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Fisheries in Geray Reservoir could be managed using biometric and reproductive characteristics of the Common carp (*Cyprinus carpio* L. 1758)

Yirga Enawgaw[1,*], Ayalew Sisay[2], Asnaku Bazezew[2], Solomon Wagaw[1], Assefa Wosnie[3]

[1] *Department of Biology, Wolkite University, Wolkite 07, Ethiopia*
[2] *Department of Biology, Debre Markos University, Debre Markos 269, Ethiopia*
[3] *Department of Biology, Dilla University, Dilla 419, Ethiopia*

Abstract

This study looked at some biometric and reproductive aspects of the Common carp (*Cyprinus carpio*) — the overexploited fish species in the Geray Reservoir as a foundation to develop an efficient fisheries management strategy. 50 fish samples (20 to 44 cm and 130 to 2,400 g) were collected between October and May 2022 using a cast net with a mesh size of 6 cm. The ratio of male to female *C. carpio* (1:0.52) was deviating from the anticipated 1:1 ratio. The absolute fecundity of *C. carpio* was relatively low (12,375 to 31,392 eggs). Gonadosomatic index varied from 0.01 to 4.6 (male) to 0.24–12.75 (female), and the spawning period of *C. carpio* extended from December to January. The length-weight relationships for males ($TW = 0.0009TL^{3.87}$) and females ($TW = 0.0007L^{3.97}$) indicate that *C. carpio* had positive allometric growth; which may have been caused by unsuitable habitat conditions and overfishing. There is a need to develop fisheries management like implementing integrated conservation efforts and reducing wetland farming. For this, this information provides a baseline data.

Keywords: Allometric, Overexploited, Overfishing, Unsuitable, Management

Introduction

Fish resources are globally losing (Tessema et al., 2020). The main causes of the global loss in fish populations, notably in Ethiopia are overfishing of select fish species and environmental deterioration brought on (Mohammed et al., 2016). Despite efforts to maintain a healthy aquatic environment and preserve both fish biodiversity and biomass, fisheries are nevertheless collapsing in some parts of the world (Dadebo et al., 2014). Keystone tool for investigation and management of fisheries include the biometric studies that deliver information on fish species for assessment of their biomass (Hailu, 2014).

Numerous studies have emphasized the significance of establishing biometric relations such as length-weight relations (LWRs) in fish (Engdaw, 2023). The LWRs-derived condition factor, which was developed as a biometric, is significant bio-

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***Corresponding author:** Yirga Enawgaw
Department of Biology, Wolkite University, Wolkite 07, Ethiopia
Tel: +251-115432311, **E-mail:** yirgaenawgaw@yahoo.com

metric instrument to develop efficient fisheries management. The condition factor or coefficient of body condition is a useful statistic that demonstrates the health of fish in either their natural environment or aquaculture (Flowra et al., 2012).

Knowledge of fish reproduction biology is essential for managing fish stocks and ensuring their long-term productivity (Hossain et al., 2017). One key biological indicator, the Gonad Somatic Index (GSL), is used to comprehend and evaluate the success of reproduction, which assures the survival of fish species, notably common carp, the study's subject fish. Shinkafi & Ipinjolu (2012) assert that while estimating reproductive potential, a range of traits, including the age at which sexual maturity occurs, fecundity, the length of the reproductive season, and daily spawning activity must be taken into consideration (Ul-Hassan et al., 2020).

To increase fish production, exotic freshwater fish species have been introduced to a number of man-made and natural water bodies in Ethiopia. The common carp, *C. carpio*, was introduced to Ethiopia in 1936 for aquaculture (Tegegnie, 2015). It has now been introduced into various reservoirs and other natural water bodies in an effort to fill the void and boost fish productivity. The fish is introduced into the Geray reservoir around 1975. *C. carpio* is one of the leading contenders for commercial fish production in the reservoir (Mohammed et al., 2016). However, it is dwindling as a result of overfishing and other environmental deterioration. It is essential to manage the reservoir's fisheries before the total loss of the fish. The goal of this study was, therefore, to assess some biometric and reproductive characteristics of *C. carpio* to provide information for efficient fisheries management for the reservoir specifically and for the nation generally.

