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Research article

Biometric Indices of Tank Goby *Glossogobius giuris* (Hamilton, 1822) from a wetland ecosystem (Bhutiyar *Beel*), southern Bangladesh

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ABSTRACT

The Tank Goby *Glossogobius giuris*, is a prominent freshwater species belonging to the family Gobiidae. This study primarily investigated the growth pattern, condition and form factor of *G. giuris* sampled from the wetland ecosystem of Bhutiyar *Beel* in southern Bangladesh. A total of 300 individuals were sampled from commercial fishers on a seasonal basis (pre-monsoon, monsoon and post-monsoon) during 2023, with recording of length and weight of each specimen. Total length (TL) ranged from 5.9 to 16.4 cm while body weight (BW) varied from 1.80 to 43.70 g. Overall, the species exhibited a negative allometric growth pattern, with a strong correlation in the length-length relationship (LLR) documented ($r^2 = 0.967$). The assessed value (0.0068) of form factor ($a_{3.0}$) indicated an eel-like body shape. Further, the average value of Fulton's condition factor (K_F) was estimated to be well below 1, indicating suboptimal health status. The findings of this study will contribute to the development of effective conservation policies for this fish species in the Bhutiyar *Beel* and connected ecosystems.

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Introduction

Bangladesh is blessed with plentiful wetlands including rivers, canals, oxbow lakes, floodplains and seasonal marshes. After China and India, Bangladesh possessed third place in Asia with 800 aquatic species distributed in the marine, brackish and freshwater habitat (Hussain & Mazid, 2001). Fisheries sector fulfills 60% of animal protein requirement for the vast population of Bangladesh (DoF, 2023). In addition, this sector provides enormous employment opportunities and acts as a vibrant source for earning foreign currency (Alam & Thomson, 2001). However, the wild fisheries resources face significant threats due to indiscriminate harvest accelerated by different ecological modifications of aquatic ecosystem (Hossen et al., 2019; Sabbir et al., 2021). Furthermore, a lack of information on the life history traits of various fish populations poses a major challenge to the implementation of effective fishing policies in these, necessitating urgent investigation (Sabbir et al., 2022).

Information about length-frequency distributions (LFDs) is indispensable to perform stock assessment program of a particular species in its wild habitat (Mawa et al., 2022; Khan et al., 2023). Moreover, LFD denotes the size structure of a fish species due to fishing mortality (Sabbir et al., 2022). Besides, LFD reveals the recruitment pattern and physical status including spawning season of a species in its natural ecosystem (Ilah et al., 2023; Sabbir et al., 2023). Knowledge about length-weight relationships (LWRs) is obligatory for determining the population structure of a specific fish species and for comparing the differences among the stocks of that particular species (King, 2007). Likewise, such information is also crucial in environment monitoring program in a specific geographic area (Froese, 2006). Fisheries conservation and management program exclusively depends on accurate estimation of LWRs (Ahmed et al., 2012; Hossain et al., 2015). Length-length relationships (LLRs) are also considered as an essential parameter to detect the population structure for executing sound management strategy of a specific fish species (Sabbir et al., 2022). Further, the calculation of form factor (a3.0) usually indicates the body structure of teleost fish species in a given ecosystem (Froese, 2006; Hossen et al., 2019). Nevertheless, the condition factor typically indicates the wellbeing of a fish stock in a wild environment by measuring several biological and ecological factors like growth, gonad development, reproductive fitness, survival and environmental status regarding feeding conditions (Mac Gregoer, 1959; Richter, 2007; Sabbir et al., 2020a).

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The Tank Goby, scientifically known as *Glossogobius giuris* belongs to the family Gobiidae within Gobiiformes order, and is predominantly distributed throughout the freshwater and estuaries of the Indian subcontinent (Talwar & Jhingran, 1991). This species typically inhabits clear to turbid water-body with rocky or sandy bottoms including streams, marshlands and ponds (Allen**,** 1991). *G. giuris* is typically known as "*Bele*" in Bangladesh. The feed items of *G. giuris* consist of crustacean, insects and small fish (Rainboth, 1996). Besides, cannibalism is somewhat frequent in this species (Hossain et al., 2009). Spawning usually takes place in freshwater body as noted by Manacop **(**1953). Remarkably, this species is considered as "least concern" globally regarding conservation status (IUCN, 2022). *G. giuris* is an important food fish for the people of south-east Asia and provides a source of nutrition with a high market price. Therefore, *G. giuris* is a significant target fish for artisanal and large-scale fishermen (Kibria & Ahmed, 2005). Consequently, this species is chronologically misplacing its trendy appearance due to overharvesting with illegal fishing gears, modification of natural wetland habitat in to agricultural field, pollution and siltation (Sabbir et al., 2020b). In order to ensure the sustainability of *G. giuris*, the river and other wild aquatic wetland habitat need to be brought under proper management plan. Information regarding biometric indices is essential to develop suitable management and conservation strategy for any aquatic species in its wild ecosystem (Sabbir et al., 2023). While some research has been conducted regarding population parameters of *G. giuris* in different inland open-water ecosystem, there is a lack of data from inland closed water-bodies in Bangladesh (Table 1). Therefore, this research aims to fill the gap by investigating the biometric data of the *G. giuris* including LFDs, LWRs, LLRs, condition and form factor sampled from Bhutiyar *Beel* wetland ecosystem in southern Bangladesh on seasonal basis.

