Open Journal of Ecology, 2024, 14, 257-273
https://www.scirp.org/journal/oje
ISSN Online: 2162-1993
ISSN Print: 2162-1985

Growth, Population Parameters and Stock Status of *Sarotherodon galilaeus* in Samandeni Reservoir, Burkina Faso

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How to cite this paper: Da, N., Ouedraogo, R., Minoungou, M. and Oueda, A. (2024) Growth, Population Parameters and Stock Status of *Sarotherodon galilaeus* in Samandeni Reservoir, Burkina Faso. *Open Journal of Ecology*, **14**, 257-273.
https://doi.org/10.4236/oje.2024.144016

Received: February 23, 2024
Accepted: April 8, 2024
Published: April 11, 2024

Abstract

Mango tilapia, *Sarotherodon galilaeus* is one of the most caught fish species in the Samandeni multi-species fishing sites of which, few data on its biology and exploitation are available. The study aimed to Assess the stock status of *S. galilaeus*. Sampling was conducted from March, 2021 to February 2022 based on commercial fish catches to analyze growth parameters, first sexual maturity size and harvest status of the stock. A total of 572 specimens including 297 females and 275 males were examined. The stock assessment was performed by using the Length based Bayesian method of Biomass (LBB) and that of growth by the ELEFAN method. The growth parameters showed a seasonality of growth and females appeared to grow faster than males. On the other hand, males had a greater asymptotic length than females. Results on the estimated length of fish at first maturity showed that females firstly reached the maturity compared to males. The relative biomass (B/B_0) estimated for the stock was higher than the relative biomass that produces maximum sustainable yield (B_{MSY}/B_0) indicating healthy biomass. In addition, the length at first sexual maturity was less than the length at the first catch, indicating the absence of overfishing of growth. In addition, extending the study to the various stocks of the reservoir would be important for the sustainable management of the Samandeni high economic fishing area.

Keywords

Growth, Stock Status, *Sarotherodon galilaeus*, Samandeni Reservoir, Maturity

1. Introduction

The Samandeni reservoir is a hydroelectric reservoir located on the Volta River in the Upper Basins region of Burkina Faso. It offers opportunities in various sectors, including agriculture, fishing and fish farming. Since its opening for fishing in 2019, Samandeni reservoir has been one of the main supports of the fisheries production in Burkina Faso. However, the ever-increasing demand for fish and fish products increases the fishing pressure on natural fish population, which sometimes leads to a significant depletion of the natural fish stock. In this context, in order to alleviate fishing pressure and to ensure its sustainability, it is essential to assess the key biological parameters and the status of fish stocks in this ecosystem. In addition, management plans must be established based on the stock assessment information [1] and scientific approaches [2]. Many commercially exploited stocks and particularly fish stocks in inland fisheries also lack quantitative assessments and reliable estimates of the fish stock status [1] [3] [4]. Furthermore, fishery landings in Samandeni Reservoir are primarily in the form of a multi-species complex, which poses a challenge to record species-specific catch and effort details, yet are required for regular stock assessment using conventional stock assessment models. Therefore, assessment of life history characteristics, such as growth, population demographics, and reproductive characteristics of the most abundant fish species, is of critical importance for sustainable fisheries management. In the Samandeni reservoir, *Sarotherodon galilaeus* is the most commercially important species. Indeed, it is an abundant fish in the reservoir where it is part of the main commercial catch [5]. In addition, a study conducted before the reservoir was opened to fishing showed *S. galilaeus* to be one of the most abundant fish species in this ecosystem [6]. Despite its considerable economic value, only one study was conducted on the biology of this species in Samandeni Reservoir prior to its exploitation [7]. Other studies were also conducted on the biology of this species in some water bodies in Burkina [8]. Although, data available from other water bodies can be used for fisheries management of *S. galilaeus*, the importance of demographic parameters specific to Samandeni Reservoir cannot be minimized. Therefore, estimates of life history characteristics and population demographics of the most abundant fish species in Samandeni Reservoir are warranted. Moreover, ecological changes observed in this reservoir over the years, as well as intensive fishing pressures, have influenced the population parameters of various fish species. Thus, this study was undertaken to determine the growth and population parameters of *S. galilaeus* in Samandeni Reservoir using length-frequency data. We therefore analyzed the population dynamics of *S. galilaeus* based on 12 months period of catch data collected from fishermen by estimating growth, mortalities, some reproductive characteristics and exploitation status of the stock and formulated recommendations to ensure the sustainable management of the fish species in the reservoir.

2. Material and Methods

2.1. Study Site and Fish Sampling

The newly created reservoir of Samandeni is located in the Volta catchment of

Burkina Faso between latitudes 11˚23' and 11˚19' North and longitudes 4˚34' and 4˚46' West (**Figure 1**). This waterbody got the status of Ramsar site in October 2020. It has 153 km^2 wide with a storing water capacity of more than one billion of m^3. The fish specimens were collected from the catch of local fishers on a monthly basis from March 2021 to February 2022 by considering nine sampling sites as shown in **Figure 1**. Fish species were identified by using the standard identification key given by [9]. In the Samandeni reservoir, the fishermen are known to use a variety of fishing methods such as gillnets with a mesh size of 10 to 40 mm, longlines, traps and cast net.

2.2. Sample Processing and Measurements

Fish were randomly sampled from several fishermen to ensure a good representation of classes size of the samples. Each specimen was examined on the same day they were collected to avoid error in the morphometric measurements posed by fixation. The total length (TL in cm) of each fish was measured by using empirical approach to calculate length frequency (LF) distributions according to [10] and to estimate growth parameters. The body weight (W) of each specimen was also measured (0.1 g) using an electronic balance.