Materials and Methods

Study area

This study was conducted at Geray Reservoir (Ethiopia). Geray irrigation scheme is located 10' 60" latitude and 37' 26" longitude (Fig. 1). It was built in 1972 (Checkol & Alamirew, 2008). It is the largest studied (618 ha) scheme representative of mid-altitude humid climatic conditions in the Amhara Region (Checkol & Alamirew, 2008). The reservoir has a surface area of 10 hectare. The average annual rainfall and temperature in Geray Reservoir, respectively, are 25.75℃ and 1,350 mm (Tegegnie, 2015). The reservoir is home to Common Carp (*C. carpio*), Beso (*V. beso*), Golden fish (*Carassius carassius*), and Tilapia (*Oreochromis niloticus* and *Tilapia randelli*) (Mohammed et al., 2016).

Fish collection

Fish samples were collected between October and May of 2022 from three landing sites biweekly using cast nets with a mesh size of 6 cm, 8 cm, 10 cm, and 12 cm. It was collected the point closest to the land at the first location, which was a more open

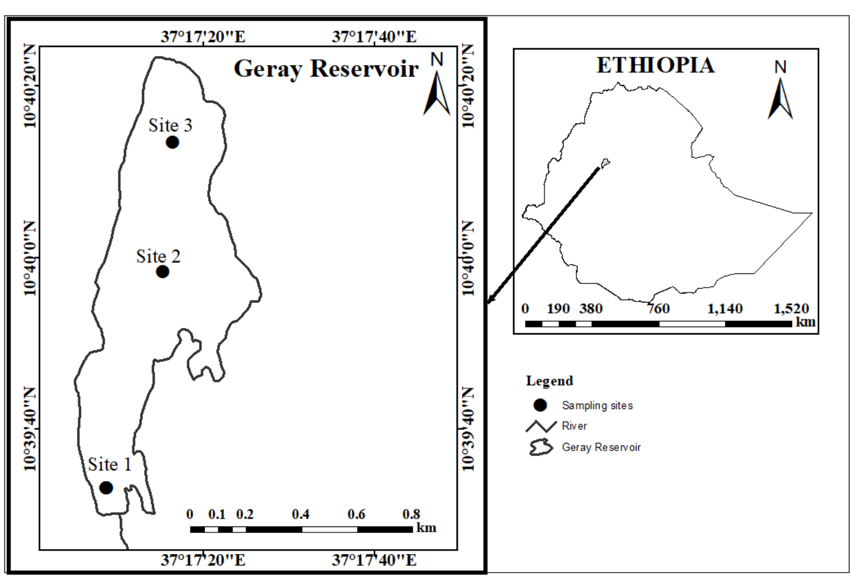

Fig. 1. Map of Geray Reservoir and fish sampling sites.

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area (inlet site). The second fish site was in the area of the marsh that was covered with macrophytes (middle area or pelagic region). Fish from the third location were collected from the main sewage exit (Fig. 1).

Biometric measurements

Total length (TL in cm) was measured using a normal ruler (48″ model hinges at 24″) and verified against a Vernier caliper to the nearest 0.1 cm. Total weight (TW) was measured using a sensitive digital balance (Model CY510, Citizen, Tokyo, Japan) with a 0.01 g precision.

Sex ration determination

Each fish specimen was dissected, and the fresh gonads were inspected under a microscope. The sex of the fish species under study was carried out using the approach recommended by Peña-Mendoza et al. (2005) formula:

$$Sex\ ratio = \frac{Number\ of\ females}{Number\ of\ males} \times 100 \quad (1)$$

Length-weight relationships (LWRs)

The LWRs equation W = a L^b was used to estimate the relationship between the weight (g) of the fish and its total length (cm) (Bolarinwa & Popoola, 2013). Using the linear regression of the log- transformed equation: log (W) = log*a* + *b*logL. The parameters "a" and "b" were calculated with "a" representing the intercept and "b" the slope of the relationship. The values of "a" and "b" were determined using non-linear regression, and the curve fitting was done using the chi-square test.

Fecundity

The absolute fecundity (AF) for particular females was estimated using a gravimetric approach (Bagenal & Tesch, 1978). The relationship between AF and TL and TW of the fish and their gonad weight (GW) was determined using least squares regression.

