Discovery

Estimates of life-history parameters and population dynamics of *Bagrus docmak* (Forsskål, 1775) in Lake Abaya, South Ethiopia

Buchale Shishitu Shija*

To Cite:
Shija BS. Estimates of life-history parameters and population dynamics of *Bagrus docmak* (Forsskål, 1775) in Lake Abaya, South Ethiopia. *Discovery* 2025; 61: e23d3133
doi: https://doi.org/10.54905/disssi.v61i338.e23d3133

Author Affiliation:
South Ethiopia Agricultural Research Institute, Arba Minch Agricultural Research Center, Ethiopia

***Corresponding author:**
South Ethiopia Agricultural Research Institute, Arba Minch Agricultural Research Center, Ethiopia; Email: buchale.shishitu@yahoo.com; Orchid: https://orcid.org/0000-0001-9134-8085

Peer-Review History
Received: 03 March 2025
Reviewed & Revised: 16/March/2025 to 25/July/2025
Accepted: 30 July 2025
Published: 07 August 2025

Peer-Review Model
External peer-review was done through double-blind method.

Discovery
pISSN 2278–5469; eISSN 2278–5450

DISCOVERY SCIENTIFIC SOCIETY

ABSTRACT

Sufficient knowledge is necessary for the responsible exploitation of inland fisheries. However, many inland fisheries do not have adequate monitoring for sustainable fisheries management. The purpose of this study was to estimate life-history parameters and population dynamics of B. docmak from Lake Abaya. For the purpose collecting length-weight data, a total of 1033 fish were sampled from the commercial fisheries of Lake Abaya. SPSS and FiSAT II software were used to analyze the population dynamics and life-history parameters of the fish. The length-weight relationship was estimated to be $W = 0.0085L^{3.04}$; $R^2 = 0.9118$. The condition factor was highly significant by months' interaction (P = 0.000), and had mean values of 0.99, 1.01, and 1.00 for females, males, and combined sexes, respectively. The estimated growth parameters were asymptotic length $L_\infty = 99.75$ cm, growth rate K = 0.55 yr^{-1}, theoretical age $t_o = -0.21$, growth performance index Φ′ = 3.74 and life-span $t_{max} = 5.24$ years. The mortality related parameters were estimated as Z = 1.43 yr^{-1}, M = 0.57 yr^{-1}, E = 0.60, and Z/K = 2.6. The length at first maturity (L_{50}), the length at first capture (Lc), and the optimum length (L_{opt}) were 52.02 cm, 44.27 cm, and 64.37 cm, respectively. The recruitment pattern was year-round, with biannual pulses in March and September. The length at first recruitment (Lr) and the corresponding age at first recruitment (Tr) were estimated to be 32 cm and 0.5 years, respectively. The study found that overfishing in recruitment and growth affected about 39.5% of the fish population. The exploitation rate (E) in the current investigation was 0.60, while the exploitation rate derived from Y′/R for $E_{0.5}$ was 0.35. Reducing the number of fishing gears is necessary for the management of B.docmak. In order to improve the sustainability of B. docmak in Lake Abaya, the current exploitation rate has been lowered by 42%.

Keywords: Condition factor, Exploitation rate, Growth pattern, Life-history parameters, Population dynamics

1. INTRODUCTION

According to numerous studies (Pauly *et al*., 2002; Myres and Worm, 2003; Welcomme *et al*., 2010; Huo *et al*., 2015; Lorenzen *et al*., 2016), human interference has significantly reduced the availability and productivity of many natural aquatic resources. Some of these resources are almost completely gone. According to Quist (2007) and Camargo *et al*. (2015), fish population parameter assessment is essential for determining the health of fish populations and their sustainable management. Recruitment, growth, and mortality rates are the main factors influencing fish population dynamics (Gulland, 1982; Pope *et al*., 2010). When growth and recruitment rates outpace mortality losses, the size of the fish population increases; if mortality is higher, the population size decreases. Fish population parameters are influenced by environmental conditions and the life-history strategies of fish species (Silvestre and Graces, 2004).

First-maturation length (L_{50}), longevity, growth curvature (K), asymptotic length ($L\infty$), mortality rates, fecundity, and maximum length (Lmax) are all essential measures of population dynamics in fish. Fish species with longer life-span have larger asymptotic lengths, lower rates of natural mortality (M), and growth curvature (Sa-Oliveira *et al*., 2015). In contrast, fish species with shorter life-span have smaller asymptotic lengths, greater natural mortality rates, and higher growth curvatures.

Lake Abaya is one of Ethiopia's Rift Valley lakes, which supply about 8% of the country's and local markets with catch fisheries (Gashaw and Wolff, 2014). This lake is home to four economically important fish species: the Nile tilapia (*O. niloticus*), Nile perch (*L. niloticus*), African catfish (*C. gariepinus*), and *Bagrus docmak*. Research on fish life-history population dynamics is crucial to the sustainable management of fish stocks. There are insufficient life-history parameters and population dynamics for *B. docmak* in Lake Abaya. To effectively evaluate population status and productivity, life-history parameters and population dynamics data are essential. Reliable and up-to-date fish life-history and growth parameters are essential to determine the state of overexploited stocks. Therefore, the purpose of this study was to determine the life-history parameters and population dynamics of *B. docmak* from Lake Abaya.

2. MATERIALS AND METHODS

2.1. The study area

Lake Abaya is the second largest lake in Ethiopia and is located between latitudes 5°55'9'' and 6°35'30'' N and longitudes 37°36'90'' and 38°03'45'' E (Fig. 1). The length and width of the lake are 60 km and 20 km, respectively. It is the largest lake in the Rift Valley and is located at 1268 meters above sea level with a maximum depth of 13 m. It has numerous islands, of which Aururo is the largest and the others are Galmaka, Alkali, Gidicho, and Welege. Arba Minch town is located on its southwest shore, while the southern banks are part of Nech Sar National Park. The main perennial rivers that flow into Lake Abaya are Galana, Bilate, Gidabo, Hamassa, and Harre.

2.2. Data collection

Fish samples were collected from four prominent landing sites every month for a period of 12 months (September 2023-August 2024) from the commercial fisheries in Lake Abaya. The four landing sites were Hillo, Langama, Gubena, and Ella. Using a measuring board and an electronic sensitive balance, the fish's morphometric measurements (total length and total weight) were measured to the nearest 0.1 cm and 0.1 g, respectively, after they were randomly selected for sampling.

2.3. Data analysis

2.3.1. Length-weight relationship and condition factor

The relationship between the length and weight of the fish was statistically associated using the following formula (Froese, 2006).

$$W = aL^{b} \quad (1)$$

Where: W = weight of fish (g), L = length (cm), *a* = intercept, and *b* = slope of length-weight regression.

It is assumed that heavier fish of a given length are in better condition. This information is essential to compare the condition, fatness, or well-being of the fish. Fulton (1904) was used to calculate the coefficient of the condition factor, CF.

$$CF = \frac{W}{L^3} * 100 \quad (2)$$

Where: 100 is a factor to move the value of CF toward unity, w = weight (g), and L = length (cm).