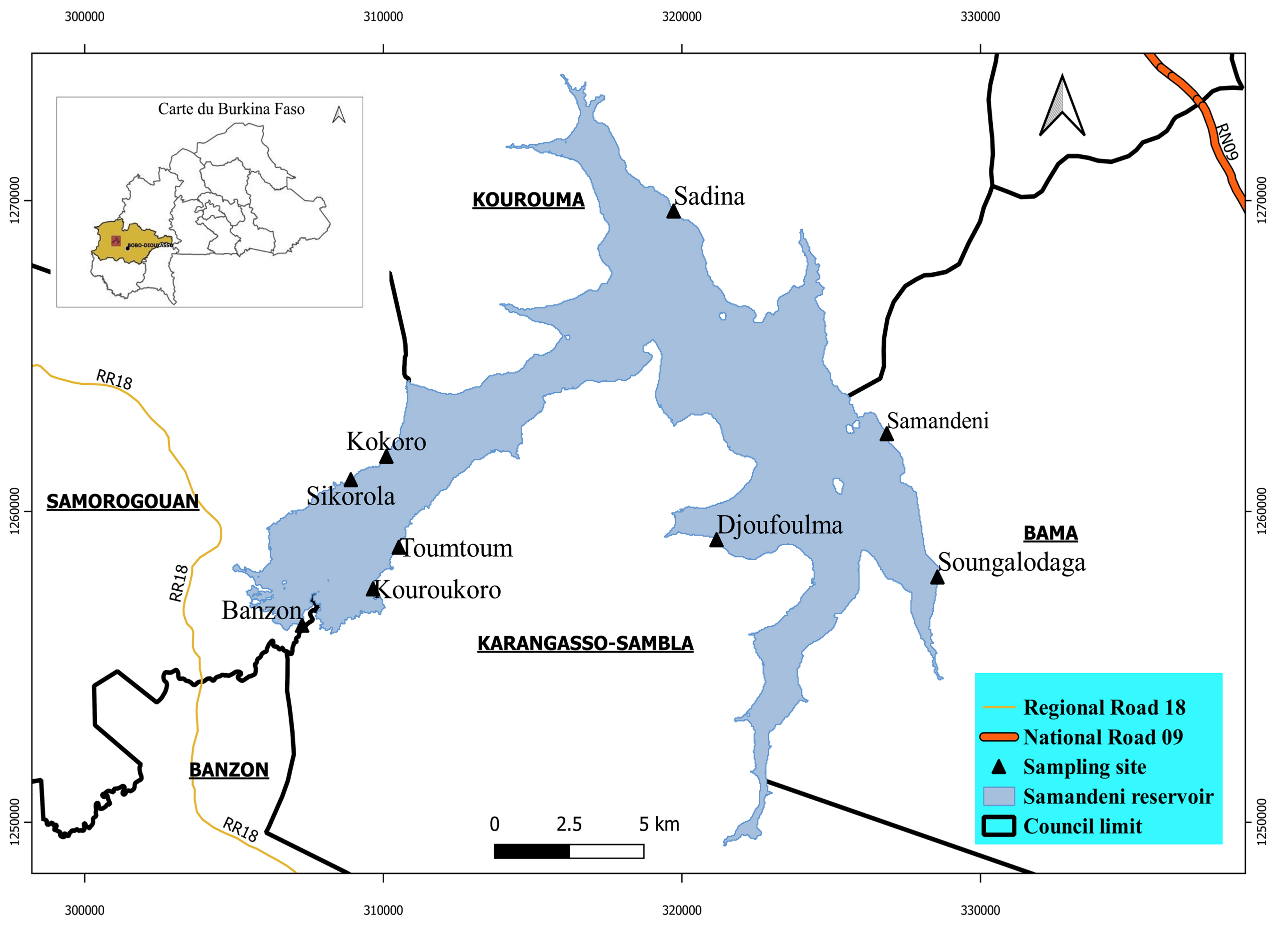

Figure 1. Map showing the study site, the man-made lake of Samandeni, and the sampling sites.

2.3. Growth Parameters Estimation

A monthly collected value of TL, grouped into class intervals of 2 cm according to [10] empirical approach, was used to estimate the fish population demographic parameters. The asymptotic length (L_{inf}), the coefficient of growth (K), the amplitude of the growth oscillations (C), and the fraction of a year from which the sine wave oscillation begins (t_s) were estimated using TropFishR, an R package ver. 3.5.1 for tropical fisheries analysis [11]. Since we collected length-frequency (LF) data, the electronic length frequency analysis method (ELEFAN) was employed to estimate the population demographic parameters [12]. A bootstrapped ELEFAN with genetic algorithm optimization function developed by [13] was applied to analyze LF data, allowing the assessment of the uncertainties around the growth parameters estimate. Growth was modeled based on Von Bertalanffy growth function (VBGF) and a seasonally oscillating VBGF was used to assess the growth parameters, which are attributed to changes in water temperature, precipitation and to the availability of food [14]. The seasonally oscillating VBGF [15] used is given as:

$$L_t = L_{inf}\left(1 - e^{-\left(k(t-t_0)+S(t)-S(t_0)\right)}\right) \tag{1}$$

With $S(t) = (CK/2\pi)\sin 2\pi(t - t_s)$, $S(t_0) = (CK/2\pi)\sin 2\pi(t_0 - t_s)$, and L_t is the length -at -age t, L_{inf} is the asymptotic length, K is the von Bertalanffy growth constant, and t_0 is the theoretical age when length equals zero, C is a constant indicating the amplitude of the oscillation, typically ranging from 0 to 1, and t_s is the fraction of a year where the sine wave oscillation begins (turns positive). A value of $C = 1$, growth stops completely once a year at a point in the annual cycle while values of C ranging between 0 and 1 results in slowed but not stopped, growth [16].

2.4. Estimation of Mortalities Coefficient

Total mortality coefficient (Z) is estimated using the length-converted catch curve method [17] from the pooled length frequency data for the study period. The slope (b) of the curve with sign change gives the total mortality. The natural mortality rate (M) was calculated using [18] equation as follows:

$$M = 4.118K^{0.73}L_{inf}^{0.33} \tag{2}$$

Fishing mortality coefficient (F) was estimated by subtracting the value of natural mortality coefficient (M) from the value of total mortality coefficient (Z) as follow:

$$F = Z - M \tag{3}$$

2.5. Length at First Capture (L_c)

The body length at first capture (L_c) is the average selection length and was estimated by interpolation of the cumulative catch curve. The probability of capture for each length class was obtained from the backward extrapolation of the linearized capture curve, according to [17]. The extrapolated points from the length-converted catch curve were used to estimate the catch probability using the moving average method to estimate the length at first capture (L_c) by linear interpolation.