Spawning season

The spawning seasons of the fish species under study were detected using the monthly fluctuations of the gonadosomatic index (GSI):

$$\mathrm{GSI} = \frac{\mathrm{Wg}}{\mathrm{W} - \mathrm{Wg}} \times 100 \quad (2)$$

where, Wg is the gonad weight (g) and W is the total weight (g) of the fish.

Condition factor

The wellbeing of *C. carpio* was determined by using the Fulton condition factor (Bagenal & Tesch, 1978). Fulton condition factor (FCF) was calculated as:

$$FCF = \frac{TW}{TL} \times 100 \quad (3)$$

where, TW and TL is the total weight (g) and total length (cm) of the fish, respectively. Good growth condition of the fish was deduced when FCF is greater than 1, while the fish is in poor growth condition when FCF is less than 1.

Data analysis

One-way ANOVA was used to assess the statistical significance of the regression model, length-weight association data and the spatiotemporal variations of fish. T-test was used to determine whether the isometric growth (b = 3) and b predictions for each species were statistically significantly different from one another. χ^2-test was used to compare the condition factor between sexes. The coefficient of determination (r^2) was used to assess how well a linear regression model predicted outcomes. IBM SPSS Statistics 20 was used to analyses data.

Results

Sex ratio

The sex ration analysis showed that *C. carpio* males (66%) outnumbered females (34%). It fluctuated considerably among the sampling months (t-test; $p < 0.05$). In the month of October (1:0.25), December (1:0.44), and January (1:0), males significantly outnumbered females ($p < 0.05$), while in February (1:5) females occurred in significantly higher proportion than males ($p < 0.05$). The overall sex ratio (1:0.52) of males to female of the population when tested statistically showed significant difference ($p < 0.05$) from the anticipated 1:1 female to male ratio (Table 1).

Length-weight relationships (LWRs)

TL and total weight (TW) of *C. carpio* ranged from 20 cm to 44 cm and from 130–2,400 g, respectively. The relationship between TL and TW of *C. carpio* was curvilinear. The LWRs of both male (TW = 0.0007TL$^{3.97}$) (Fig. 2) and female (TW = 0.0009TL$^{3.87}$) (Fig. 3) *C. carpio* was strongly correlated, and their r^2 value of male (0.9608) and female (0.9635) closed to 1 (Table 2). The "*b*" values of both male (3.97) and female (3.87) *C. carpio* were significantly different from 3 (isometric growth), indicating the fish had a positive allometric growth in Geray reservoir (Fig. 4 and Table 2).

Table 1. The number of female and male and their sex ration (female: male) of *Cyprinus carpio* in monthly collected from Geray reservoir during the study period (2022)

Sampling months	Sex ratio (male:female)	χ^2	Sig.
October	1:0.25	1.8	**
November	1: 0.44	1.9	NS
December	1:0.46	2.58	NS
January	1:0	4.0	**
February	1:5	2.67	**
March	ND	ND	ND
April	0:1	1.0	NS
May	1:0	2.0	NS
Total	1:0.52	5.12	**

NS, statistically not significant ($p > 0.05$).
** Statistically significant ($p < 0.05$).
ND, not detected.

Fecundity

For fecundity analysis, 16 matured female *C. carpio* with total lengths ranging from 24.9 to 44 cm, weights ranging from 729

Table 2. Length–weight relationship of male and female *Cyprinus carpio* in Geray reservoir

Sex	N	Regression equation	R^2	Sig.	Growth pattern
Male	33	0.0007L$^{3.97}$	0.9608	0.000***	Positive allometry
Female	17	0.0009TL$^{3.87}$	0.9635	0.000***	Positive allometry

*** Statistically significant at $p < 0.001$.

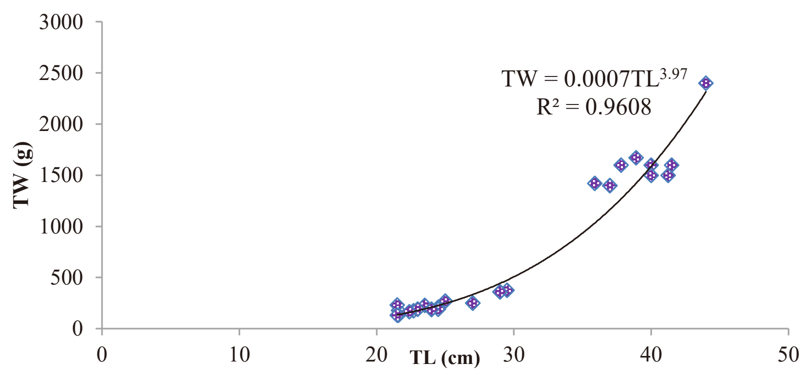

Fig. 2. Length-weight relationships of Male *Cyprinus carpio* in Geray reservoir (n = 33).