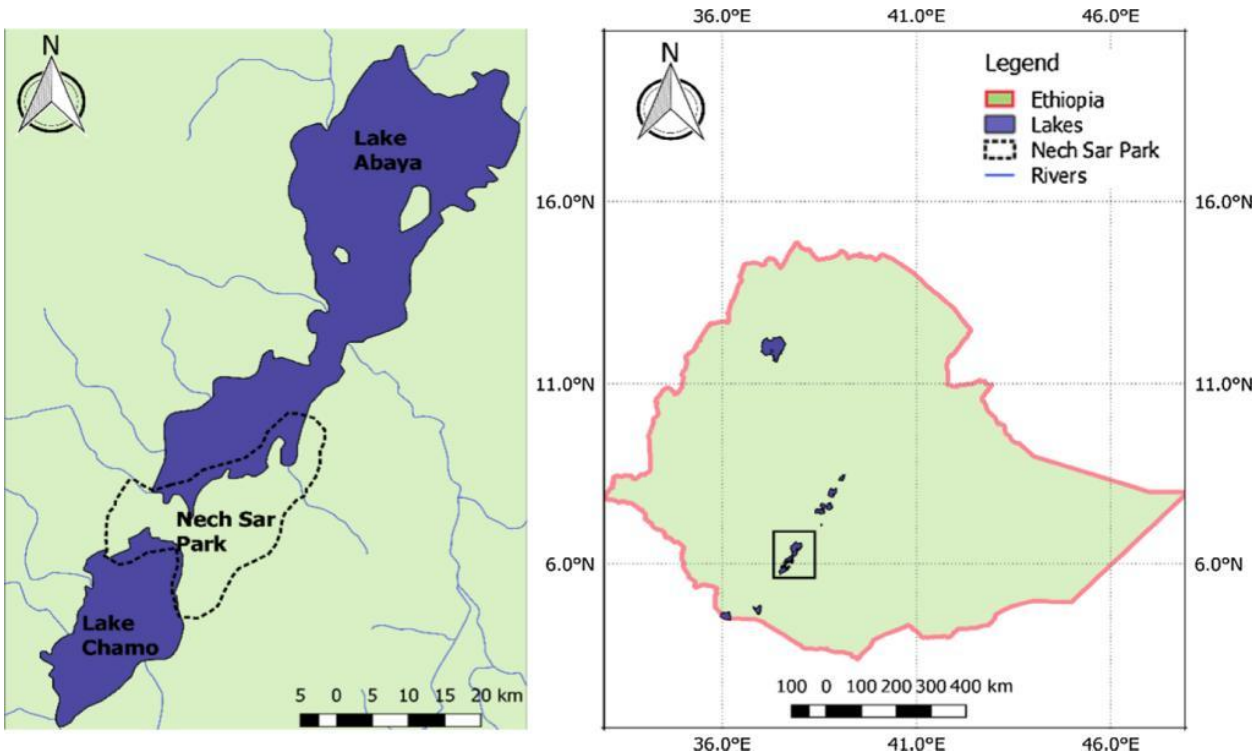

Figure 1. Lakes Abaya and Chamo outline map (source: www.maplibrary.org)

2.3.2. Growth parameters and mortality rates

In order to evaluate mortality rates and stock status, growth parameters are calculated using the length-frequency data. The von Bertalanffy growth parameters asymptotic length ($L\infty$) and growth coefficient (K) were estimated using the ELEFAN feature of FiSAT II software (Gayanilo and Sparre, 2005). The theoretical at zero length (t_o) was calculated using Pauly's empirical equation (Pauly, 1979).

$$\text{Log}(-t_o) = -0.3922 - 0.2752 * \text{LogL}\infty - 1.0381 * \text{LogK} \text{ ——— } (3)$$

Where: t_o = the theoretical age at zero length, $L\infty$ = asymptotic length (cm), and K = the von Bertalanffy growth coefficient.

In accordance with Pauly and Munro (1984), the growth performance indicator Phi (Φ') is calculated as follows:

$$\Phi' = \text{LogK} + 2 * \text{LogL}\infty \text{ ——— } (4)$$

The von Bertalanffy growth function (VBGF) was fitted to the length at age zero (L_o) using the original von Bertalanffy equation (1938).

$$L_o = L\infty\left(1 - exp^{(Kto)}\right) \text{ ——— } (5)$$

Natanson *et al*. (2006) devised a formula to estimate longevity (t_{max}), which is the time it takes for an individual to attain 95% of asymptotic length ($L\infty$).

$$\text{Longevity } (t_{max}) = \left(\frac{1}{K}\right) * ln\left(\frac{L\infty - Lo}{L\infty(1-X)}\right) \text{ ——— } (6)$$

Where: $X = (1 - \frac{Longevity}{L\infty}) = 0.95$

The length-converted catch curve approach, which is used in FiSAT II, was applied to estimate the total instantaneous mortality rate (Z). The natural mortality rate (M) is calculated by using Tailor's method (1958) as follows:

$$M = \frac{-\ln(1-0.95)}{tmax} \text{ ——— } (7)$$

The formulas F = Z-M and E = F/Z are used to calculate the fishing mortality rate (F) and exploitation rate (E), respectively (Pauly, 1980). Beverto and Holt's (1957) equation is used to estimate the length at first capture (Lc) at which 50% of the fish are retained by the fishing gear. The age at first capture (Tc) is determined by converting Lc to age using the von Bertalanffy equation (Gulland and Holt, 1959) as follows:

$$Lc = \bar{L} - K\left(\frac{L\infty - \bar{L}}{Z}\right) \text{ ——————————— } (8)$$

$$Tc = to - \frac{1}{K} * \ln\left(1 - \frac{Lc}{L\infty}\right) \text{ ——————————— } (9)$$

Where: Lc = the length at first capture, $\bar{L}$ = the mean length of fish in the catch sample, and Tc = the age at first capture, while K, L∞, Z, and t_o are as defined above.

The following equation (Froese and Binholan, 2000) estimates the optimum length (L_{opt}), the corresponding age at first sexual maturity (T_{50}), and the first maturity length (L_{50}), at which half of the fish are mature:

$$\text{Log}(L_{50}) = 0.8979 * \text{Log}(L\infty) - 0.0782 \text{ ——————— } (10)$$

$$T_{50} = to - \frac{1}{K} * \ln\left(1 - \frac{L50}{L\infty}\right) \text{ ——————————— } (11)$$

$$\text{Log}(L_{opt}) = 1.042 * \text{Log}(L\infty) - 0.2742 \text{ ——————— } (12)$$

2.3.3. Recruitment patterns

Based on the length-frequency data, the number of pulses per year and the relative intensity of each pulse were determined using the FiSAT II's recruitment patterns procedure. As inputs, the growth parameters L∞ and K were employed. The graphic presentation of the seasonal recruitment pattern is produced by backward projecting the length-frequency data onto the time axis of a time series sample (Dadzie *et al*., 2007). Beverton and Holt (1957) estimate the age at first recruitment (Tr) using the following formula:

$$Tr = to - \frac{1}{K} * \ln\left(1 - \frac{Lr}{L\infty}\right) \text{ ——————————— } (13)$$

Where: Lr = is the smallest length in the collected sample.