Table 1: Available studies on population parameters of *Glossogobius giuris* from different water-bodies.

Aspects	Country	References
Length-weight and morphometric relationships of *G. giuris*	Ganges River, northwestern Bangladesh	Hossain et al. (2009)
Length-weight relationship and condition factor of *G. giuris*	Manchar Lake, Sindh, Pakistan	Achakzai et al. (2014)
Population biology of *G. giuris*	Mekong Delta, Vietnam	Dinh et al. (2017)
Morphometric relationships of *G. giuris*	Gorai River, Bangladesh	Azad et al. (2018)
Length-weight relationship and condition factors of *G. giuris*	Lapompakka lake, South Sulawesi, Indonesia.	Suwarni et al. (2022)

Materials and methods

Specimen identification and data collection

The experimental specimen (*Glossogobius guiris*) was identified according to the distinctive identifying characters outlined in Rahman (2005). Together 300 individual specimens were harvested on seasonal basis (pre-monsoon, monsoon and post monsoon) with the help of native fishers during January to December, 2023 from the Bhutiyar *Beel* wetland ecosystem (Terokhada upazilla, Khulna district, southern Bangladesh) (Figure 1). After the harvest, fish samples were preserved in ice instantaneously to prevent decomposition. Specimens were washed carefully after arriving at laboratory. Moisture from the surface of each specimen was absorbed with blotting paper to ensure the exact body weight. Thereafter, different lengths (TL and SL) and body weight (BW) were documented.

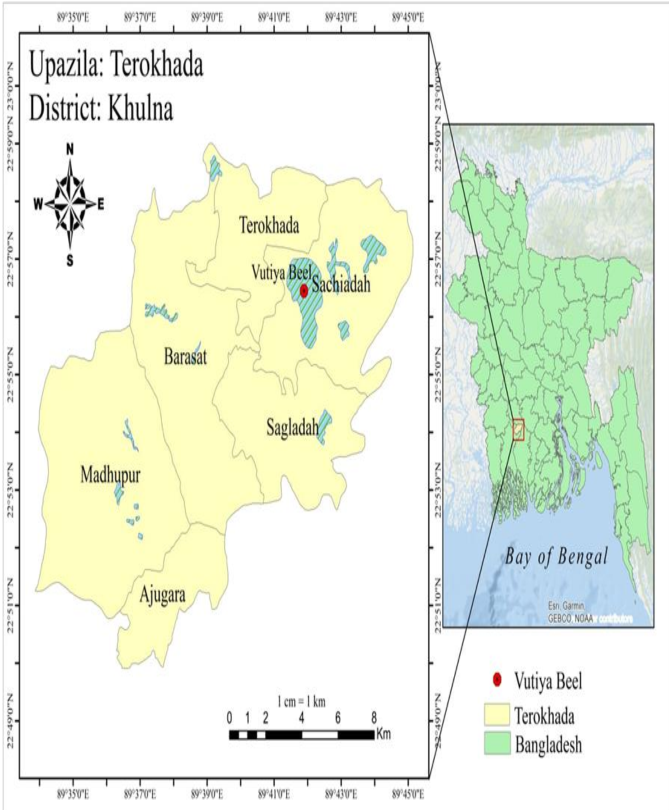

Figure 1. Location of the study area (Bhutiyar *Beel* wetland ecosystem, Terokhada upazilla, Khulna district, southern Bangladesh).

Determination of LFDs, LWRs and LLRs

The LFD of G. giuris was determined by assembling 1 cm intervals of TL. With the purpose of discovering growth pattern (b), LWRs was calculated as $W = a \times L^b$ (Tesch, 1968), where W represents the total body weight and L indicates the total length. Further, the value of *a* and *b* were assessed with linear regression analysis from natural logarithms: $\ln(W) = \ln(a) + b \ln(L)$. Moreover, LLRs (TL vs. SL) were explored through linear regression model (Hossain et al., 2006).