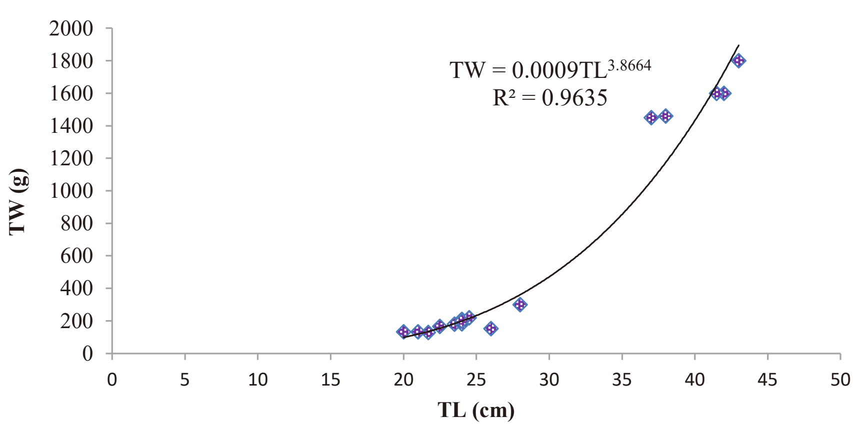

Fig. 3. Length-weight relationships of Female *Cyprinus carpio* in Geray reservoir (n = 17).

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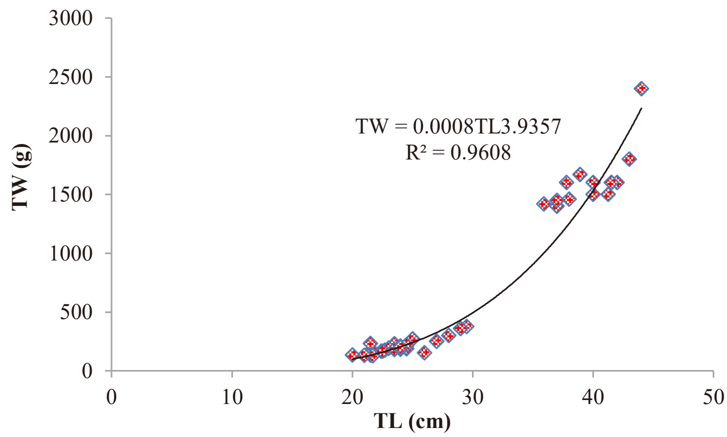

Fig. 4. Length-weight relationship of the combined *Cyprinus carpio* in Geray Reservoir (n = 50).

to 2,400 g, and gonad weights ranging from 3.2 to 26.6 g were used. This study found that the average AF per fish was 19,920 eggs, ranging from 12,375 to 31,392 eggs (Table 3). Despite being significantly and positively correlated with TL and TW ($p < 0.05$), AF was not correlated with GW ($p > 0.05$).

Breeding seasons

C. carpio had a GSI that varied from 0.01 to 4.6 (male) to 0.24–12.75 (female). The corresponding mean GSI was 1.06375 ± 0.59273 for males and 3.3375 ± 1.72382 for females. The GSI values found in this study fish demonstrated that females had greater GSI values than males in each of stages of gonad maturation. GSI did significantly correlate with total length and total weight of the fish ($p < 0.001$). GSI revealed monthly variation in both males and females ($p < 0.05$). The maximum GSI for both male (12.75) and female (4.6) *C. carpio* was observed in December. Relatively high GSI was also seen in October and November. Low GSI was observed in January, April, and May (Fig. 5). It indicated that the breading season of *C. carpio* in Geray reservoir is extended from December to May with the peaks in December (Fig. 5).

