardochée Ephraïm Achoh
Laboratory of Hydrobiology and Aquaculture (LHA), Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 Box 526 Cotonou, Benin

Impact of dredging on the ichthyofauna of the lowlands: comparison of the reproduction parameters of *Sarotherodon melanotheron* populations (Rüppell, 1852) of dredged lowlands and the coastal lagoon at togbin in southern Benin

Mardochée Ephraïm Achoh, Hyppolite Agadjohouede, Luc Gangbe, Kolawolé Romaric Bertrand Laleye, Mahugnon Hamil Vodougnon and Philippe Laleye

Abstract
The sampling between June and September yielded 428 specimens (230 for lagoon and 198 for shallows) on which breeding parameters were determined; monitoring monthly measurements of the physicochemical parameters of the water. In the long run, only the depth differs between the two environments (Prof lag = 1.57 m, Prof bottom = 6.2 m) ($p < 0.05$). The absolute fertility obtained in the lagoon (1,552 eggs) did not differ from that of the lowlands (1,468 eggs) ($p > 0.05$). The sex ratios obtained are not different from the unit (lagoon p = 0.99204, lowlands p = 0.7113). The first sexual maturity sizes of females and males are respectively 6.51 cm and 7.17 cm for the lagoon and 15.32 cm and 10.65 cm for the dredged bottomlands. The ovarian diameter revealed the size of the eggs in the shallows (0.17 cm) compared to the lagoon (0.11 cm). Ultimately, dredged water bodies will only serve biodiversity.

Keywords: *S. melanotheron*, breeding performance, fisheries development, Benin

1. Introduction
Fishing contributes to the fight against poverty and food insecurity. It exploits 4.4% of the world's agricultural labor force [1]. In Benin, fishing, one of the important links in agriculture, directly employs 56,876 fishermen, 20,000 fishmongers and nearly 300,000 direct and indirect jobs [2] and contributes 31% to the consumption of protein of animal origin [3]. It faces enormous problems with declining yields [4]. The direct consequence of this is the reduction of the fishing community's income, malnutrition, the development of very poor activities and the rural exodus [5]. The resilience of fishermen to this situation is the development of illegal fishing (use of gear and prohibited methods) but also other activities such as lagoon and fluvial sand dredging [6]. In Benin, the industrial dredging of lagoon and fluvial sand was born following the application of the decree prohibiting the exploitation of the sea sand since February 24th, 2009 (decree N°2008-615 of October 22nd, 2008). The importance of the demand for sand has made economic operators who have settled down with large machines giving rise to formal enterprises authorized by the Benin Environmental Agency (ABE) under the supervision of the Ministry of the Environment and Environment. Sustainable Development and registered at the Chamber of Commerce and Industry of Benin [7]. This sand harvesting activity leads to a modification of the habitat resulting in a structural, behavioral and trophic modification of the aquatic biodiversity [8]. It also leads to a modification of the hydrological network of the habitat [9]. The changes may be beneficial for biodiversity but may also be destructive to habitat and biodiversity [10] and unfavorable to other species of aquatic diversity [11]. Sand dredging benefits the population, but few studies have focused on assessing the biological response of the fish fauna to sand dredging. It is to provide information on the biology of the ichthyofauna of dredged bottomlands that this study was conducted and aims to compare the physicochemical parameters and reproductive parameters of the population of

Sarotherodon melanotheron dredged bottomlands and that of the coastal lagoon at Togbin.

2. Materials and Methods
2.1 Characterization of sudy area
The dredged lowlands and the Togbin coastal lagoon are two aquatic ecosystems side by side in the heart of the west complex of Ramsar 1017 and located between 06°21'13.5"N and 002°18'25.4"E. The Togbin area is characterized by vegetation dominated more than 60% by the mangrove (*Rhizophora racemosa* and *Avicennia africana*), followed by *Acrostichum aureus*, *Drepanocarpus lunatus*, *Paspalum vaginatum*, *Cyperus articulatus* and *Imperata cylindrica* [12]. The ambient temperature varies between 25 °C and 27.7 °C (Adité *et al*., 2013) and can reach 32.6 °C during the peak period of the dry season [13]. The climate is subequatorial with two rainy seasons (April to July and September to October) and two dry seasons (December to March and late July to early September). The average rainfall is about 1,307.3 mm [14]. The dredged bottomlands are in communication with the lagoon, especially during periods of high water. The economic activities of the populations in the environment are mainly fishing, agriculture, salt production and a spectacular development of the sand dredging companies officially authorized by the Benin Environmental Agency (ABE).