2.3.4. The Beverton and Holt Y′/R and B′/R analyses

Pauly and Soriano (1986) modified the Beverton and Holt (1966) model, which serves as the basis for the relative yield per recruit model. The knife-edge selection approach uses the Lc/L∞ and M/K ratios as inputs to calculate the relative yield per recruit. The following formula is used to determine the relative yield per recruit (Y′/R):

$$Y'/R = EU^{\frac{M}{K}}\left(1 - \frac{3U}{(1+m)} + \frac{3U^2}{(1+2m)} - \frac{U^3}{(1+3m)}\right) \text{ ——————————— } (14)$$

Where: E = F/Z, Z = F+M; U = 1-(Lc/L∞); m = (1-E)/(M/K) = K/Z

The following formula is used to estimate the relative biomass per recruit (B′/R):

$$B'/R = \frac{(Y'/R)}{F} \text{ ——————————————————— } (15)$$

In order to estimate the biological reference points, $E_{0.1}$, and $E_{0.5}$, the first derivative of this function is utilized. The exploitation rates at maximum sustainable yield (MSY), maximum economic yield (MEY), and optimal exploitation rate are denoted by the letters E_{max}, $E_{0.1}$, and $E_{0.5}$, respectively.

3. RESULTS AND DISCUSSIONS

3.1. The length-weight relationship and condition factor

The sample used in this experiment consists of 1033 *Bagrus docmak* specimens. The fish's overall length varied from 29 to 98 cm, while its weight ranged from 217 to 11000 g. Out of the total samples, 84.32% of the catches were between 44 and 74 cm; however, the remaining 7.36% and 8.33% were less than 44 cm and greater than 74 cm, respectively. The mid-length of 50 cm has a significant contribution to the catch (23.81%), followed by the mid-length of 62 cm, which has contributed about 19.17% (Fig. 2).

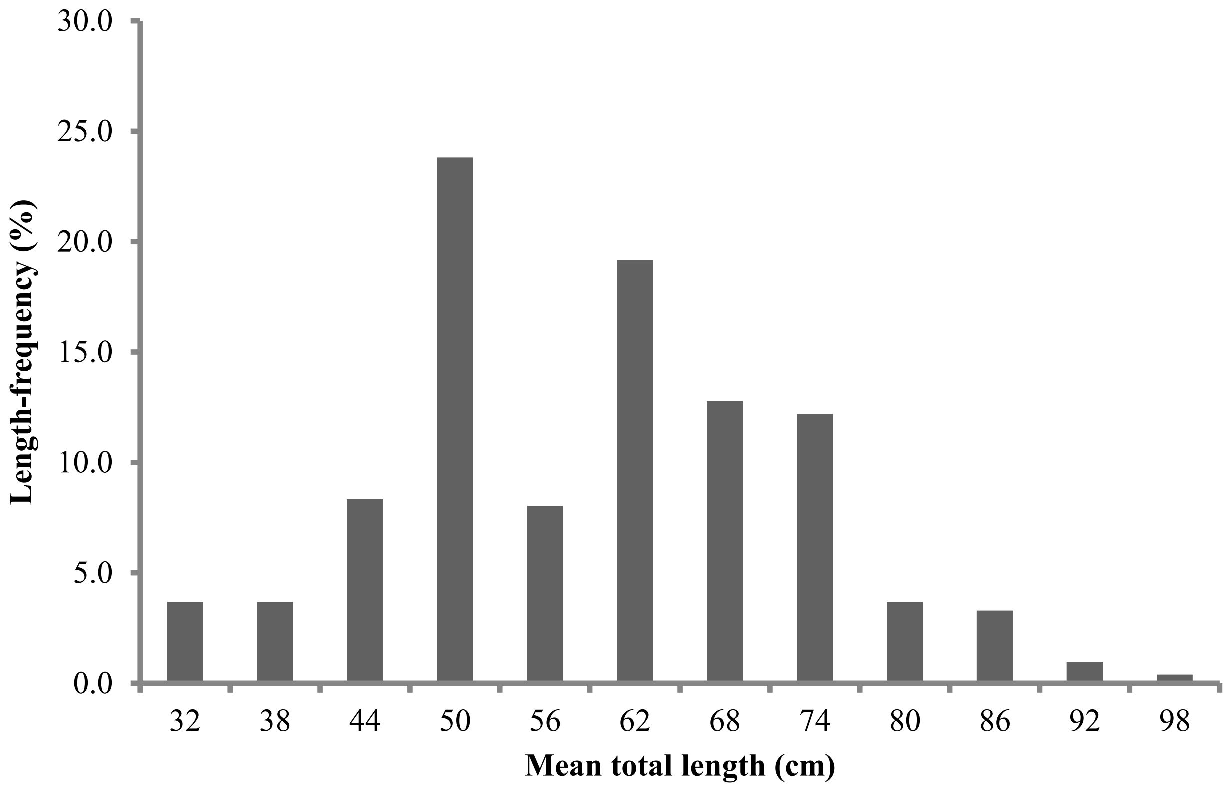

Figure 2: The length structure of *Bagrus docmak* in Lake Abaya

A scatter plot diagram and a power function are used to illustrate the relationship between *B.docmak's* total length and total weight (Fig. 3). The *b* value obtained from the length-weight relationship was 3.0428 and was described by the equation $W = 0.0058L^{3.0428}$ (R^2 = 0.9118, r = 0.9548). The length and weight of *B. docmak* in Lake Abaya had a high positive correlation (r = 0.9548). The regression coefficient *b* is found to be 3.0428 and did not show a statistically significant difference from the hypothetical value 3.0 ($P > 0.05$).

The fish may exhibit isometric, negative, or positive allometric growth patterns. When a fish grows isometrically, its body form does not alter. Positive allometric growth suggests that the fish gets comparatively stouter or deeper in body as it grows, whereas negative allometric growth makes the fish thinner or lighter in weight as it gets longer (Riedel *et al*., 2007).

The isometric growth pattern (*b* = 3.0428) observed in the present study suggests that *B. docmak* in Lake Abaya remains unchanged in body shape as it grows. The high coefficient of determination value (0.9118) stated that the length-weight relationship was a good prediction of curvilinear regression. The results of the current study were found to be in agreement with some other regional and international findings on length-weight relationship, while others were not, according to a comparison with those of earlier studies.

The growth pattern observed in this study was consistent with the isometric growth reported by Buchale Shishitu (2024) for *O. niloticus* (b = 3.02) from Lake Abaya and El-Drawany and Elnagar (2015) for *B. docmak* (b = 3.05) from the Muess Channel in Egypt. However, Yongo and Agembe (2021) and Ikongbeh *et al*. (2012) reported that *B. docmak* from Lake Victoria (b = 2.89) and Lake Akata (b = 2.79) exhibited negative allometric growth. Also, Eel-Drawany, and Elnagar (2015) reported b = 3.1 for *B. bayad* from the Muess Channel in Egypt, while Buchale Shishitu (2022), and Hailu Anja *et al*. (2009) reported a positive allometric growth b = 3.1 and b = 3.24 for *B.docmak* from Lake Chamo, respectively.