The capture probability was estimated by backward extrapolation, of the descending limb of the length-converted catch curve. A selectivity curve was generated using linear regression fitted to the ascending data points from a plot of the probability of capture against length, which was used to derive values of the lengths at capture at probabilities at 50%, 75% and 95% [12].

2.6. Length at First Sexual Maturity

The body length at which 50% of the individuals were mature (L_m) was estimated by fitting the logistic function of a non-linear regression relating the proportions of mature individuals (P) and total length (LT) of fish. The gonads maturity stages were determined by macroscopic observation of gonads according to [19]. Specimens falling within Stage II and above gonad maturity were used for L_m determination. The percentage of mature individuals in each length class was calculated based on the total number of individuals in each length class. The sigmoid curve was fitted using a standard logistic regression model as follows:

$$P = \frac{1}{1 + \exp^{-(\alpha LT + \beta)}} \quad (4)$$

where α and β are the model parameters. Following a logarithmic transformation of the previous formula and, by substituting $P = 50\%$ in the equation, L_m is obtained by:

$$L_m = -\frac{\alpha}{\beta} \quad (5)$$

2.7. Biological Reference Points and Stock Status

The stock status was estimated using the LBB method that is a recent approach developed by [20] to access the stock, which uses LF data as input and applies a Bayesian Monte Carlo Markov Chain (MCMC) method to estimate indicators of stock status. The LBB model is suitable for species that grow throughout their life, such as most economic fish and invertebrates [20]. It estimates the asymptotic body length (L_{inf}), the first catch body length (L_c), the relative natural mortality (M/K) and the relative fishing mortality (F/M) in the age range represented by LF samples. With these parameters as input, standard fisheries equation can be used to estimate the depletion or the current exploited biomass with regards to unexploited biomass (B/B_0). These parameters also allow the estimation of the length at first capture that would maximize catch and biomass for the given fishing effort (L_{c_opt}), and the estimation of a proxy for the relative biomass capable of producing maximum sustainable yields (B_{MSY}/B_0). The method uses a pre-specified set of priors, but users can manually incorporate priors for asymptotic length (L_{inf}), length at first capture (L_c), and relative natural mortality

(M/K) from local studies. The L_{inf} priors were estimated from the median maximum length rather than the absolute maximum length. The M/K prior is set as 1.5, and L_c is estimated from the catch curve generated from the input LF data. We used a first maturity body length (L_m) estimates by this study and computed the numeric percentage of specimen in the catches larger than L_m. In the present study the basic equations are given below, however, for more details on the LBB method see [20]. **Table 1** stands for the basic information and priors (L_{inf}, L_c, Z/K, M/K, F/K, and α) for the LBB analysis.

The analysis presented was done using R code (LBB_33a. R), downloaded from http://oceanrep.geomar.de/44832/ following the guidelines provided in the new user guide of the code.

First of all, a major assumption of the LBB method is that growth in length follows VBGF:

$$L_t = L_{inf}\left[1 - e^{-K(t-t_0)}\right] \tag{6}$$

where L_t is the length at age t, L_{inf} is the asymptotic length, K is the growth rate, t_0 is theorical age at length null.

The function of the selectivity ogive (here assumed trawl like) is given by the following equation:

$$S_L = \frac{1}{1 + e^{-\alpha(L-L_c)}} \tag{7}$$

where S_L is the fraction of individuals that are retained by the gear at length L, and α describes the steepness of the ogive and L_c the body length at first capture.

To estimate L_{inf}, L_c, α, M/K and F/K simultaneously the following equation fitting the whole fishing quantity curve are use:

$$N_{Li} = N_{Li-1}\left(\frac{L_{inf} - L_i}{L_{inf} - L_{i-1}}\right)^{\frac{M}{K}+\frac{F}{K}S_{Li}} \tag{8}$$

$$C_{Li} = N_{Li} S_{Li} \tag{9}$$

where L_i is the number of individuals at length i, L_{i-1} is the number at the previous length, where C refers to the number of individuals vulnerable to the gear and all other parameters are as described above.

3. Results

3.1. Length Frequency Distribution

A total of 2844 fish specimen were sampled from March 2021 to February 2022. As shown in **Figure 2**, the length distribution was unimodal, and ranged from

Table 1. Basic information of *S. galilaeus* and prior for the LBB method.

Length			Prior					
Min	Mean	Max	L_{inf}	Z/K	M/K	F/K	L_c (cm)	alpha
5.5	18.2	30.9	32.3	2.6	1.5	1.11	12.8	14.6