2.2 Sampling and Data Collection
The species studied is *Sarotherodon melanotheron* (Rüppell, 1852). This species is the most abundant of the continental aquatic ecosystems of Benin and the most represented in the catches of these two water bodies in Togbin [15]. Sampling was done exclusively on the basis of small-scale fishing between June and September 2017 and collected 428 specimens of *S. melenotheron* (all stages combined) with 230 specimens for the lagoon and 198 specimens for basins. dredged funds. Morphometric measures including total length (cm), total weight (g) and ovarian weight (g) were taken, followed by determination of sexual maturity stages. The scale used for the determination of sexual maturation stages is that used by Panfili *et al*. [16]. It states that in females, stage I corresponds to the immature; stage II at the beginning of maturation; stage III at maturation; stage IV corresponds to females tending towards reproduction; stage V corresponds to females in ovulation and stage VI corresponds to post-breeding. In males, stage I is immature; stages II and III correspond to the development of the testes; stage IV corresponds to individual maturity and stage V corresponds to sperm gonads. The gonads of stage III and IV females were removed, weighed and stored in Gilson's liquid (100 ml ethanol, 9 ml glacial acetic acid, 20 ml 60% nitric acid, 20 g mercury (II) chloride and 875 ml distilled water) where they were regularly shaken to promote separation of the eggs for counting and measuring their diameter.

2.3. Data Analaysis
2.3.1. Physicochemical characterization
Physico-chemical parameters including temperature (° C) and dissolved oxygen (mg / L) (surface and depth), pH, salinity (‰), transparency (cm) and depth (m) were taken in situ and were statistically analyzed using the Statistica Version 61984-2003 software. The average of each physicochemical parameter was calculated and after verification of normality, the Mann-Whitney U-test was used to test a probable significant difference in physico-chemical parameters between water bodies.

2.3.2. Absolute fertility, relative fertility and Gonado-Somatic Index
Absolute fecundity (Fa) was determined from counting oocytes in a sub-sample of eggs of known weight and consisting of three pieces taken from the rostral, middle and caudal regions of the gonads. This count was made 48-72 hours after the conservation of the eggs in the Gilson's liquid while appreciating the state of dissociation of the eggs. The highly advanced stage V and stage V females, whose easily expulsible eggs, which may have been partly released naturally or when sorting the catches [17] were not taken into account. Relative fertility was determined by the formula Fr = Fa / PT with Fa = absolute fertility (number of oocytes) and PT = total weight (g). The gonado-somatic index (IGS) is determined from the formula IGS = (PGo * 100) / PT with PGo = gonad weight (g) and PT = total weight (g).

2.3.3. Ovarian Structure
One hundred (100) oocytes per female were collected from a sample of twenty (20) stage IV females. Their diameters were measured using a hand magnifier and a graph paper. This structure was established using Statistica Version 6 software 1984-2003. The homogeneity of the oocytes is tested by calculating the coefficient of variation (CV) according to the formula CV = (100 * S / X) ; S is the standard deviation and X is the average. According to the coefficient of variation scale of Panfili *et al*. [16], the structure of oocytes is very homogeneous when CV is less than% 2% (CV <2%); the structure is homogeneous when CV is between 2% and 30% (2%> CV< 30%) and the structure is heterogeneous when CV is higher than 30% (CV>30%).

2.3.4. Size of first sexual maturity
The size of first maturity (L50) was determined by the equation of the sigmoid curve of evolution of the percentages (P) of sexual maturity as a function of size classes (LT). This curve is obtained by logistic transformation according to the method of Dagnelie, 1973 *in* Panfili *et al*. [16] and given by the formula P = x / 1 + x with x = e (a + bLT), P = percentage of mature individuals of all sizes of fish, a and b are coefficients of the model. The logarithmic transformation of the equation made it possible to put it in the form of Ln (P / 1-P) = a + bLT in which the L50 is.
obtained by the formula L50 = (-a / b) replacing P = 50% in the equation. The L100 is the size for which all individuals are mature.

2.3.5. Sex ratio
The sex ratio, which is the numerical ratio between males and females [18] was calculated by considering individuals in stages II to IV. The values obtained are compared to the theoretical 1: 1 sex ratio using the $\chi 2$ test at the 5% threshold with the Statistica version 6 1984-2003 software.

2.3.6. Regression between absolute fertility and morphometric measurements
The relationships between absolute fertility and some morphometric variables were established. These relationships are: Absolute Fertility (F) - Total Length (LT), Absolute Fertility (Fa) - Total Weight (PT), Absolute Fertility (Fa) - Gonad Weight (PGo) using the following formulas : Fa = aLTb, Fa = a + bPT and Fa = a + bPGo where a and b are the

parameters of the regression. These relationships have been studied to highlight the correlation between the number of eggs produced and the morphometric measurements.

3. Results

3.1. Physico-chemical characterization

For the entire study period, the average surface and depth temperatures were respectively 27.13 ± 0.53 ° C and 27.06 ± 0.61 ° C for the lagoon and 27, 33 ± 0.46 ° C and 27.5 ± 0.18 ° C for the shallows. These averages did not differ significantly between water bodies (p> 0.05). It was the same for dissolved oxygen where the average obtained respectively in surface and in depth were 1.638 ± 1.1 mg / L and 1.625 ± 1.08 mg / L for the lagoon and 2.73 ± 0, 41 mg / L and 2.58 ± 0.54 mg / L for dredged bottomlands. The overall average pH was 8.25 ± 0.31 for the lagoon and 8.11 ± 0.21 for the dredged bottomlands. Although the average pH at the lagoon appeared to be higher than that of dredged shoals, the Man-Whitney U test revealed no significant difference between them at the 5% level. As for the salinity, the averages obtained did not differ from each other and were respectively 5.25 ± 0.89 ‰ for the lagoon and 5.63 ± 0.92 ‰ for the dredged lowlands. The average transparency obtained for the lagoon was 63.75 ± 9.91 cm and 65.25 ± 10.08 cm forthe dredged bottomlands with a non-significant difference at the 5% level. The average depth obtained for dredged shoals (6.2 ± 1.21 m) was significantly greater than that of the lagoon which was 1.57 ± 0.57m (*p*<0.0007). This parameter remained the main aspect of difference between the two bodies of water.