Condition factor

The condition factor (also known as "k-factor") of *C. carpio* in the Geray reservoir did not significantly varied between sexes ($p > 0.005$). However, the mean FCF of females (1.3 ± 0.99) were slightly higher than males (1.3 ± 1.3) (Table 4). The k-factor of both sexes was varied significantly among the sample months ($p < 0.05$) (Table 4). It ranged from lower values of 1.1 (November and December) to higher values of 1.8 (January) for male and from 1.1 (May) to 1.7 (January) for female. The results revealed that in the sampling months where fish existed, the fish had k-factor greater than 1 (Table 4).

Table 3. Biometric and reproductive aspects of the matured *Cyprinus carpio* taken for fecundity analysis (n = 16)

Biometric parameters	*C. carpio*	Sig.
TL (cm)	24.9–44	**
TW (g)	729–2,400	*
AF (number of egg)	12,375–31,392	NA
AF(number of egg)-average	19,920	NA
GW (g): range (minimum-maximum)	3.2–26.6	NS
GW (g): Mean ± SE	24.1 ± 2.1	NS

AF, absolute fecundity (in terms of number of egg) of the matured fish; GW, gonad weight of the matured fish (g); SE, standard error; TL, total length of the matured fish (cm); TW, total weight of the matured fish (g).
[*] Significant at $p < 0.05$; [**] Significance at $p < 0.001$.
NA, not applicable; NS, not statistically significant.

Discussion

The study confirmed that *C. carpio* in the Geray reservoir is dropping because there is high selected overfishing of the fish and unsuitable habitat condition. In the study reservoir, though the total number of fish catch is limited, *C. carpio* greatly outnumbered females. This sex bias may be caused by sexual segregation during spawning, behavioral differences between the sexes, gear type, and fishing location. The sex difference could be affected by several factors, such as gender-based disparities in mortality, migration patterns, and other behaviors (Anteneh et al., 2023).

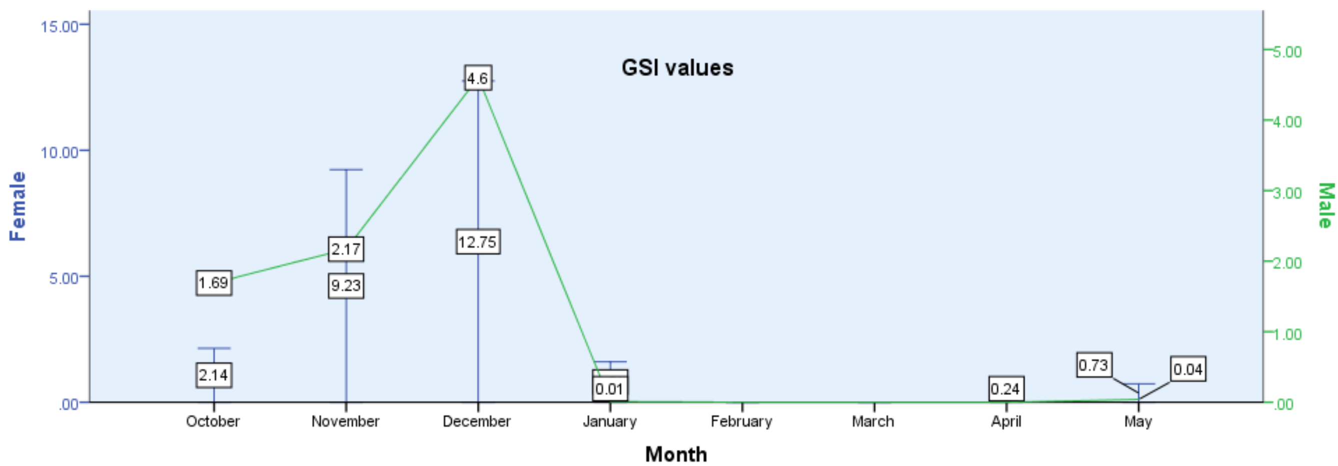

Fig. 5. Monthly variations in GSI of female (blue line) and male (green line) *Cyprinus carpio* in Geray reservoir during the study period.