Fish may exhibit distinct growth patterns due to factors such as water quality, food availability, habitat conditions, season, and life stages (Yilmaz *et al*., 2012; Ali *et al*., 2016). According to Tsoumani *et al*. (2006), differences in fish growth patterns may also be related to the species' overall health, phenotype, and geographic location. The growth process of a fish species may be influenced by several biotic and abiotic factors based on its habitat.

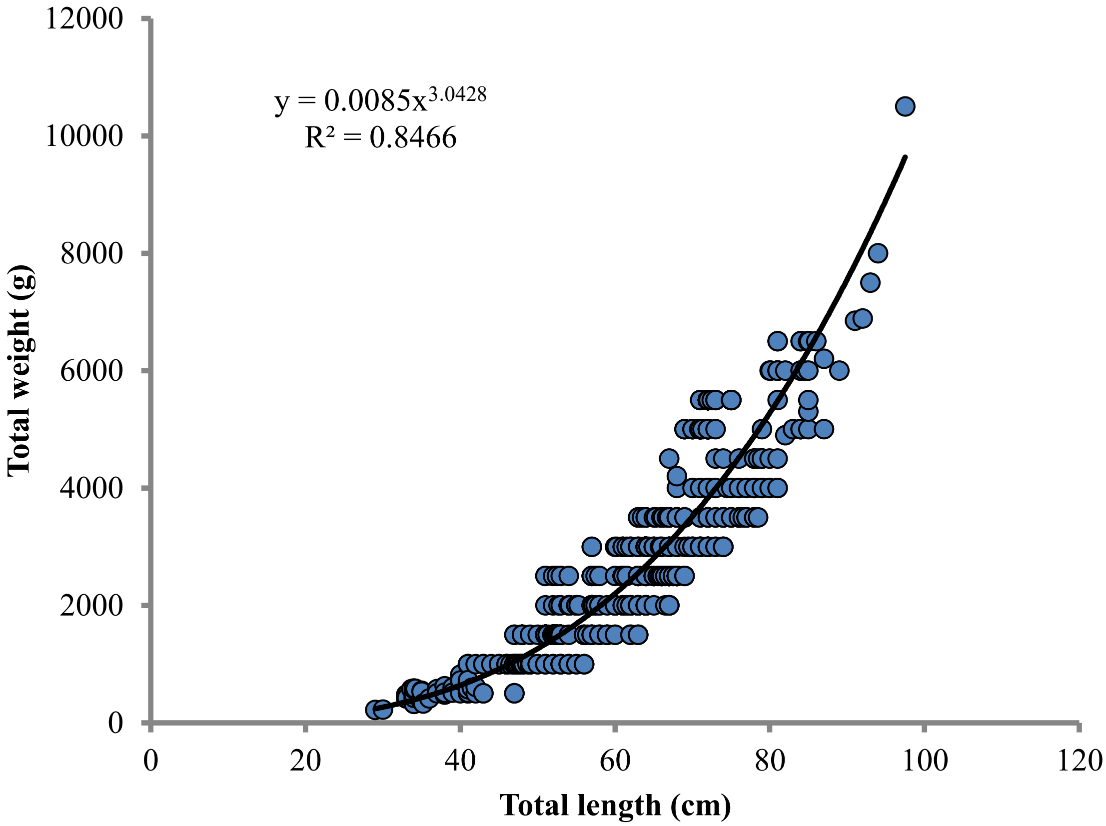

Figure 3: Length-weight relationship of *B. docmak* from Lake Abaya

3.2. Condition factor (CF)

For females, males, and combined sexes of *B. docmak*, the mean condition factor (CF) was 0.99, 1.01, and 1.00, respectively (Table 1). Although there was no significant difference in the mean condition factor between the sexes ($P > 0.05$), there were significant differences in the condition factor by month's interaction ($P = 0.000$; Table 2).

The coefficient of the condition is a measure of the condition factor, which states how healthy the fish are in their environment. It measures several ecological and biological factors, such as gonad development, level of fitness, and environmental suitability for feeding circumstances (Murtuza and Ai-Misned, 2013; Yongo *et al*., 2016). The fish have improved in condition when the condition factor value is equal to or higher than one (LeCren, 1951; Ayoade, 2011; Ujjania *et al*., 2012).

Based on the mentioned criteria, *B. docmak* sampled from Lake Abaya during the present study was in a good condition, with a mean value of 1.00. This result was comparable with the findings of Yongo and Agembe (2021) for *B. docmak* (CF = 1.0) from Lake Victoria, Buchale Shishitu (2022) from Lake Chamo (CF = 0.99), Mutethya *et al*. (2020) for *S. intermedius* (CF = 1.00), and Yongo and Wairimu (2018) for *S. victoriae* (CF = 1.01) from the Nyanza Gulf of Lake Victoria. However, the result of the present study was not in agreement with the results of Ikongbeh *et al*. (2012) for *B. docmak* from Lake Akata (CF = 1.62), Buchale Shishitu (2022) for *L. niloticus* from Lake Abaya (CF = 1.31), Buchale Shishitu (2024) for *O. niloticus* from Lake Abaya (CF = 1.69), Hail Anja *et al*. (2009) for *B. docmak* from Lake Chamo (CF = 0.4-05), and Buchale Shishitu and Atnafu (2025) for *C. gariepinus* from Lake Abaya (CF = 0.76).

Fish condition factor might differ depending on the species, the environment, and the availability of food in their habitats (Okach and Dadzie, 1988; Wanyanga *et al*., 2016). Seasons, reproductive cycles, fishing pressure and water quality characteristics can also have an impact on fish condition factors (Khallaf *et al*., 2003; Buchale Shishitu and Atnafu, 2025).

Table 1: Mean condition factors of *B. docmak* from Lake Abaya

Sex	Mean	Std. Deviation	Std. Error of Mean
Females	0.99	0.113	**0.033**
Males	1.01	0.113	**0.033**
Combined sexes	1.00	0.106	**0.030**

Table 2: Variations of condition factor by months

Sources of variation	Sum of Squares	df	Mean Square	F	Sig.
Between groups	0.255	11	0.023	9.860	0.000
Within groups	0.028	12	0.002		
Total	0.284	23			

3.3. Growth parameters and mortality rates

The von Bertalanffy growth model was used to estimate the growth parameters, and the estimated parameters of growth for *B. docmak* indicated that asymptotic length (L_∞) = 99.75 cm, growth rate (K) = 0.55 yr^{-1}, the age at birth (t_o) = -0.21, the length at birth (Lo) = 10.88 cm, the length at first maturity (L_{50}) = 52.07 cm, the growth performance index (Φ′) = 3.74, and the longevity (t_{max}) was 5.24 years. According to the finding of this study, the optimum length (L_{opt}) in Lake Abaya at which *B. docmak* attains its optimum weight is 64.37 cm.