3.2. Reproduction Settings

3.2.1. Fertility, IGS and Sex ratio

Fertility, IGS and sex ratio examined for 32 females for the lagoon (mean total length 13.83 ± 3.56 cm and total mean weight 62.96 ± 34.39 g) and 38 females for the shallows (mean total length 18.43 ± 2.11 cm and average total weight 121.54 ± 30.50 g). The average weight of the gonads studied varies between 0.47 g and 2.13 g for the lagoon and between 0.01 g and 8.33 g for the lowlands. Absolute fecundity varies between 712 and 2970 oocytes for the *S. melanotheron* population of the lagoon and then between 548 and 3417 for dredged bottomlands. The mean absolute fertilization was 1,552 ± 797 oocytes for the lagoon and 1,468 ± 823 oocytes for the dredged bottomlands. The Student's T test revealed no significant difference between the averages of the two absolute fertility rates (p> 0.05). The relative fecundity, which was the ratio of the number of oocytes per body weight, varies from 8 to 140 oocytes / g of body weight and from 2 to 27 oocytes / g of body weight respectively for the lagoon and the lowlands. dredged. The average obtained for the relative fertility of the lagoon (65 ± 35 oocytes / g) was significantly higher than that of dredged bottomlands (12 ± 6 oocytes / g) (p <0.0001). As for the Gonado-Somatic Index (IGS), the averages obtained were respectively 2.10% for the lagoon and 1.8% for the dredged bottomlands with a non-significant difference (p> 0.05). The sex ratio obtained for the *S. melanotheron* population of the lagoon was 1.01: 1; which was not significantly different from the theoretical sex ratio of 1: 1 (χ2 = 0.0001, p = 0.99204). For the dredged bottom population, the sex ratio obtained was 1: 1.37, which was statistically equal to the theoretical sex ratio of 1: 1 (χ2 = 0.1399, p = 0.7113).

3.2.2. Ovarian structure of *Sarotherodon melanotheron* by body of water

The ovarian structure of the *S. melanotheron* population of dredged lowlands and lagoon showed in Figures 2 A and B, respectively. A total of 2018 and2238 eggs measured respectively for the lagoon population and dredged bottomlands. It appeared that the ovarian structure of the *S. melanotheron* population of both water bodies was multi-modal with four (4) modes for the lagoon and six (6) modes for the lowlands (modes greater than 5% considered) and each modal class corresponds to a spawning sequence. In this way, the population of *S. melanotheron* of the lowlands had a higher number of oviposition than that of the lagoon. This modal class multiplicity confirmed by the coefficient of variation, which was respectively 34.79% and 43.12% for the lagoon and for the dredged bottomlands. These values, all greater than 30%, indicated a heterogeneity of the diameter of the eggs in the two water bodies and this heterogeneity was more marked in the shallows than in the lagoon with p <0 . 0002. As for the diameter of the eggs, it was significantly larger (p <0.0001) for the low-dredged population (0.17 ± 0.07 cm) than for the lagoon population (0.11 ± 0.04 cm).