Table 4. The monthly Fulton's Condition factors for males and females of each species of fish that were evaluated throughout the current study period (2022) in Geray Reservoir

Month	*Cyprinus carpio*	
	Male	Female
October	1.3	1.14
November	1.1	1.3
December	1.1	1.6
January	1.8	1.7
February	ND	ND
March	ND	ND
April	ND	1.3
May	1.2	1.1
Mean SE	1.3 ± 1.3	1.36 ± 0.99

SE, standard error of mean; ND, not determined.

The length-weigh relationships (LWRs) provides vital information on the functioning of fish populations (Wagaw et al., 2022) and is an important tool in fish stock assessment to know the growth status and management of the fishes (Ujjania et al., 2012). The LWRs of *C. carpio* in Geray reservoir is curvilinear, and hence the line fitted to the data that was described by the regression equation. The coefficient (b) values of *C. carpio* in the study reservoir fell within the range of b values (2–4) for fishes generally, but it is a little higher in tropical fishes (b = 2.5 – 3.5) specifically (Bagenal & Tesch, 1978). Several authors have provided descriptions of the isometric and allometric growth patterns of *C. carpio* from different bodies of water. The slope of the regression line for both sexes of *C. carpio* in the current study indicated an allometric (positive) growth pattern of the fish, where the fish's form and specific gravity do change as it grows in size. The allometric growth of *C. carpio* in the Geray reservoir shows that the fish is not developing properly, presumably as a result of the inappropriate environmental conditions as well as overfishing. The variation of *b* can be attributed to a variety of factors, including habitat, seasonal effects, degree of gut fullness, gonad maturity and food availability, sex differences, and environmental toxicology (Sahtout et al., 2017).

Fecundity is among the most essential parameters in studying the reproductive biology of every fish. Knowledge on the fecundity of fish is important to examine the potential of its stocks and actual management of the fishery (Flowra et al., 2012). Fecundity of *C. carpio* depends on body size and produce between 500,000 and 3 million eggs per spawning (Syed et al., 2020). In the Geray reservoir, the maximum AF of *C. carpio* is 15 times lower than the minimal number of eggs that the fish is projected to produce. The low AF of *C. carpio* in the Geray reservoir may be due to the fish's inappropriate growth as a result of an unsuitable environment. The number of eggs varies greatly, with larger samples producing more eggs than smaller samples (Shinkafi & Ipinjolu, 2012). The smaller sample of fish may be contributed the lower AF in the present study case. Fecundity exhibited a greater correlation with gonadal weight than total length or weight. This suggests that total weight is a stronger predictor of fecundity in this study than total length. The fact that there is a

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negative correlation between egg size and fecundity indicates that in this species, larger eggs are more prevalent when there are fewer of them. The size of the fish affected its fecundity, so the bigger the fish, the more eggs it produced, maybe because its viscera has more space to retain the eggs.

Fish spawning biology could be studied using a metric called the gonadosomatic index (GSI) (Calagui et al., 2020). In fish, the GSI is a reliable indicator of reproductive activity (Tesfaye et al., 2020). The GSI values found in this study demonstrated that in all six stages of gonad maturation, females exhibited higher GSI values than males. This was correlated with the ovaries' greater weight while the eggs were present. Females' TL, TW, and stage of gonad maturation were found to have high relationships with GSI compared to males. Monthly GSI estimations showed that the mature captive *C. carpio* population becomes ready to spawn twice, from October to December and April to May, with the peak spawning periods occurring in December. Our findings are consistent with the more than one spawning seasons seen in *C. carpio* in other Ethiopian water bodies such as the Amerti Reservoir (Hailu, 2014), Lake Hayq (Tessema et al., 2020), and Lake Ziway (Tesfaye et al., 2020). This is ultimately because the consistently warm environment. External environmental factors such as rainfall, water surface temperature, pH, hormone release, and turbidity are essential for determining the optimal period for *C. carpio* reproduction in Ethiopia (Mohammed et al., 2016). In line with the findings of the present study, the peak breeding season was seen in Amerti Reservoir (Hailu, 2014) and Lake Ziway (Tesfaye et al., 2020) during periods of rising water temperature.