Form factor

Form factor ($a_{3.0}$) of *G. giuris* population was analyzed following the equation $a_{3.0}$ = 10log a-s(b-3) (Froese, 2006).

Determination of condition factors

The K_F was calculated as $K_F = 100\times (W/L^3)$ (Fulton, 1904), where W indicates the BW in g and L is the TL in cm.

Statistical analysis

Microsoft® Excel-add-in-DDXL software was used for data analysis considering the significance level at 5%.

Results

LFDs

The LFD of *G. guiris* displayed that the size ranged from 5.9 to 16.4 cm TL. The highest TL was recorded 16.4 cm in post-monsoon. The lowest size was documented 5.9 cm in post-monsoon as well. The study also showed that the body weight ranged from 1.80 to 43.70 g for the pooled data set (Table 2). Further, LFD specified that 10.00 to 10.99 TL group was more susceptible to fishing mortality (Figure 2).

Growth pattern

As a whole '*b*' value for *G. guiris* denoted negative allometric growth pattern (b < 3.00) (Figure 3). Although positive allometric growth pattern (b > 3) was found in monsoon. All LWRs were found highly correlated with all r^2 values ≥ 0.945 (Table 3). Further, LLR (TL vs. SL) was found significantly correlated with r^2 = 0.967(Figure 4).

Form Factor

The projected form factor ($a_{3.0}$) was 0.0068 indicated eel-like body shape of the experimental specimen (Froese, 2006).

Table 2: Total length (cm) and body weight (g) measurements of *Glossogobius guiris* from the Bhutiyar *Beel*, southern Bangladesh.

Season	*n*	TL (cm)				BW (g)			
		Min	Max	Mean ± SD	95% CL	Min	Max	Mean ± SD	95% CL
Pre-Monsoon	100	6.7	16.1	11.92±2.67	11.40-12.46	2.38	28.01	13.93±7.20	12.50-15.36
Monsoon	100	7.3	15.0	11.33±1.50	11.04-11.64	4.09	32.71	12.93±5.93	11.76-14.12
Post-Monsoon	100	5.9	16.4	10.97±1.84	10.60-11.33	1.80	43.70	13.23±6.98	11.85 - 14.62

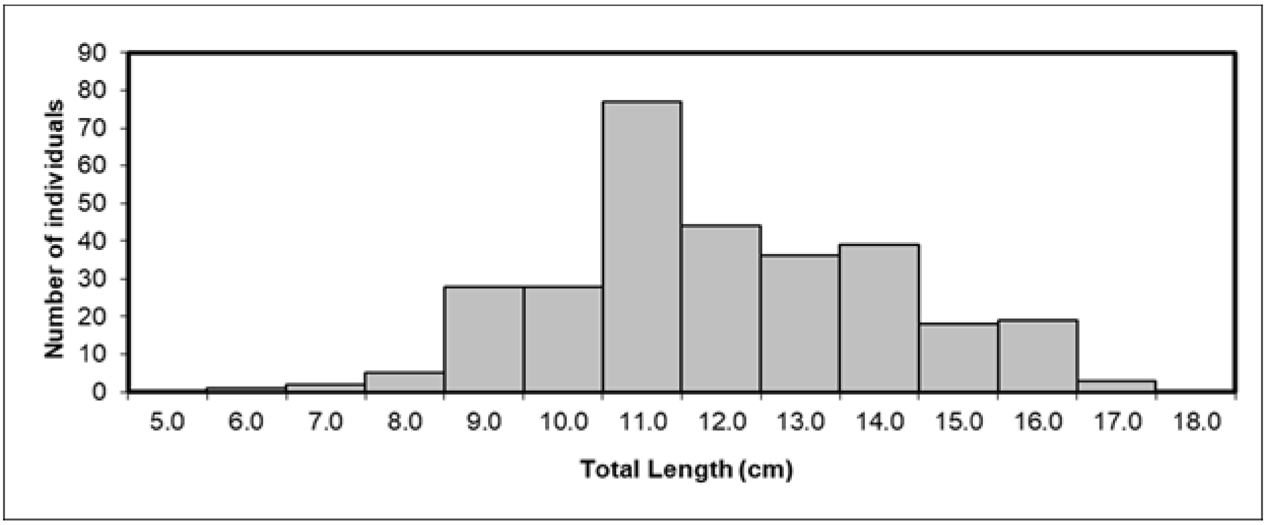

Figure 2. LFDs of *Glossogobius guiris* from the Bhutiyar *Beel*, southern Bangladesh

Table 3: Seasonal variation of LWRs of *Glossogobius guiris* from the Bhutiyar *Beel*, southern Bangladesh.