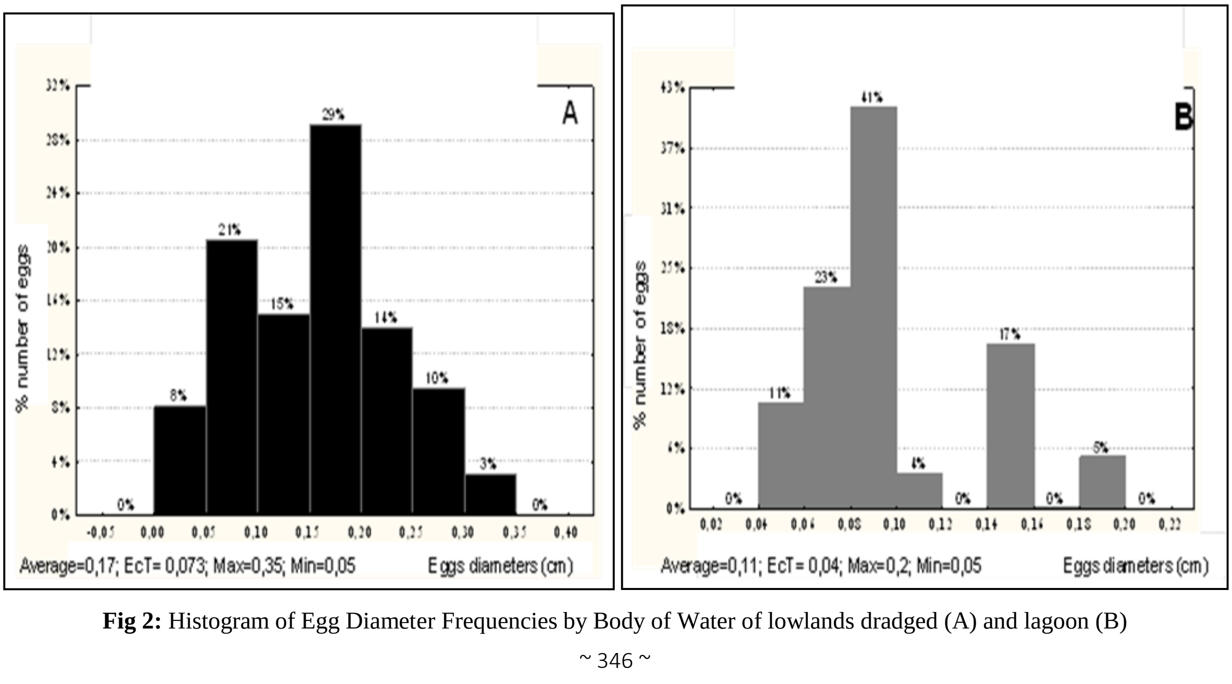


Fig 2: Histogram of Egg Diameter Frequencies by Body of Water of lowlands dradged (A) and lagoon (B)

3.2.3. Size of first sexual maturity of *Sarotherodon melanotheron* by body of water

The size of first sexual maturity noted L50 represented on figure 3 A and B. The comparison of this size within the same medium according to the sex revealed that for the low-bottoms dredged (figure 3 A), the females (L50 = 15.32 cm, R2 = 0.86) had a higher first maturity size than males (L50 = 10.65 cm, R2 = 0.83). On the other hand, at the lagoon level (Figure 3B), the size of first sexual maturity was relatively higher at the level of males (L50 = 7.17 cm, R2 = 0.64) than at the level of females (L50 = 6 51 cm, R2 = 0.88). The comparison of the size of first sexual maturity at the level of each sex according to the two environments revealed that whatever was the sex, the size of first sexual maturity of the individuals of the dredged bottomlands wassuperior to that of the individuals of lagoon.

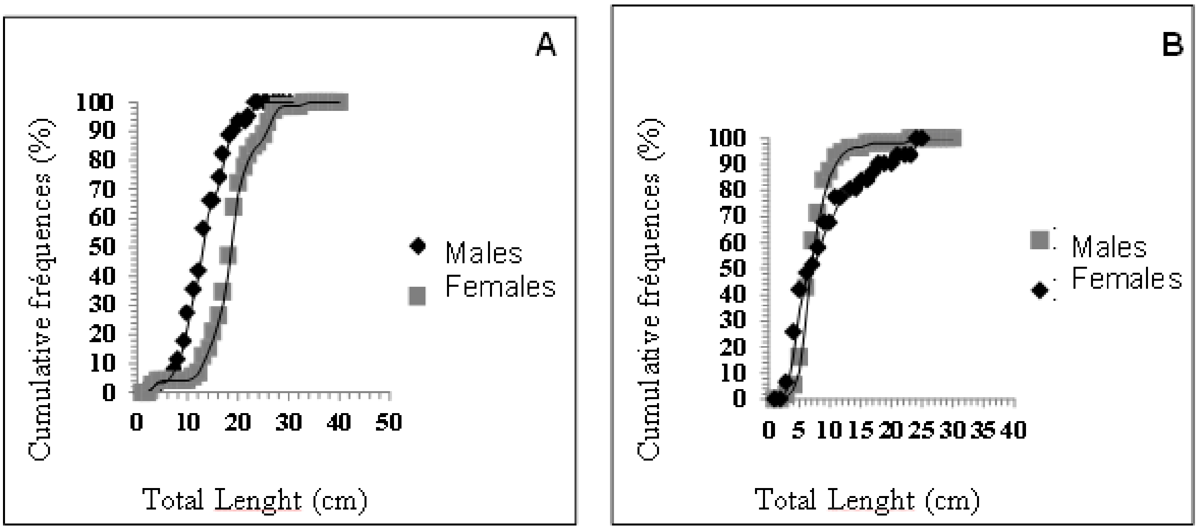
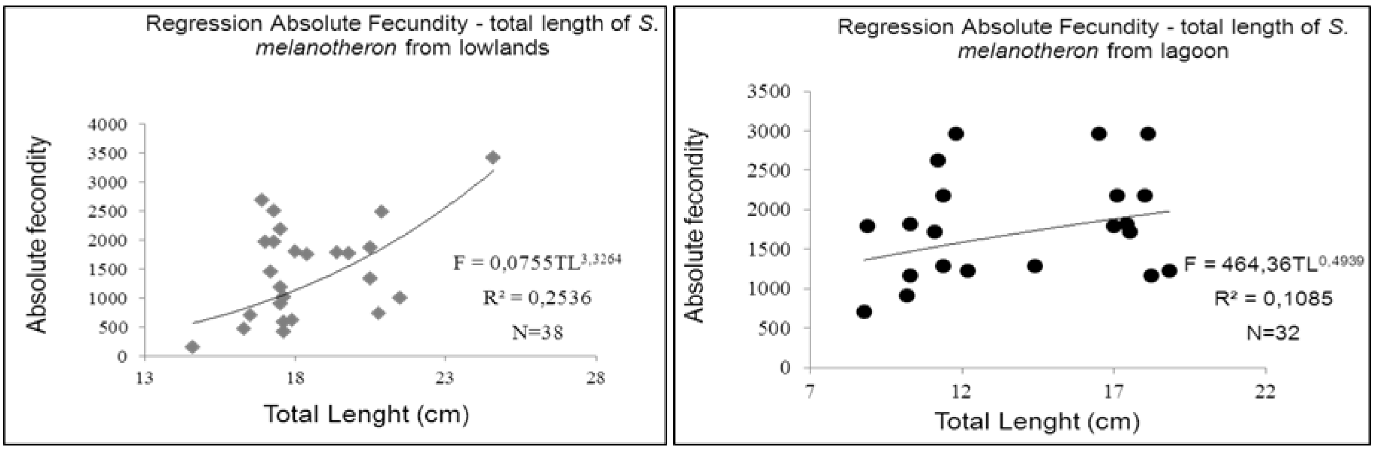