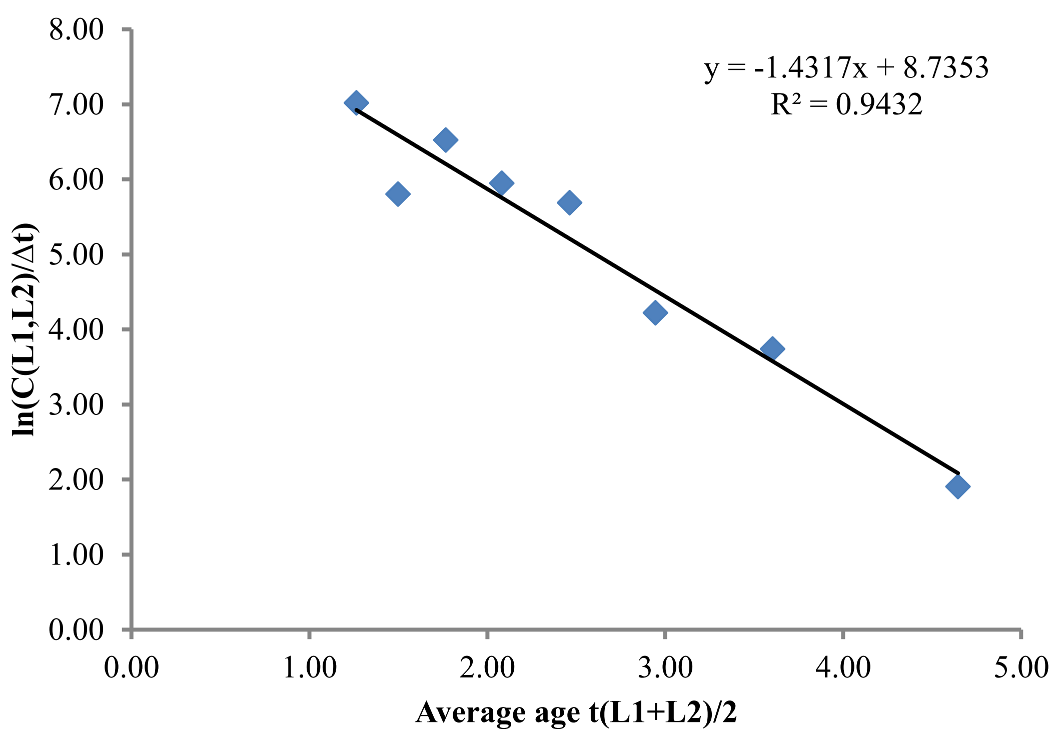

Figure 4: Linearized length-based catch curve of *B. docmak* from Lake Abaya.

The growth parameters of *B.docmak* reported by Musinguzi *et al*. (2024) were $L\infty$ = 107.9 cm, K = 0.10, and Φ′ = 3.08 and $L\infty$ = 104.9 cm, K = 0.10, and Φ′ = 3.06 from Lakes Edward and George, respectively. When compared to a similar study, the differences in von Bertalanffy growth parameter estimations were caused by the varied water bodies' environmental circumstances. The size of the fish population and how fish adjust throughout their lives are other elements that influence growth. The growth characteristics can be affected by a number of factors, including population density, resource availability, and genetics. The fishing pressure is also a factor in changing the asymptotic length of fish in a given water body.

The length-converted catch curve regression analysis was linearized to estimate the total mortality rate (Z) of *B. docmak.* The slope of the regression line (b) is computed to be -1.43, and hence, the estimated total mortality rate was 1.43 (Fig. 4). The estimated natural mortality rate (M) and fishing mortality rate (F) were 0.57 and 0.86, respectively. According to the obtained mortality parameters, the current exploitation rate (*E*) was calculated to be 0.60, which is stating overexploitation. The relative fishing mortality (F/M) was 1.51, confirming the state of overexploitation. According to Palomares *et al*. (2018), the overexploited stocks have a relative fishing mortality higher than 1.2. A number of human-caused factors, including fishing, are responsible for fishing mortality. Predation, illness, and aging may be the main causes of natural mortality in the aquatic environment. A mortality-dominated fish population was indicated by the estimated Z/K ratio of 2.6 for *B.docmak*. The general criteria of Beverton and Holt (1957) say that a population is growth-dominated if the Z/K ratio is less than 1, mortality-dominated if it is greater than 1, and in equilibrium if it is equal to 1. The results of this investigation indicate that *B. docmak* is heavily exploited in Lake Abaya.

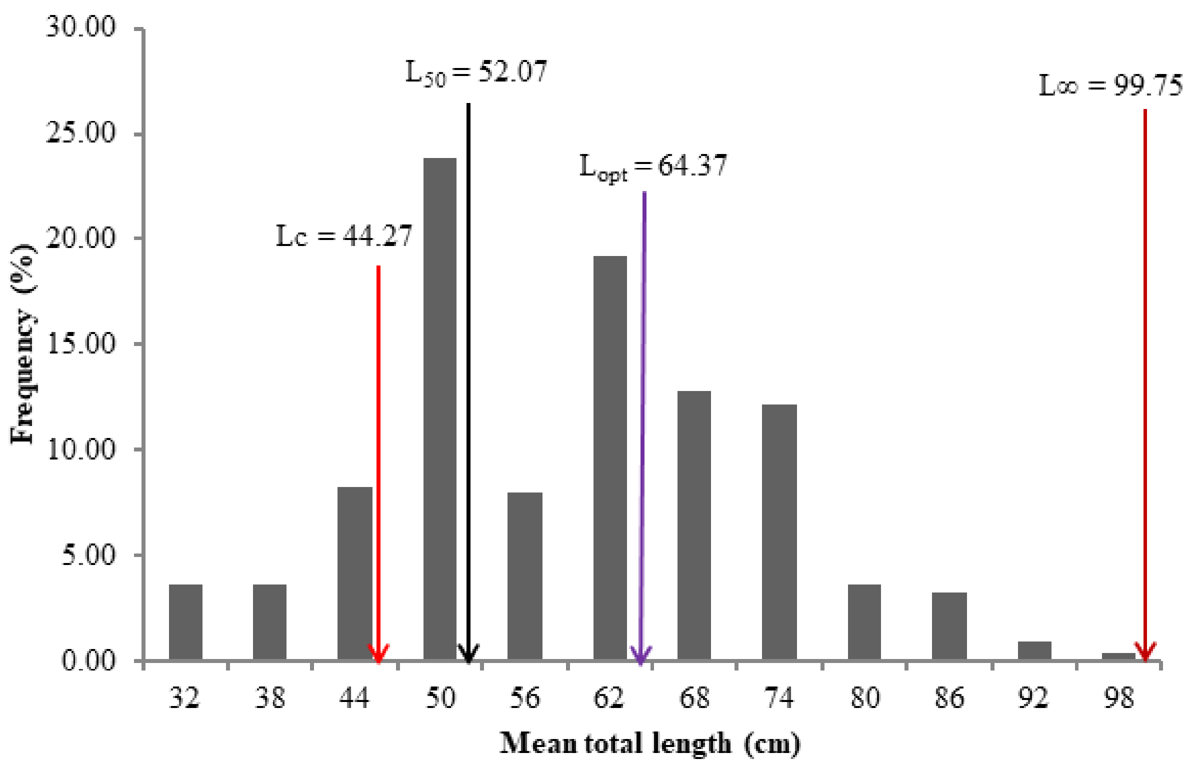

Figure 5: Size spectra of *B. docmak* from Lake Abaya

According to Figure 5, *B. docmak's* estimated lengths at first capture (Lc) and first maturity (L_{50}) were 44.27 cm and 52.07 cm, respectively. *B. docmak* in Lake Abaya was susceptible to capture at around eight months of life, as evidenced by the estimated age at first capture (Tc) of 0.86 years. Approximately 39.5% of the fish were caught before their length at first maturity (L_{50}), whereas approximately 15.69% of the fish removed before their length at first capture (Lc).