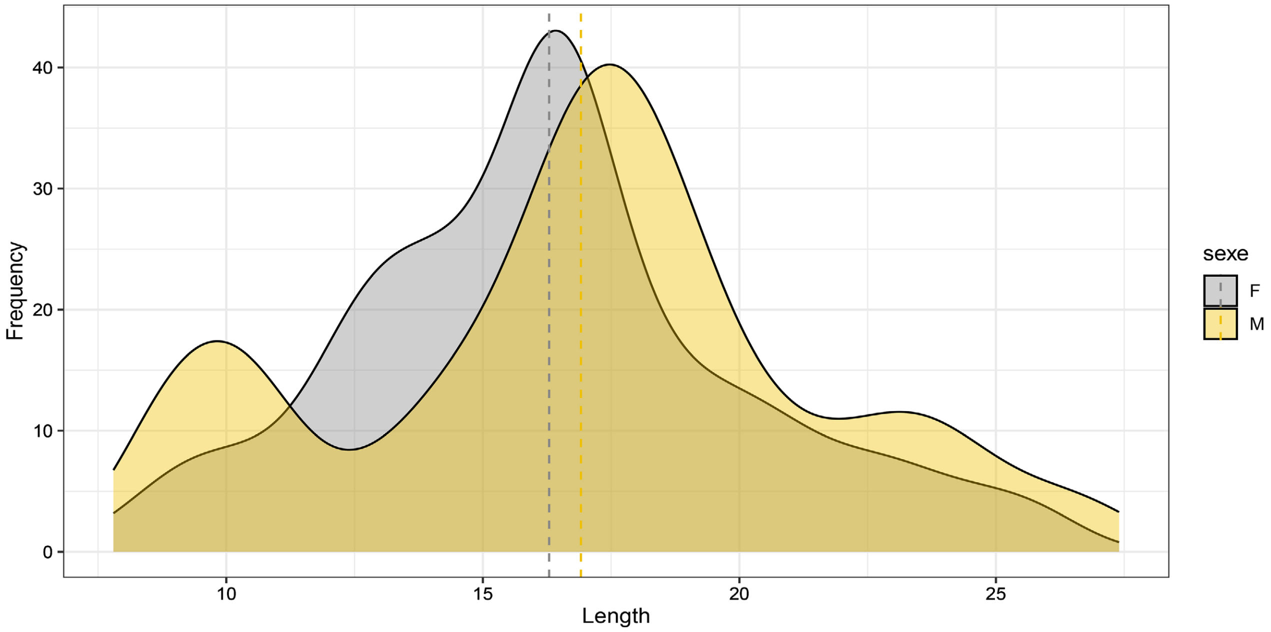

Figure 2. Length frequency distribution of *S. galilaeus* population in Samandeni reservoir, Burkina Faso. The vertical lines represent the mean length.

7.8 to 27.4 cm. Analysis shows that the mean and median are practically confused for male and female, indicating that the length frequencies are normally distributed in these samples. The mean length is 16.3 and 16.9 cm respectively for male and female, showing that male is longer than female on average.

3.2. Asymptotic Length and Growth Rate

The parameters of growth as estimated from the maximum density shown in **Table 2** and illustrated by **Figure 3** and **Figure 4**. The growth rate (K) was 0.94 yrs^{-1} for male fish while that of females were 0.68 yrs^{-1}. The asymptotic length (L_{inf}) was 29.4 and 27.4 cm respectively for males and females. **Figure 4** shows the reconstructed length distribution frequency diagram of the assessed fish species. The value of growth oscillation intensity (C) suggests seasonality in the growth of the Mango tilapia and the summer point (t_s) was estimated as 0.58 (July) and 0.41 (June) as shown in **Figure 3**. The estimated K values were similar between male and female fish: 0.72 and 0.61/yrs for female and male respectively (**Figure 4**).

The maximum density estimates of the parameter *t* anchor was 0.57, and 0.64, representing the months of September, where yearly repeating growth curves cross length equal to zero for female and male of *S. galilaeus* respectively.

3.3. Mortality Estimates

The total rates of mortality (Z) obtained through the length-converted catch curves were 2.64 yrs^{-1}. The parameters of natural mortality rate (M) estimated by Then (2015) empirical equation were 1.33 yrs^{-1}. For Samandeni reservoir, the fishing mortality rates (F) were 1.27 yrs^{-1}.

Table 2. Life history parameters of *Sarotherodon galilaeus* collected from commercial fishermen during March 2021-Febraury 2022 from Samandeni reservoir. L_{inf} (cm): Asymptotic length; K (yr·s^{-1}): Growth rate; *t_anchor*: Fraction of the year where the length is zero; *C*: Intensity of the oscillation; t_s: Fraction of the year where growth is positive.

Parameters	Male	Female
L_{inf} (*cm*)	29.4	27.4
K (yrs^{-1})	0.61	0.72
t_anchor	0.64	0.57
C	0.47	0.62
t_s	0.58	0.41