Fig 3: Dagnelie curve for the size of first sexual maturity of population of lowlands dradged (A) and lagoon (B)

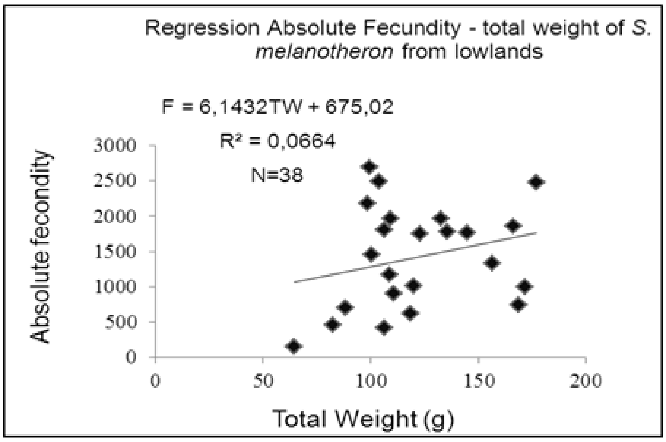
3.2.4. Absolute Fertility - Total Length, Absolute Fecundity - Body Weight and Absolute Fecundity - Gonad Weight

Figure 4 (A, B, C, D, E and F) showed the relationship between absolute fertility and morphometric measurements (total length, body weight and gonad weight) at the two waterbodies. For dredged lowlands, the relationship between absolute fertility and total length (Figure 4A) had the equation Fa = 0.0755LT3, 3264. Linearization of this relationship following a logarithmic transformation gives LnFa = -2.5834 + 3.3264LnLT with a positive correlation coefficient of r = 0.5036 (p = 0.01). As for the relationship between absolute fertility and the total weight of the *S. melanotheron* population at the lowland level (Figure 4 B), the associated equation is Fa = 6.1432PT + 6.7502 with a coefficient of determination low R2 = 0.06. The correlation coefficient was r = 0.2578 (p> 0.05). With respect to the relationship with ovarian weight (Figure 4C), the correlation coefficient (r = -0.4321, p <0.05, Fa = 1873.92-158.54PGo) was significantly negative and revealed that gonad weight was inversely proportional to absolute fertility.

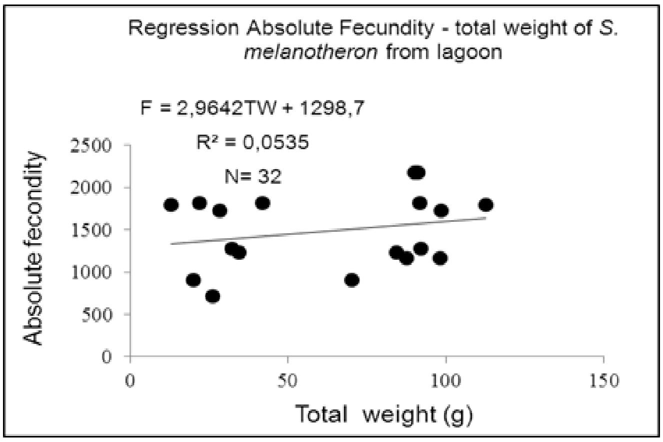
For the lagoon, the relationship between fertility and total length (Figure 4D) had the equation Fa = 464.36LT0.4939 with a coefficient of determination of R2 = 0.1085. The logarithmic transformation linearization yields LnFa = 6.1407 + 0.4939LnLT with a non-significant positive correlation coefficient (r = 0.3293, p = 0.1499). With the total weight (Figure 4 E), the correlation coefficient (r = 0.2313, p = 0.3557) showed that fertility is weakly in positive relationship. The relationship between absolute fertility and gonad weight at the lagoon expressed by the equation Fa = 1059,299 + 972,05PGo (Figure 4F) showed a significantly positive correlation coefficient (r = 0.5929; = 0.0036).