Fulton's condition factor (hereinafter referred to as the "K-factor") is one of the most often used biometric indices (Batubara et al., 2019). The mean k-factor value of *C. carpio* in this study for both sexes is larger than 1, implies that the examined fish is in a state of well-being. Fish reproduction cycles, food availability, habitat, and environmental factors are just a few of the variables that affect fish growth conditions (Syed et al., 2020). Comparing individual male and female fish of the same length, but if the female is gravid (full of eggs); comparatively high k-factor is usually observed in females rather than males. Similar results have been reported for other nearby water bodies around the world, such as the Damsa Dam (Mert & Bulut, 2014) and Almus Dam (Karataş et al., 2007) in Turkey, the Foum El-Khanga Dam in Algeria (Sahtout et al., 2017), and the Amerti Reservoir (Hailu, 2014) and Lake Hayq (Tessema et al., 2020) in Ethiopia. During fish spawning in the Geray Reservoir, k-factor results are frequently poor. This could be caused by the lack of food and malnutrition brought on by mouth brooding throughout the reproductive season. During spawning, fish typically reduce their feeding activity and consume their lipid reserves, which results in a decline in condition. The high k-factor values that exist may help to explain why these fish become more aggressive eaters throughout the warm season. In fact, during warmer months when the temperature is optimal an increased k-factor may be associated with more food availability or a higher feeding activity (Asnake & Mingist, 2018).

Conclusion

It is essential to collect area-specific data on the reproductive and biometric aspects such as length-weight relations, condition factor, fecundity, and spawning periods of fish to develop an effective management for fish in their habitats. The biometric and reproductive aspect of *C. carpio* is the first study on the Geray reservoir which will be used as baseline information to design efficient fisheries management strategies for sustainable utilization of fisheries in the reservoir. The study found that the growth of *C. carpio* in the reservoir is the allometric growth of fish, indicating the fish are not properly growing as a result of overfishing. Fishermen are strongly urged to avoid catching *C. carpio* during the breeding season or for a specified period of time until the fish population has recovered.

Competing interests

No potential conflict of interest relevant to this article was reported.

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Availability of data and materials

Upon reasonable request, the datasets of this study can be available from the corresponding author.

Ethics approval and consent to participate

This study conformed to the guidance of animal ethical treatment for the care and use of experimental animals.

ORCID
Yirga Enawgaw https://orcid.org/0000-0001-6146-7294

References

Anteneh YE, Mamo SW, Tilahun MA. Fisheries in Lake Tinishu Abaya (Ethiopia) could be managed using dietary nature of Nile Tilapia (*Oreochromis niloticus* L. 1757). Fish Aquat Sci. 2023;26:491-9.

Asnake W, Mingist M. Freshwater fisheries resource potential estimation: the case of Lake Ardibo, northern Ethiopia. Fish Aqua J. 2018;9:1-7.

Bagenal TB, Tesch FW. Age and growth. In: Bagenal T, editor. Methods for assessment of fish production in fresh waters. Oxford: Blackwell Science Publications; 1978. p. 101-36.

Batubara AS, Muchlisin ZA, Efizon D, Elvyra R, Irham M. Length-weight relationships and condition factors of the naleh fish, *Barbonymus gonionotus* (Pisces, Cyprinidae) harvested from Nagan Raya Waters, Indonesia. Vestn Zool. 2019; 53:75-82.

Bolarinwa JB, Popoola Q. Length-weight relationship and condition factors of six economic fishes of Ibeshe water side, Lagos Lagoon, Nigeria. In: Proceedings of the International Conference on Oceanography; 2013; Orlando, FL.

Calagui LB. Length-weight relationship (LWR), gonadosomatic index (GSI) and fecundity of *Johnius borneensis* (Bleeker, 1850) from lower Agusan River basin, Butuan City, Philippines. J Aquac Res Dev. 2020;11:1-8.

Checkol G, Alamirew T. Technical and institutional evaluation of Geray irrigation scheme in West Gojjam zone, Amhara region, Ethiopia. J Spat Hydrol. 2008;8:36-48.

Dadebo E, Aemro D, Tekle-Giorgis Y. Food and feeding habits of the African catfish *Clarias gariepinus* (Burchell, 1822) (Pisces: Clariidae) in Lake Koka, Ethiopia. Afr J Ecol. 2014;52:471-8.