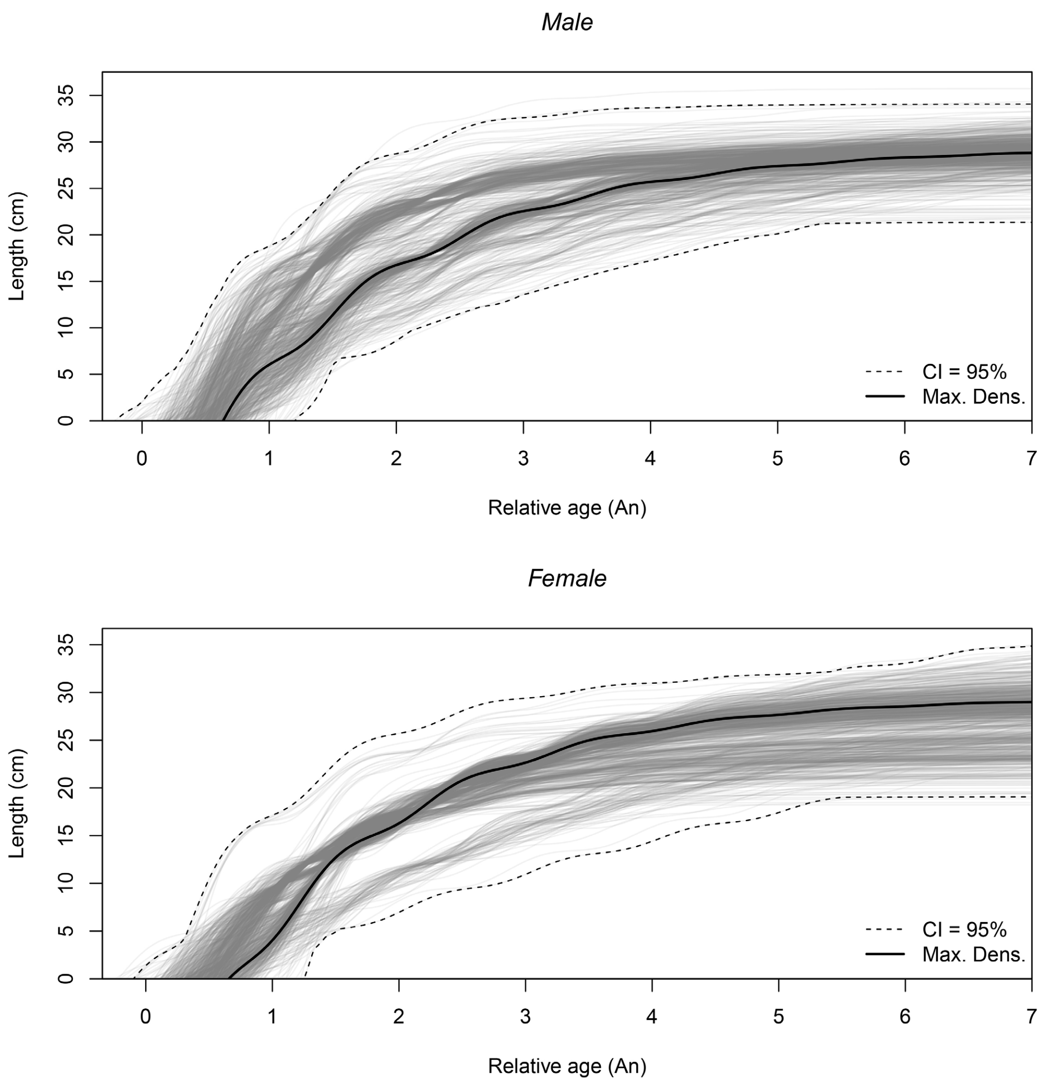

Figure 3. Seasonalized VBGF growth curve plot of Sarotherodon samples from the Samandeni reservoir, Burkina Faso using an ELEFAN_GA_boot, Sinusoidal growth curve represents the maximum density peak (thick black line) of the kernel density distribution with its 95% confidence contours (black dashed lines) and the individual sinusoidal curves (grey lines).

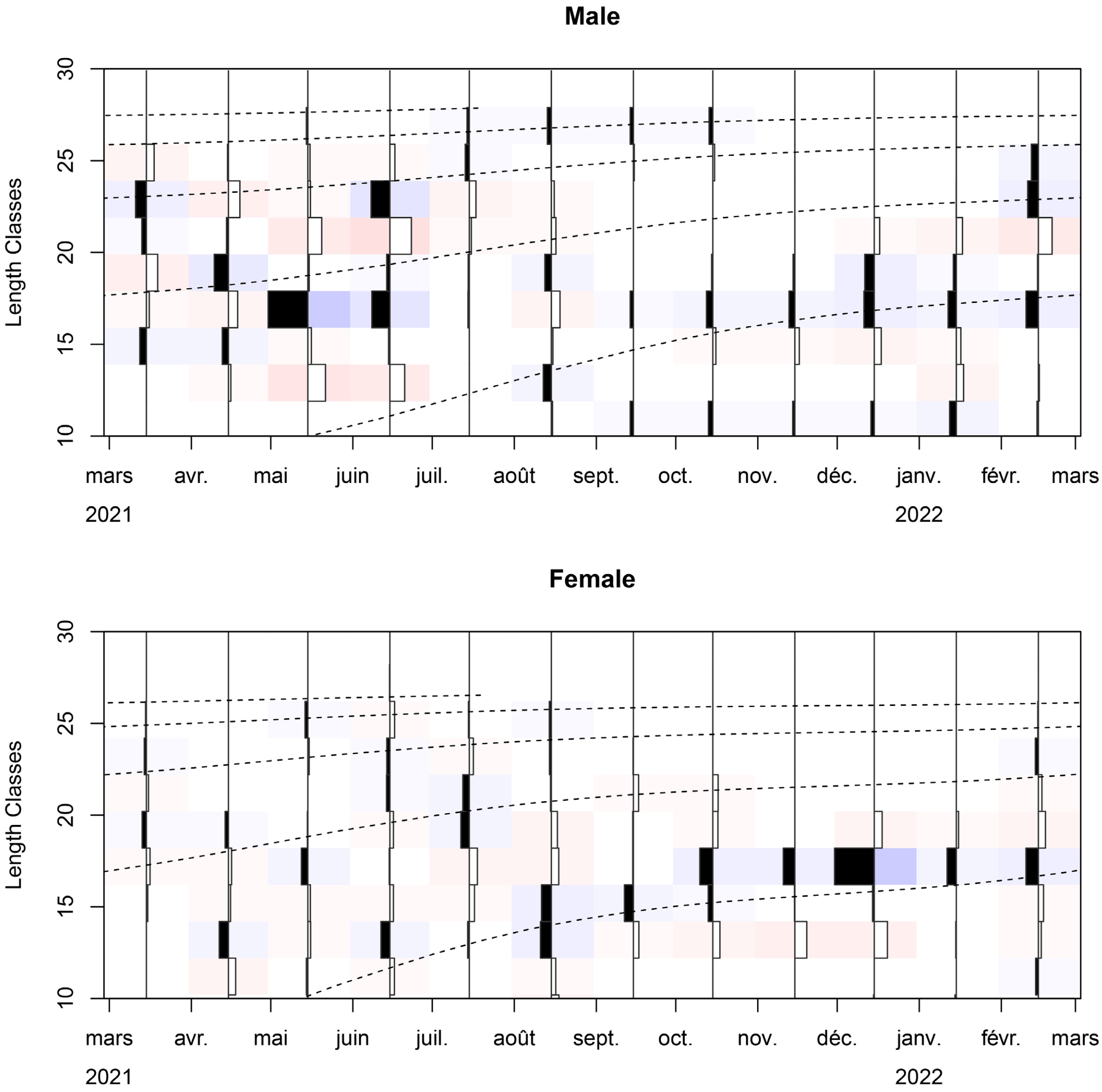

Figure 4. Length-frequency histograms with the growth curves (dashed lines) obtained through the bootstrapped ELEFAN with GA analysis superimposed for *Sarotherodon galilaeus*. The bars represent the restructured length frequency data, where black bars indicate positive peaks and white bars represent negative peaks. The method tries to maximize the number of positive peaks hit. The faint blue and red colors emphasize positive and negative peaks, respectively.

3.4. The Body Length at First Capture

The length at first capture (L_c) was 17 cm. **Figure 5** shows the probability of capture in terms of age.

3.5. Body Length at First Sexual Maturity

The body length at first sexual maturity of the Mango tilapia, *S. galilaeus* was 12.5, 12.1 and 13.4 cm for both sexes, male and female, respectively (**Figure 6**). The least matured male and female in the population were 8.3 and 7.8 cm TL, respectively. The difference is not statistically significant although females appear to reach sexual maturity early.