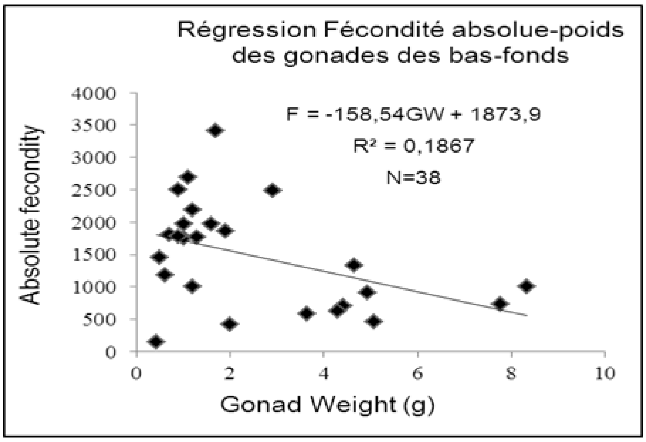
(A) (B)



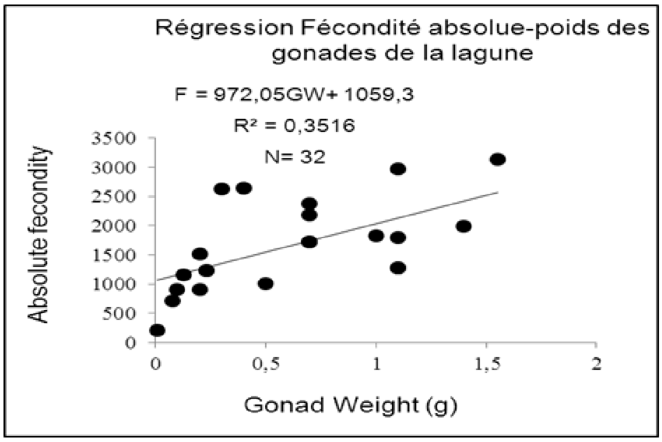
(C)



(D)



(E)



(F)

Fig 4: Regression between Absolute Fertility and Morphometric Measurements

3. Discussion

The physico-chemical characteristics of aquatic environments are very important in the physiology of aquatic species. In general, the average temperature and pH obtained correspond to the vital tolerance interval of *S. melanotheron* species which is 17°C - 32°C for temperature [19] and from 6.37 to 8.77 for the pH according to Ouattara *et al*. [20]. It is the same for the salinity and transparency whose averages obtained are favorable to the species according to the recommendations of Ouattara *et al*. [21]. As for dissolved oxygen, the average values obtained for the two areas are below the minimum rate favorable to *S. melanotheron* species which is 3 mg / L according to Ouattara *et al*. [22]. These dissolved oxygen levels obtained are related to the study period which corresponds to the rainy season characterized by low sunlight, which consequently reduces the phytoplankton activity of oxygen production in aquatic environments. With respect to depth, the high average obtained for shallow water (6.2 m) compared to the lagoon (1.57 m) is due to sand dredging activities. This depth given to the shallows will contribute to a better vital condition of the species in this environment in that it allows the species to go deep when the temperature of the surface water becomes unbearable especially in dry season [23]. Also, the depth allows the particles in suspension to settle out and thus promotes a better penetration of the solar light pledge of the primary production essential for the production of aquatic ecosystems [24].

The absolute fecundities obtained for the two populations of *S. melanotheron* are above that obtained by Legendre and Trebaol, [25] for the same species which varied between 377-723 oocytes for couples loaded in cement basins. Also, the relative fertility obtained is higher than the observations of Panfili *et al*. [16], which ranged from 4 oocytes / g to 6 oocytes / g for lagoons with annual salinities ranging from 0-38 mg / L and 17- 38 mg / L. The numerical superiority trend of absolute fertility for the benefit of the lagoon population is due to an eco-physiological response of the population to fishing pressure, low oxygen and shallow depth [23, 26]. This response is materialized by the production of a large number of eggs to perpetuate the species. According to Legendre and Ecoutin, [26], the absolute fertility is all the more important as the diameter of the eggs is small. This is in line with the observations obtained in this study related to egg diameters where small diameters are derived from the population of the lagoon. The average diameter of the eggs obtained for the population of the two bodies of water is below that obtained by Koné and Teugels, [27] (0.38 cm) and by Panfili *et al*. [16] (0.77 cm).

The ovarian structure shows significantly greater heterogeneity for the dredged bottom population. This shows the reproduction strategy adopted by *S. melanotheron* (asteropic iteroparum) in both environments [28], and even more the ease of this species to express these reproductive potentialities in the dredged bottomlands.

For the gonado-somatic index (IGS), the low index obtained at the level of the population of the lagoon takes into account the eco-physiological response where low weight gonads are full of a large number of small eggs.

The size of first sexual maturity of individuals at the lagoon level is low, while the population of dredged bottomlands has a size of first sexual maturity comparable to that obtained for the same species by Panfili *et al*. [16] which was 12.6 cm to 17 cm for females and 11.1 cm to 17.1 cm for males. The trend in size of first sexual maturity according to the sex observed in the lowlands (male reaches maturity more quickly than the female) is consistent with the observations of Legendre and Ecoutin, [26] in the lagoon Ebrié and Koné and Teugels, [27] in a dam lake. This trend is explained by the higher proportion of females compared to males (sex ratio 1: 1.37) leading to an early solicitation of males to reproduction and therefore to earlier gonad maturation than to females. At the lagoon level, the small size of first sexual maturity compared to that obtained in the lowlands (all sexes combined) is also proof of a response to difficult ecological conditions and fishing pressure. Observations of this size in both media indicate that the size of *S. melanotheron*'s first sexual maturity varies from one medium to another [29, 30].