According to Froese and Binohlan (2000), the length at first maturity (L_{50}) in proportion to the length at first capture can be a biological reference point for any target species, and the length at first capture (Lc) is essential to detect the proper mesh sizes of the applied gears. Overfishing in recruitment is possible if Lc is less than L_{50}. During the current investigation, small-sized *B. docmak* in Lake Abaya showed signs of growth and recruitment overfishing, as evidenced by the length at first catch (Lc) being smaller than L_{50} and Lopt. To obtain a maximum yield from the fishery, any catch greater than L_{50} could make the fishery sustainable in Lake Abaya.

3.4. Virtual population analysis (VPA) and recruitment patterns

As the results of the virtual population analysis (VPA), a total length between 41 cm and 77 cm was more exposed to fishing gear; in contrast, a total length above 65 cm had a greater fishing mortality rate (Fig. 6).

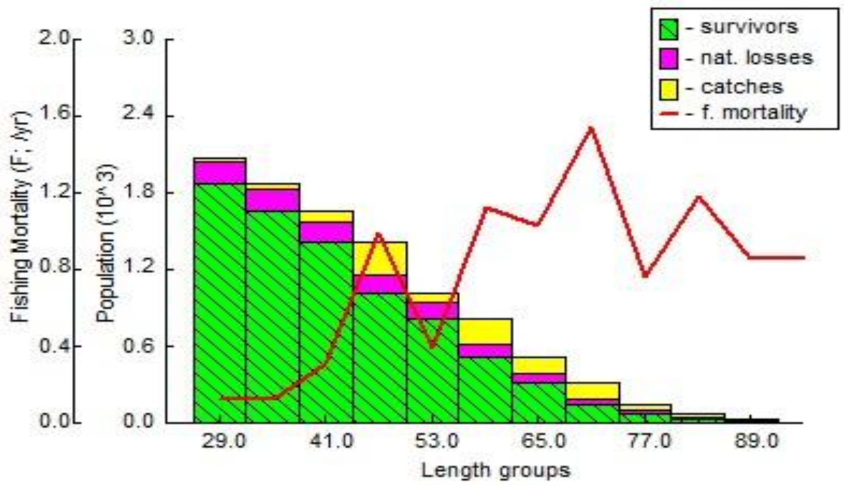

Figure 6: Virtual population analysis of *B. docmak* from Lake Abaya

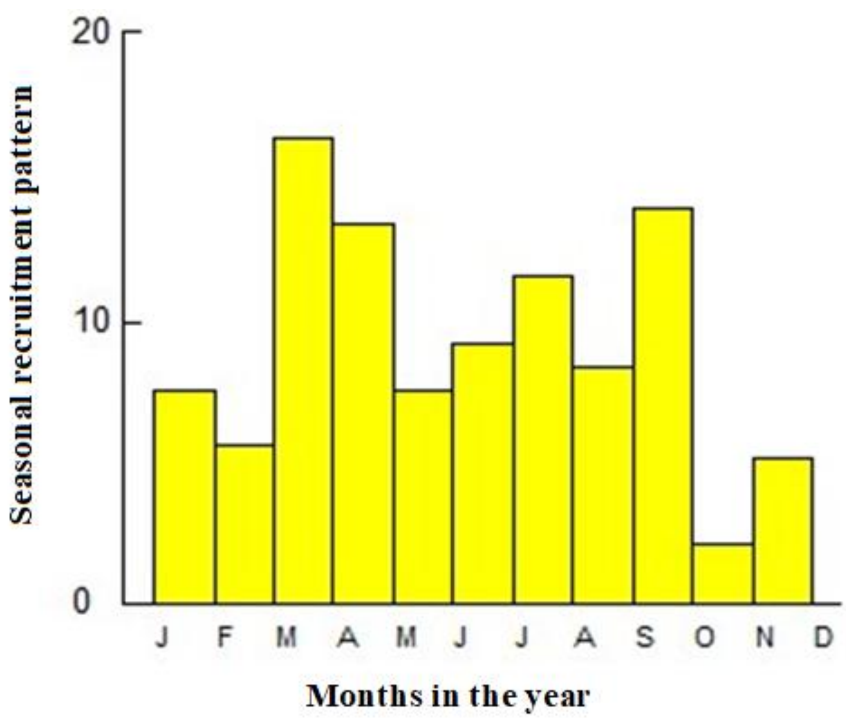

Figure 7: Seasonal recruitment pattern of *B. docmak* from Lake Abaya

The smallest mid-length in the sample was the length at recruitment (Lr), and the youngest fish in the sample was the proper age at recruitment (Tr). The current study found that *B. docmak* in Lake Abaya had a length at recruitment (Lr) of 32 cm and a corresponding age of recruitment (Tr) of 0.5 years. The recruitment trend occurs throughout the year, with March and September marking the biannual peak (Fig. 7).

The year-round recruitment and breeding are typical features of tropical fish due to relatively stable and elevated water temperatures in the tropics (Etim and Sankare, 1998). The rainfall patterns and water level fluctuations appear to be major influencing factors in the breeding biology of tropical freshwater fish species (Wootton, 1990). One of the likely causes of the peak recruitment in March and September may be the greater monthly average rainfall in the study area from March to October.

3.5. Relative Yield and relative Biomass per recruit (Y'/R, B'/R)

The exploitation rate (*E*) in the current study was 0.6, and the exploitation rates derived from the analysis of relative yield per recruit were $E_{0.1}$ = 0.507, $E_{0.5}$ = 0.350 and E_{max} = 0.614 (Fig. 8). The present exploitation rate (*E*) was higher than $E_{0.5}$, which conserves 50% of the biomass of the spawning stock, and nearly equal to E_{max}, which attains the maximum Y'/R. Based on the current rate of exploitation, *B. docmak* in Lake Abaya have been overfished. Lowering the exploitation rate from 0.6 to 0.35 (42%) annually is necessary to obtain a sustainable yield from *B. docmak* in Lake Abaya.