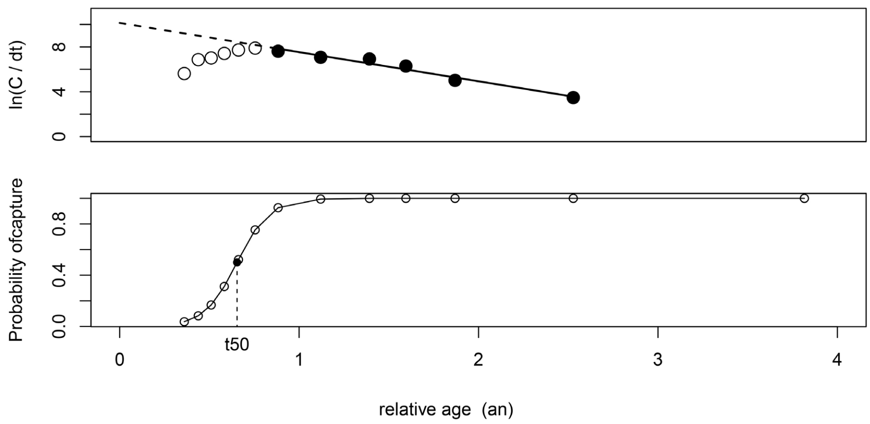

Figure 5. Length converted catch curve of *S. galilaeus* samples from the Samandeni reservoir, Burkina Faso indicating the mean length (age) at first capture (L_c).

3.6. Stock Status

Results for specific evaluation of LBB method are shown in **Figure 7**. The blue line in the figure represents the fit of the data and the LBB estimation, and the red line is the evaluation from the LBB method of population resources. The parameters L_{mean}/L_{opt}, L_c/L_{c_opt}, L_{95th}/L_{inf}, B/B_0, B/B_{MSY}, B_{MSY}/B_0 and F/M were obtained (**Table 3**). The estimated B/B_{MSY} was 1.2, which confirmed the healthy condition of *S. galilaeus* stock and indicated the safe biomass level capable of producing the MSY. The calculated B/B_0 (0.41) was near to the reference limit for *S galilaeus* stock biomass and denoted that the biomass was in the safe condition, whereby 59% of the wild stock of this species were harvested. The assessed B/B_0 was larger than B_{MSY}/B_0 (0.34), and F/M was 0.81, which indicated an underfishing condition. The output result for L_c/L_{c_opt} and L_{mean}/L_{opt} was 1, showing the healthy stock with the fishing of prominent individuals. The output result of L_{95th}/L_{inf} (=0.91) is close to one, indicating the presence of the significant number of individuals in the stock. In addition, a smaller estimation was observed for L_c (17) than L_{c_opt} (20), indicating that overfishing increased and recommended that the first fish catch was more extensive. Furthermore, the $B/B_0 > B_{MSY}/B_0$ and $L_c < L_{c\_opt}$ suggested that the existing fishing pressure and mesh sizes may influence the biomass. However, it is recommended that slightly increasing the mesh size for fishing may be beneficial for the sustainability of the *S. galilaeus* population in the Samandeni.

4. Discussion

The growth curve in males is characterized by the following von Bertalanffy parameters: L_∞ = 29.4 cm and K = 0.6 yrs^{-1}. For females, the same values were 27.4 and 0.7 respectively. In terms of growth, the results of the present study indicated that there were differences in the growth curves of *S. galilaeus* by sex and that these differences are mainly reflected in the mean asymptotic total length (L_∞) since the growth constants (K) were almost the same. A comparative analysis of the fish population parameter estimates for different settings is provided in