By analyzing the relationships between fertility and morphometric measurements, it can be deduced that, whatever the water level, although it is weak, there is a positive correlation between absolute fertility and total length, and between absolute and absolute fertility. the total weight. These observations are consistent with those of Koné and Teugels, [27] who reported a low correlation between fertility and body weight of *S. melanotheron* living in a dam lake. Specifically for the absolute-weight gonad-gonad relationship, the correlation trend obtained at the lowland level (gonad weight inversely proportional to absolute fertility) is related to the fact that females of *S. melanotheron* from this body of water have larger eggs, which in small quantities weigh more than many small eggs [27]. On the other hand, at the level of the population of the lagoon, the correlation between these two parameters is positive and joins the observations of Montchowui *et al*. [17]. This allows to say that the weight of the ovaries is not related to the size of the eggs but rather to the importance of the number of eggs. These observations are similar to those of Koné and Teugels, [27].

Conclusion

Dredging affects the hydrology of aquatic environments but contributes to improving the productivity of biodiversity. As a result of this study, it was found in the population of *Sarotherodon melanotheron* dredged bottoms in Togbin that eggs produced are larger with a size of first sexual maturity superior to that obtained for the same species at the coastal lagoon in Togbin. These observations are reinforced by the value obtained for the lowland condition factor, which is nearly 10 times that of the lagoon and thus confers an ecological condition more suited to the expression of the reproductive performance of the species in the lagoon. the dredged bottomlands. It should be remembered that the dredging of aquatic ecosystems is the only point-in-time alternative to revive aquatic environments, especially in the current climate change and deforestation conditions that lead to increased runoff and leaching of watersheds.

Acknowledgment

The authors address their thanks to the Academy of Research for Higher Education (ARES) for funding, at the National Institute of Agricultural Research of Benin (INRAB) which, through its Laboratory of Veterinary and Halieutic Animal Research (LRZVH), provided a framework for the execution of this study and anonymous evaluators for contributing to the improvement of the scientific quality of this manuscript.