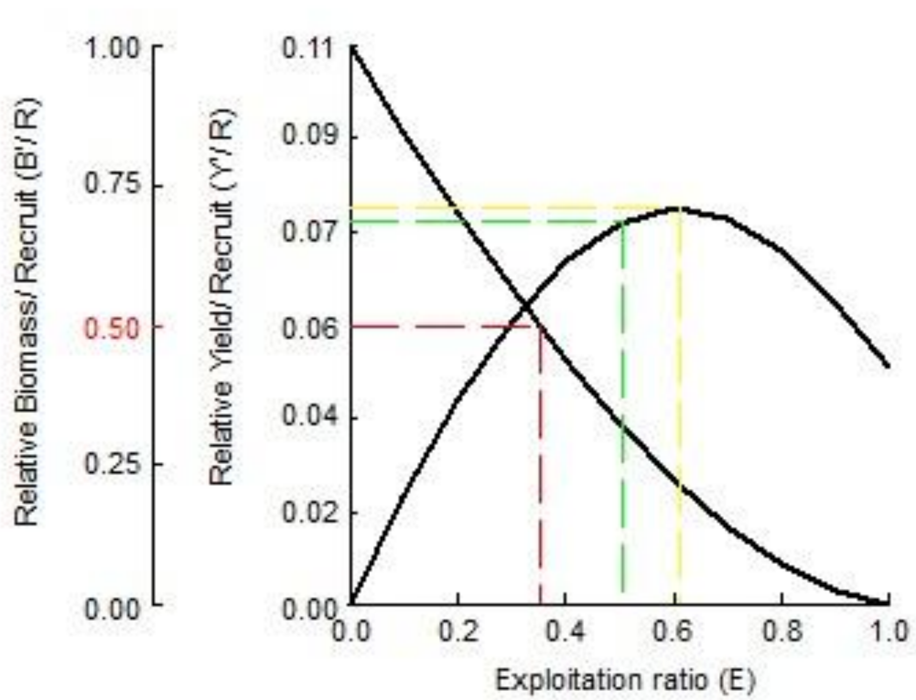

Figure 8: Beverton and Holt relative yield and biomass per recruit of *B. docmak* from Lake Abaya

4. CONCLUSION

The study's findings stated that *B. docmak* in Lake Abaya has an isometric growth pattern (b = 3.04). The growth parameters were estimated to be 99.75 cm for asymptotic length (L_∞) and 0.55 yr^{-1} for growth curvature (K). The removal of 39.5% of the fish before they reach the length at first maturity (L_{50}) due to extreme fishing pressure indicates overfishing in terms of both recruitment and growth. The length at recruitment (Lr) and the corresponding age of recruitment was 32 cm and 0.5 years, respectively. Although the recruitment takes place throughout the year, there are biannual pulses in March and September. Reducing fishing hours and /or the number of fishing gears is necessary for the management of this resource. In order to improve the sustainability of *B. docmak* in Lake Abaya, the current exploitation rate has been lowered by 42%.

Acknowledgement

The author extends gratitude to Ethiopian Institute of Agricultural Research (EIAR) and Arba Minch Agricultural Research Center for providing facilities and logistic allocation to undertake the study.

Informed consent

Not applicable.

Conflicts of interests

The author declares that there are no conflicts of interests.

Ethical approval & declaration

Even though Ethiopia does not have a specific animal research ethics code, this research has conducted based on the general ethical principles and international guidelines for animal research.

Funding

The study has not received any external funding.

Data and materials availability

All data associated with this study are presented in the paper.

REFERENCES

1. Ali RAS, Elawad AN, Khalifa MM, El-Mor M. Length-weight relationship and condition factor of Liza ramada from Eastern coast of Libya. International Journal of Fisheries and Aquatic Research 2016; 2: 1-9.
2. Ayoade AA. Length-weight relationship and diet of African Carp Labeooogunensis (Boulenger, 1910) in Asejire Lake Southwestern of Nigeria. Journal of Fisheries and Aquatic Science 2011; 6(4): 472-478.
3. Beverton RJH, Holt SJ. Manual of methods for fish stock assessment. Part II. Tables of yield function. FAO Fisheries Technical Paper No. 38(Review 1) 1966; 67.
4. Beverton RJH, Holt SJ. On the dynamics of exploited fish populations, Fisheries Investigation series. Ministry of Agriculture, Fisheries, and Food, London 1957; *19*, 1-533.
5. Buchale SS, Atnafu WY. Assessing Growth and Stock Status Parameters of African Catfish (*Clarias gariepinus* Burchell, 1822) from Lake Abaya, South Ethiopia. International Journal on Emerging Technologies 2025; 16(1): 30-40.
6. Buchale SS. Length-based estimates of growth parameters and mortality rates of Nile Tilapia (*Oreochromis niloticus,* L. 1758) in Lake Abaya, Southern Ethiopia. East Afr. J. Biophys. Comput. Sci. 2024; 5(1): 51-67.
7. Buchale SS. Length-weight relationship, Fulton's condition factor and sex ratio of *Bagrus docmak* (Forsskål, 1775) in Lake Chamo, Ethiopia. J. Agric. Environ. Sci. 2022; 7(2): 69-78.
8. Camargo M, Giarrizzo T, Isaac VJ. Population and biological parameters of selected fish species from the middle Xingu River, Amazon Basin. Brazilian Journal of Biology 2015; 75:112-124.
9. Dadzie S, Abou-Seedo FS, Moreau J. Population dynamics of *Parastromateus nigerin* Kuwaiti waters as assessed using length–frequency analysis. Journal of Applied Ichthyology 2007;23:592–597. doi: 10.1111/j.1439-0426.2007.00903.x.
10. El-Drawany MA, Elnagar WG. Growth, food and feeding habits of *Bagrus bayad* and *Bagrus docmac* inhibiting Muess Channel, Sharkia Province, Egypt. Journal of Aquaculture Research and Development 2015;6:348. doi: 10.4172/2155-9546.1000348.
11. Etim L, Sankare Y. Growth and mortality, recruitment and yield of the freshwater shrimp, *Macrobrachium vollenhoven ii,* Hoirklots 1998; 1851.
12. Froese R, Binohlan C. Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. Journal of Fish Biology 2000; *56*, 758–773.
13. Froese R. Cube law, condition factor, and weight-length relationships: History, meta-analysis, and recommendations. Journal of Applied Ichthyology 2006; 22: 241-253. doi: 10.1111/j.1439-0426.2006.00805.x.