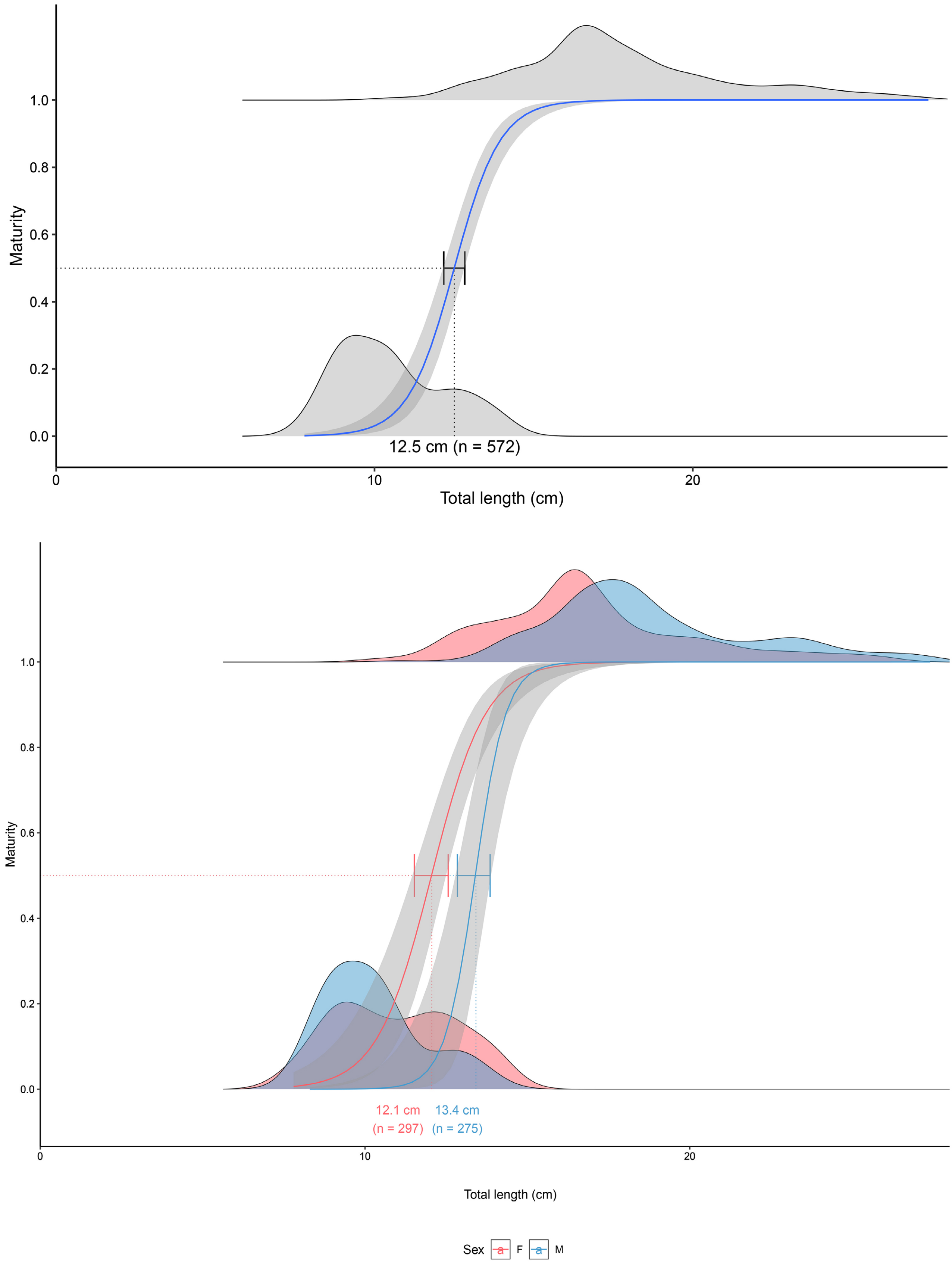

Figure 6. Body length at first maturity of *Sarotherodon galilaeus* in Samandeni reservoir.

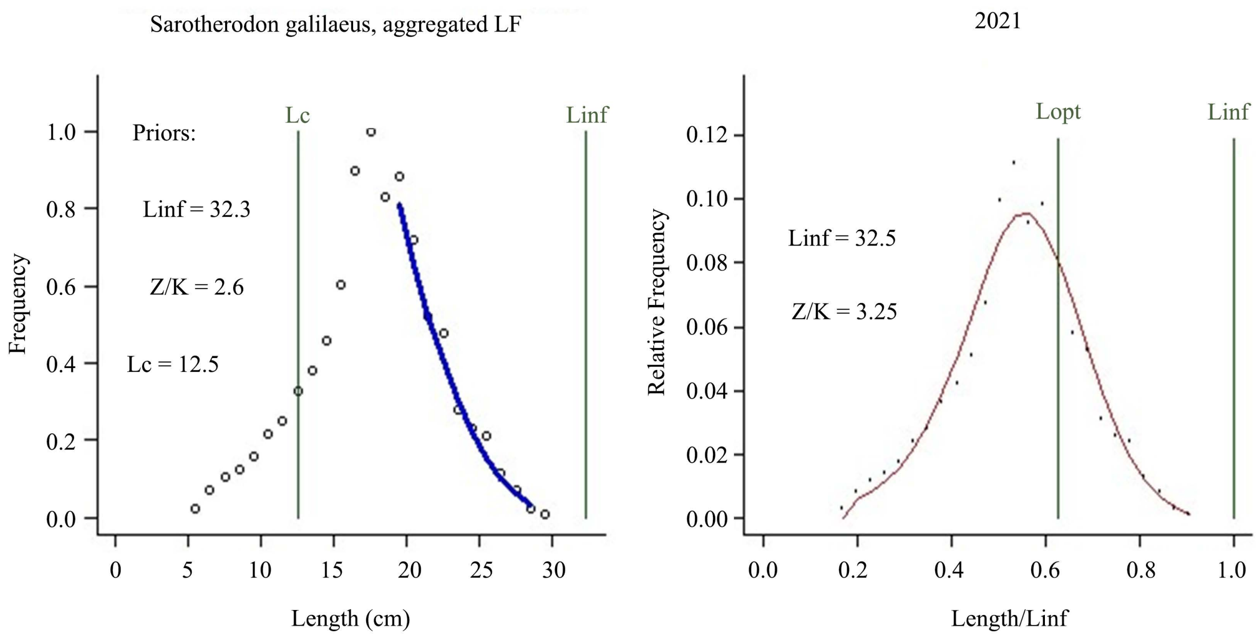

Figure 7. Graphical representation of LBB results for Mango tilapia populations in the Samandeni reservoir, Burkina Faso. Left curves depict the LBB model's fit to the length data, and right curves depict the LBB method's prediction, where L_c denotes the length of 50% of the individuals caught, L_{inf} indicates the asymptotic body length. L_{opt} stands for the length when the maximum catch is achieved.

Table 3. Estimated LBB for *S. galilaeus* using length frequency (LF).

L_c (cm)	L_{c_opt} (cm)	L_{mean}/L_{opt}	L_c/L_{c_opt}	L_{95th}/L_{inf}	B/B_0	B_{MSY}/B_0	B/B_{MSY}	F/M
17	17	1	1	0.91	0.41	0.34	1.2	0.81

Table 4. Although the results of the present study are comparable to those reported by other studies for the population of *S. galilaeus* (**Table 2** and **Table 3**), the asymptotic length values reported in the present study were found to be comparatively higher than those obtained by [21] in two lakes in Benin and [22] in the Botanga reservoirs, Tono and Golinga in northern Ghana. Similarly, the present study reported higher growth constants than [6] and [8]. On the contrary, the asymptotic length estimated in the present study was lower than the estimates documented by other studies such as [6] and [8]. Many studies have documented differences in the growth of a given species in different geographic areas [23] [24], and differences may be due to habitat heterogeneity and genetic diversity and fishing pressure [25] [26]. Since the opening of the reservoir to fishing, there was observed a strong fishing pressure on fishery resources and the development of vegetable cultivation around the reservoir, which could modify environmental parameters and influence growth parameters. Thus, the variations from pre-opening assessments are explained by differences in the mesh size of fishing gear used and the ever-increasing level of fishing pressure observed in the Samandeni fishing site.

Table 4. Growth parameter of *S. galilaeus* in African reservoir.