References

1. FAO, Situation mondiale de la pêche et de l'aquaculture 2014, 275
2. PSRSA. Plan stratégique de relance du secteur agricole. Ministère de l'agriculture, de l'élevage et de la pêche (Revue), Bénin, 2011, 116.
3. Cakpo-Kiossa C. Biodiversité et exploitation de quelques espèces de poissons de la rivière Sô au Bénin. Mémoire de Master de recherche en analyse des populations des espaces halieutiques, Université Polytechnique de Bobo-Dioulasso, 2012, 113
4. Montchowui E, Agadjihouèdé H, Yaovi R, Poncin P, Laleye P. Comparative study of fisheries exploitation using biological indicators in the small lakes in Benin. In 14th European Congres of Ichthyology « ECI14 », 2012.
5. MAEP. Stratégie d'opérationnalisation et déclinaison en plans d'investissements sectoriels de la vision Bénin 2025 « Agenda vers une économie émergente » 2008, 171
6. Dakpo PC, Ahonnon A, Abalot EE, Boko CG, Houngan C, Okou C. Impact socio-environnemental de l'exploitation du sable marin sur le développement humain durable dans la commune de Grand-Popo au Bénin. Journal de la Recherche Scientifique de l'Université de Lomé. 2013; 15(2)
7. CCIB. Listes des Entreprises, Rapport annuel d'activité de la Chambre du Commerce et d'Industrie du Bénin, 2015, 163
8. Hakkou M, Benmohammadi A, Castelle B, Bertin X, Labraimi M, El-Hassani A *et al.* Perspectives d'optimisation technique de la gouvernance environnementale des activités du dragage du sable marin au Maroc. Bulletin de l'Institut Scientifique, Rabat, Section Sciences de la Terre. 2015; (37)
9. Demir H, Otay EN, Work PA, Borekci OS. Impacts of dredging on shoreline change. Journal of Waterway, Port, Coastal, and Ocean Engineering. 2004; 130(4):170-178.
10. Newell RC, Seiderer JL, Hitchcock DR. The impact of dredging works in coastal waters: a review of sensitivity to disturbance and subsequent recovery of biological resources on the seabed. Revue annuelle d'Océanographie et de biologie marine. 1998; (36):127-78.
11. Grégoire P. Modèle conceptuel d'aide à la décision multicritère pour le choix négocie d'un scenario de dragage maritime. Thèse de doctorat de l'université d'Artois. 2004, 299.
12. Akotossodé CC, Achoh ME, Agadjihouèdé H, Vodougnon MHB, Amadou, S, Tchabi IV. Etat des ressources naturelles de Djègbadji et de Adounko (site Ramsar 1017) au Sud-Ouest Benin (Afrique de l'Ouest) dans le contexte actuel de changement climatique. Soumis au Journal de Recherche Scientifique de l'Université de Lomé, Reference JRSUL-044A, 2018
13. ASECNA (Agence pour la Sécurité de la Navigation Aérienne en Afrique et à Madagascar). Nouvelles données météorologiques /Aérodrome /Cotonou/ Bénin. 2014, 1.
14. Adite A, Abou Y, Sossoukpe E, Fiogbe ED. 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. 2016; 3(10):087-094.
15. Adité A, Toko I, Gbankoto A. 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. 2013; (4):1461-1475
16. Panfili J, Abdou M, Durand J, Diop K, Diouf K, Thior D *et al.* Influence of salinity on the life-history traits of the West African black-chinned tilapia (*Sarotherodon melanotheron*): Comparison between the Gambia and Saloum estuaries. Aquatic Living Resources. 2004; (17):65-74.
17. Montchowui E, Lalèyè P, Philippart JC, Poncin P. Biologie de la reproduction de *Labeo parvus* Boulenger, 1902 (Cypriniforme, Cyprinidae) dans le bassin du fleuve de l'Ouémé au Bénin (Afrique de l'Ouest). Cahier Éthologie. 2007; 22(2):61-80.
18. Dajoz R. Précis d'écologie. Ed. Bordas. Paris, 1982, 503.
19. Amoussou TO, Toguyeni A, Imorou Toko I, Chikou A, Issaka YAK. Caractéristiques biologiques et zootechniques des tilapias africains *Oreochromis niloticus* (Linnaeus, 1758) et *Sarotherodon melanotheron* Rüppell, 1852 : une revue. International. Journal of Biological and. Chemical Sciences. 2016; 10(4):1869-1887
20. Ouattara NI, N'Douba V, Kone T, Snoeks J, Philippart JC. Performances de croissance d'une souche isolée du tilapia estuarien *Sarotherodon melanotheron* (Perciformes, Cichlidae) en bassins en béton, en étangs en terre et en cages flottantes. Annale de l'Université Marien Ngouabi. 2005; 6(1):113-119.
21. Ouattara NI, Iftime A, Mester LE. Age et croissance de deux espèces de Cichlidae (Pisces): *Oreochromis niloticus* (Linnaeus, 1758) et *Sarotherodon melanotheron* Rüppell, 1852 du lac de barrage d'Ayamé (Côte d'Ivoire, Afrique de l'Ouest). Travaux du muséum national d'histoire naturelle «Grigore Antipa». 2009; LII:313-324.
22. Ouattara NI, Teugels GG, N'Douba V, Philippart JC. Aquaculture potential of the black-chinned tilapia, *Sarotherodon melanotheron* (Cichlidae). Comparative study of the effect of stocking density on growth performance of landlocked and natural populations under cage culture conditions in Lake Ayame (Côte d'Ivoire). Aquaculture Research. 2003; 34(13):1223-1229.
23. Page LM, et Burr MB. Afiel guide freshwater fiches of Nord American of north Mexico. Houghton Mifflin Company. Boston 1991, 423. http://dx.doi.org./
24. Sarmento H, Isumbisho M, Stenuite S, Darchambeau F, Leporcq B, Descy JP. Phytoplanktonecology of Lake Kivu (eastern Africa) : biomass, production and elemental ratios. Verh. Internat. Verein. Limnol. 2009; 30(5):709-713.
25. Legendre M, Trebaol L. Efficacité de l'incubation buccale et fréquence de ponte de *Sarotherodon melanotheron* (Rüppel, *185l)* en milieu d'élevage (lagune Ebrié, Côte d'Ivoire), p. 375-386. *In* R.S.V. Pullln, J. Lazard, M. Legendre, J.B. Amon Kothias et D. Pauly (éds.), Troisième Symposium International sur le Tilapia en Aquaculture. ICLARM Conf. Proc. 1996; 41:630.
26. Legendre M, Ecoutin JM. Aspects de la stratégie de reproduction de *Sarotherodon melanotheron*, comparaison entre une population naturelle (lagune Ebrié, Côte d'Ivoire) et différentes populations d'élevage, p. 360-374. In R.S.V. Pullin, J Lazard, M. Legendre, J.B. Amon Kothias et D. Pauly (éds.), Troisième Symposium International sur le Tilapia en Aquaculture. ICLARM Conf. Proc. 1996; 41:630.
27. Koné T, et Teugels GG. Données sur la reproduction d'un tilapia estuarien (*Sarotherodon melanotheron*) isolé dans un lac de barrage Ouest-Africain. Aquatic Living Resources, 1999; 12(4):289-293.
28. Lazard J, Legendre M. La reproduction spontanée du tilapia: Une chance ou un handicap pour le développement de l'aquaculture Africaine? In: Troisième symposium international sur le tilapia en aquaculture, ICLARM (ed). Jakarta; 1996, 82-98.
29. Duponchelle F, Panfili J. Variation in age and size at maturity of female Nile tilapia, Orechromis niloticus, populations from man-made lakes of Côte d'Ivoire. Environment Biology Fiches. 1998; (52):453-465.
30. Duponchelle F, Pouyaud L, Legendre M. Evidence of environment effect on reproductive characteristics of Nile tilapia (*Oreochromis niloticus*) populations from man-made lakes of Ivory Coast. Aquatic Living Ressources. 1998; (11):137-144.