Engdaw F. Morphometric relations and diet compositions of Nile tilapia *Oreochromis niloticus* (Linn. 1758) in Lake Tana Gorgora gulf, Ethiopia. Fish Aquat Sci. 2023;26:169-80.

Flowra FA, Nahar DG, Tumpa AS, Islam MT. Biochemical analysis of five dried fish species of Bangladesh. Univ J Zool Rajshahi Univ. 2012;31:9-11.

Hailu M. Gillnet selectivity and length at maturity of Nile Tilapia (*Oreochromis niloticus* L.) in a tropical reservoir (Amerti: Ethiopia). J Agric Sci Technol A. 2014;4:135-40.

Hossain MY, Hossen MA, Ahmed ZF, Hossain MA, Pramanik MNU, Nawer F, et al. Length–weight relationships of 12 indigenous fish species in the Gajner Beel floodplain (NW Bangladesh). J Appl Ichthyol. 2017;33:842-5.

Karataş M, Çiçek E, Başusta A, Başusta N. Age, growth and mortality of common carp (*Cyprinus carpio* Linneaus, 1758) population in Almus Dam Lake (Tokat-Turkey). J Appl Biol Sci. 2007;1:81-5.

Mert M, Bulut S. Some biological properties of carp (*Cyprinus carpio* L., 1758) introduced into Damsa Dam Lake, Cappadocia region, Turkey. Pak J Zool. 2014;46:337-46.

Mohammed B, Tewabe D, Zelalem W, Melaku A. Physical, chemical, biological properties and fish species type of Geray reservoir, -W/Gojjam zone, Ethiopia. Int J Aquac Fish Sci. 2016;2:008-11.

Peña-Mendoza B, Gómez-Márquez JL, Salgado-Ugarte IH, Ramírez-Noguera D. Reproductive biology of *Oreochromis niloticus* (Perciformes: Cichlidae) at Emiliano Zapata dam, Morelos, Mexico. Rev Biol Trop. 2005;53:515-22.

Sahtout F, Boualleg C, Khelifi N, Kaouachi N, Boufekane B, Brahmia S, et al. Study of some biological parameters of *Cyprinus carpio* from Foum El-khanga Dam, Souk-Ahras, Algeria. AACL Bioflux. 2017;10:663-74.

Shinkafi BA, Ipinjolu JK. Gonadosomatic index, fecundity and egg size of *Auchenoglanis occidentalis* (Cuvier and Valenciennes) in River Rima, North-western Nigeria. Nig J Basic Appl Sci. 2012;20:217-24.

Syed N, Shah TH, Balkhi MH, Bhat FA, Abubakr A, Wani GB, et al. Length-weight relationship and condition factor of *Cyprinus carpio* var. *communis* in Manasbal Lake, Kashmir. J Pharmacogn Phytochem. 2020;9:1539-44.

Tegegnie ME. Impacts of fish introduction on aquatic environment: a study with special reference to common carp (*Cyprinus carpio* Linnaeus, 1758). J Agric Environ Sci. 2015;1-15.

Tesfaye A, Getahun A, Fetahi T. Food and feeding habits of the juvenile and adult common carp (*Cyprinus carpio*) in Lake Ziway, Ethiopia. SINET Ethiop J Sci. 2020;43:77-87.

Tessema A, Getahun A, Mengistou S, Fetahi T, Dejen E. Reproductive biology of common carp (*Cyprinus carpio* Linnaeus, 1758) in Lake Hayq, Ethiopia. Fish Aquat Sci. 2020;23:16.

Ujjania NC, Kohli MPS, Sharma LL. Length-weight relationship and condition factors of Indian major carps (*C. catla*, *L. rohita* and *C. mrigala*) in Mahi Bajaj Sagar, India. Res J Biol. 2012;2:30-6.

Ul Hassan H, Ali QM, Rahman MA, Kamal M, Tanjin S, Farooq U, et al. Growth pattern, condition and prey-predator status of 9 fish species from the Arabian Sea (Baluchistan and Sindh), Pakistan. Egypt J Aquat Biol Fish. 2020;24:281-92.

Wagaw S, Mengistou S, Getahun A. Diet composition and feeding habits of *Oreochromis niloticus* (Linnaeus, 1758) in Lake Shala, Ethiopia. Fish Aquat Sci. 2022;25:20-30.