Country	Site	L_{inf} (cm)	K (an^{-1})	References
Burkina Faso	Samandeni reservoir	30.2	0.5	(Minougou *et al.*, 2021)
Burkina Faso	Sourou	30	0.36	(Baijot *et al.*, 1994)
Burkina Faso	Petit Balé reservoir	35	0.22	(Baijot *et al.*, 1994)
Benin	Lake Doukon	26.2	0.73	(Lederoun *et al.*, 2016)
Benin	Lake Togbadji	23.6	0.87	(Lederoun *et al.*, 2016)
Ghana	Bontanga reservoir	17.8	0.79	(Abobi *et al.*, 2019)
Ghana	Tono reservoir	17.8	0.79	(Abobi *et al.*, 2019)
Ghana	Golinga reservoir	17.8	0.79	(Abobi *et al.*, 2019)
Ghana	Bontanga reservoir	36.8	0.26	(Ofori-Danson *et al.*, 2008)

Mortality rates are a measure of describing the rate at which fish in a population are disappearing and are essential parameters in the formulation of sustainable fishery regulations [24] [27]. Analysis of the length converted catch curve predicted that total mortality (Z) was 2.6 yrs^{-1} for *S. galilaeus* in the Samandeni reservoir in Burkina Faso. We noted that the estimated Z-value in the present study was much larger than those of [21] in lakes Doukon and Togbadji, Benin (Z = 2.21 yrs^{-1}) and [22] in the Golinga and Bontanga reservoirs in northern Ghana (2.64 and 2.03 yrs^{-1}). On the contrary, mortality in this study remains comparatively lower than that obtained by [6] in the same reservoir and for the same species before its opening to fishing. In this study, the value of natural mortality (M) was recorded at 1.36 yrs^{-1}, resulting in an instantaneous fishing mortality coefficient (F) of 1.68 yrs^{-1}.

Contrary to our results, *S. galilaeus* in some African lakes is exploited to a lesser extent by fishermen. Thus, [21] reported mortality of 0.47 and 0.27 years^{-1} respectively in lakes Doukon and Togbadji in Bénin while Abobi *et al.* (2019) had reported mortalities of 1.34 and 0.91 yrs^{-1} respectively in Botanga and Golinga in Ghana. This difference in mortality rates could be explained by the different sampling methods and fishing effort from one reservoir to another. Indeed, [6] evaluated mortality based on experimental fishing while in the present study the sampling was realized on caught fish from commercial fishermen that use fishing methods and gear other than those in experimental fishing. Comparatively, the fishing mortality in the present study was relatively higher than the estimated natural mortality, which, according to [28] should not exceed this mortality during the exploited phase of the stock, suggesting that the assessed population of *S. galilaeus* is more prone to fishing activities than naturally induced morality situation such as predation, competition, diseases and old age. This observation could be explained by the gradual increase in fishing activities since the reservoir opened to fishing in 2019.

The body length at first sexual maturity determined was 13.4 cm in males and

12.1 cm in females, suggesting that females reach maturity before males. These results were similar to those reported in Lake Doukon and Togbadji [21], Lake Ahozon [29] and small reservoirs in Burkina Faso [30] on Mango tilapia, where females reach early maturity. Similarly, [31] in Ghana, and [32] in Lake Ahémé in Benin observed that females of the sympatric species *Sarotherodon melanotheron* reach maturity first. On the other hand, the size of first maturity estimated for both sexes in this study, is lower than that obtained by [33] in Lake Gougan in Benin which notes a body length at first maturity of 19 cm in *S. galilaeus* without sex distinction. This observed size difference is explained by the fact that the body length at first sexual maturity is not only related to environmental factors but also to genetic factors [34]. According to some authors, the size at first sexual maturity also depends on the growth of individuals in many cases. Differences in size were associated to sex differences related to the relative distribution of energy for gamete production [34] [35]. The variations encountered may be attributed to different strategies developed in different environments for better adaptation [21] [36]. These strategies may be food, reproduction, or both. In this case, the pressure on fish resources developed on the Samandeni reservoir would be an adverse factor (stress) leading the species to reproduce at a smaller size. In addition, the recorded first sexual maturity size is lower than the first catch size. This implies that in the Samandeni reservoir, *S. galilaeus* populations all have a chance to breed at least once before being caught by fishing gear.

The stock status was given in the LBB model based on the B/B_{SMY} parameter, which were described in details in previous studies [20]. In this study, the LBB method was used to assess the state of *S. galilaeus* resources in the Samandeni reservoir. So far, our research may be the first study to assess stocks of this species in the reservoir. The results showed that the assessed stock was in full operation. The B/B0 ratio was higher than the B_{SMY}/B_0 ratio, suggesting that the stock of *S. galilaeus* has a high biomass. The relative biomass (B/B_0) of *S. galilaeus* from the Samandeni reservoir assessed was 0.41 on average, indicating a depletion rate of 60%. The ratios L_{mean}/L_{opt} and L_c/L_{c_opt} were all equal to one, suggesting the capture of adult fish in the fishing site. According to Froese 2018 the exploitation of a species is only sustainable if the fish breed at least once before being caught, this was probably the case in the Samandeni reservoir concerning *S. galilaeus* [1]. Therefore, decision markers for fisheries management should apply appropriate regulations to maintain the current level of exploitation of the stock. The presence of large specimen of fish in the population is known to ensure the resilience of the stock, which is indicated by the value of L_{95th}/L_{inf}. Despite the observed full exploitation of biomass, the L_{95th}/L_{inf} ratio was close to 1, suggesting that large individuals of *S. galilaeus* were still present in the reservoir to ensure stock renewal. However, as a precautionary measure, management rules such as the temporary closure of fishing and the use of regulatory mesh sizes must be maintained to ensure the conservation of the biological resources of this commercial species.

5. Conclusion

This study assessed the growth, Body length at first sexual maturity and stock status of *Sarotherodon galilaeus* in the Samandeni reservoir, Burkina Faso. Growth appeared to be rapid and seasonal. A fully exploited status for *S. galilaeus* was observed. The exploitation of *S. galilaeus* in the Samandeni reservoir is slightly well below the optimal limit, providing an excellent opportunity for commercial fishermen to increase their yield in a sustainable manner. This study indicates that even if the species is currently fully exploited, its fishing is far from collapsing. Nevertheless, to reduce fishing pressure on these commercial species, it is necessary to maintain appropriate fisheries management options. In addition, the results of this study revealed that S galilaeus is a fast-growing species and could be targeted for aquaculture. This study also estimated male and female sexual maturity. The estimated body length at first sexual maturity shows that females reach sexual maturity early compared to males. Current data on the population characteristics of this species will also serve as baseline data for the management and conservation of this species in the Samandeni reservoir in Burkina Faso. For better management of the reservoir, it would be essential to extend this work to all existing stocks in the reservoir.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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