14. Fulton TW. The rate of growth on fishes. Twenty second Annual Report, Part III. Fisheries Board of Scotland, Edinburgh 1904; 141-241.
15. Gashaw T, Wolff M. The state of inland fisheries in Ethiopia: A synopsis with updated estimates of potential yield. Ecohydrol. Hydrobiol 2014; 14(3): 200-219.
16. Gayanilo FC, Sparre P, Pauly D. FAO-ICLARM Stock Assessment Tools II (FiSAT II). User's guide. FAO Computerized Information Series (Fisheries). No. 8, Revised version, FAO, Rome 2005; 168pp.
17. Gulland JA, Holt SL. Estimation of growth parameters for data at unequal time intervals. Journal du Conseil International pour l'Exploration 1959; 25: 47-49.
18. Gulland JA. Why Do Fish Numbers Vary? Journal of theoretical Biology 1982; 97:69-75.
19. Hailu A, Elias D, Mengistou S. Reproductive biology and condition factor of the catfish *Bagrus docmak* (Forsskål) (Pisces: Bagridae) in Lake Chamo, Ethiopia. Ethiopian Journal of Sciences 2009; 32(1): 29–36.
20. Huo B, Ma BS, Xie CX, Dua YJ, Yang XF, Huang HP. Stock assessment and management implications of an endemic fish, *Oxygymnocypris stewartii*, in the Yarlung Zangbo River in Tibet, China. Zoological Studies 2015; *54*: 53. doi: 10.1186/s40555-015 0129-4.
21. Ikongbeh OA, Ogbe FG, Solomon SG. Length-weight relationship and condition factor of *Bagrus docmak* from Lake Akata, Benue state, Nigeria. Journal of Animal & Plant Sciences 2012; 15(3), 2267–2274.
22. Khallaf E, Galal M, Athuman M. The biology of *Oreochromis niloticus* in a polluted canal. Ecotoxicology 2003; 12: 405–416.
23. Le Cren ED. The length- weight relationship and seasonal cycle in gonadal weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology 1951; *20*: 201–219.
24. Lorenzen K, Cowx IG, Entsua-Mensah REM, Lester NP, Koehn JD, Randall RG, So N, Cooke SJ. Stock assessment in inland fisheries: a foundation for sustainable use and conservation. Reviews in Fish Biology and Fisheries 2016; *26*: 405–440. doi: 10.1007/s11160-016-9435-0
25. Mortuza MG, Al-Misned F. Length-weight relationships, condition factor and sex ratio of Nile tilapia, *Oreochromis niloticus* in Wadi Hanifah, Riyadh, Saudi Arabia. World Journal of Zoology 2013; 1, 106–109.
26. Musinguzi L, Kamya A, Nsega M, Natugonza V, Okello W, Snoeks J, Van Steenberge, M. Estimates of life-history and growth parameters of exploited fish species in lakes Edward and George: Implications on exploitation status, population dynamics, management, and conservation of native species. Journal of Fish Biology 2024; 1–15. doi: 10.1111/jfb.15929
27. Mutethya E, Okoth S, Yongo E. Biological aspects of *Schilbe intermedius* (Ruppell, 1832) in the Nyanza Gulf of Lake Victoria, Kenya. Lakes and Reservoirs: Research and Management 2020; 1–5.
28. Myers RA, Worm B. Rapid worldwide depletion of predatory fish communities. Nature 2003; 423: 280-283. doi: 10.1038/nature01610
29. Natanson LJ, Kohler NE, Ardizzone D, Cailliet GM, Wintner SP, Mollet HF. Validated age and growth estimates for the shortfin mako, Isurus oxyrinchus, in the North Atlantic Ocean. Environ Biol Fish 2006; 77:367-383
30. Okach JO, Dadzie S. The food, feeding habits and distribution of a Silurid catfish, *Bagrus docmak* (Forsskal), in the Kenya waters of Lake Victoria. Journal of Fish Biology 1988; 32: 85–94.
31. Palomares MLD, Froese R, Derrick B, Nöel SL, Tsui G, Woroniak J, Pauly D. A preliminary global assessment of the status of exploited marine fish and invertebrate populations. A report prepared by the *Sea around Us* for OCEANA. The University of British Columbia, Vancouver 2018; 64.
32. Pauly D, Christensen V, Guénette S, Pitcher TJ, Sumaila UR, Walters CJ, Watson R, Zeller D. Towards sustainability in world fisheries. Nature 2002; 418: 689–695. doi: 10.1038/nature01017
33. Pauly D, Munro JL. Once More on the Comparison of Growth in Fish and Invertebrates. ICLARM Fishbyte 1984; 2: 21.
34. Pauly D, Soriano ML. Some practical extensions to Beverton and Holt's relative yield-per-recruit model. In: J. L. Maclean, L. B. Dizon, & L. V. Hosillo (Eds.), The first Asian fisheries forum. Manila, Philippines: Asian Fisheries Society 1986; 491-496.
35. Pauly D. On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. ICES Journal of Marine Science 1980; 39(2): 175–192. doi: 10.1093/icesjms/39.2.175
36. Pauly DG. Estimation of mortality and growth parameters from the length frequency of a catch. Rapp. P.–V. Reun. CIEM 1979; 175: 167-169.
37. Pope KL, Lochmann SE, Michael KY. Methods for Assessing Fish Populations. In W. A. Hubert & M. C. Quist (Eds.). Inland fisheries management in North America (3rd Ed.). Bethesda, Maryland, USA: American Fisheries Society; 2010.
38. Quist MC. Evaluation of Techniques Used to Index Recruitment Variation and Year-Class Strength. North American Journal of Fisheries Management 2007; 27:30- 42.

39. Riedel R, Caskey LM, Hurlbert SH. Lengthweight relations and growth rates of dominant fishes of the Salton Sea: Implications for predation by fisheating birds. Lake Reserv. Manag 2007; 23(5): 528-535.
40. Sa-Oliveira JC, Angelini R, Isaac-Nahum VJ. Population parameters of the fish fauna in a long-established Amazonian reservoir (Amapa, Brazil). Journal of Applied Ichthyology 2015; 31:290-295.
41. Silvestre GT, Garces LR. Population parameters and exploitation rate of demersal fishes in Brunei Darussalam (1989-1990). Fisheries Research 2004; 69:73-90.
42. Taylor CC. Cod growth and temperature. Journal du Conseil International pour Exploration de la Mer 1958; 23: 366-370.
43. Tsoumani M, Liasko R, Moutsaki P, Kagalou I, Leonardos I. Length–weight relationships of an invasive cyprinid fish (*Carassius gibelio*) from 12 Greek lakes in relation to their trophic states. Journal of Applied Ichthyology 2006; *22*: 281–284. doi: 10.1111/j.14390426.2006.00768.x.
44. Ujjania NC, Kohli MPS, Sharma LL. Length-weight relationship and condition factors of Indian major carps (*Catla catla, L. rohita* and *C. mrigala*) in Mahi Bajaj Sagar, India. Research Journal of Biology 2012; 2(1): 30-36.
45. Von Bertalanffy L. A quantitative theory of organic growth (inquiries on growth laws II). Hum Biol 1938; 10:181–213
46. Wanyanga A, Yongo E, Mwangudza P. Diet of *Synodontis victoriae* (Mochokidae) from Kunya beach, Lake Victoria, Kenya. International Journal of Fisheries Aquatic Research 2016; 1: 11–15.
47. Welcomme RL, Cowx IG, Coates D, Be´ne´ C, FungeSmith S, Halls AS, Lorenzen K. Inland capture fisheries. Philossophical Transactions of the Royal Society 2010; 365: 2881–2896. doi: 10.1098/rstb.2010.0168.
48. Wootton RJ. Ecology of teleost fishes. Fish and fishers series1. Chapman and Hall publication London UK, 1990; 404.
49. Yilmaz S, Yazıcıoglu O, Erbasaran M, Esen S, Zengin M, Polat N. Length-weight relationship and relative condition factor of white bream, *Blicca bjoerkna* (L.1758), from Lake Ladik, Turkey. Journal of Black Sea/Mediterranean Environment 2012; 18: 380–387.
50. Yongo E, Agembe S. Some biological aspects of the Silurid Catfish, *Bagrus docmak* (Forksskal, 1775) in Lake Victoria, Kenya. Lakes & Reserv 2021; doi: 10.1111/lre.12371
51. Yongo E, Manyala JO, Kito K, Matsushita Y, Outa NO, Njiru JM. Diet of Silver Cyprinid, *Rastrineobola argentea* in Lake Victoria, Kenya. International Journal of Advanced Research 2016; 4(4): 144–149.
52. Yongo E, Wairimu A. Studies on the Biology of *Synodontis victoriae* in the Nyanza Gulf of Lake Victoria, Kenya. Journal of Fisheries & Aquaculture 2018; 9(2): 1-3.