Season	*n*	Regression parameters		95% CL of *a*	95% CL of *b*	r^2	GT
		a	*b*				
Pre- Monsoon	100	0.0188	2.63	0.0162 -0.0218	2.57 -2.69	0.987	-A
Monsoon	100	0.006	3.16	0.0039-0.0080	3.01-3.31	0.945	+A
Post-Monsoon	100	0.0128	2.87	0.0093-0.0176	2.73-3.00	0.945	-A

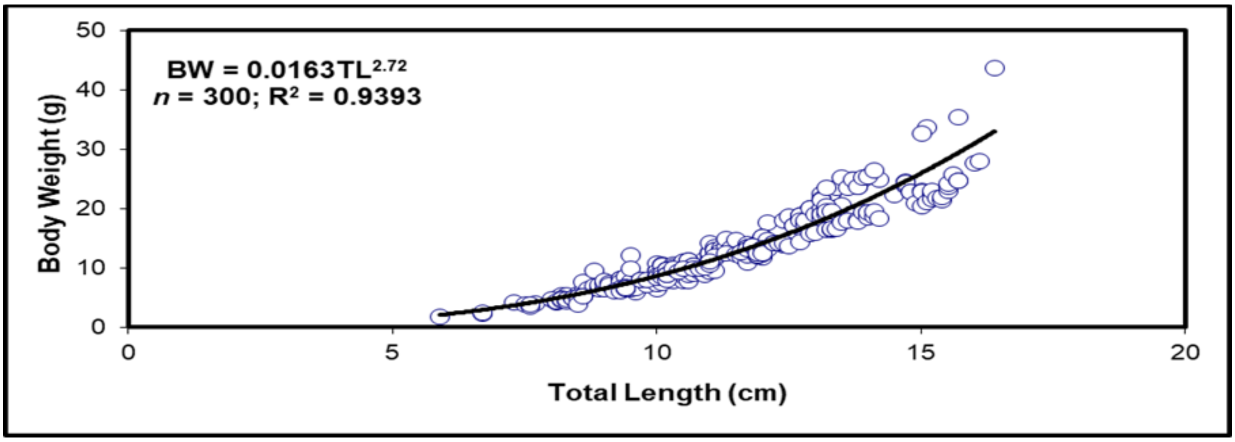

Figure 3. Relationships between TL and BW of *Glossogobius guiris* from the Bhutiyar *Beel*, southern Bangladesh.

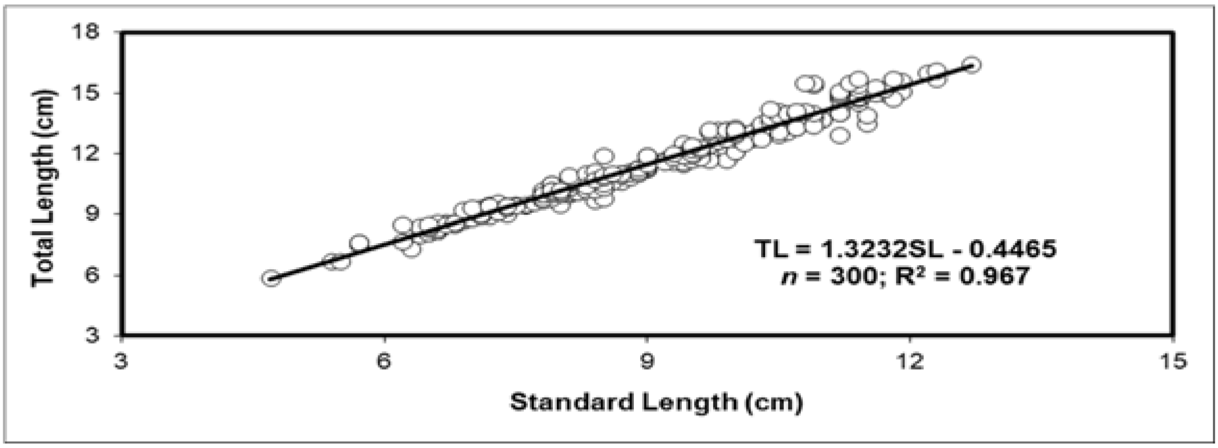

Figure 4. TL vs. SL relationship of *Glossogobius guiris* from the Bhutiyar *Beel*, southern Bangladesh.

Fulton's condition factor (K_F)

The minimum and peak K_F values were recorded as 0.58 and 1.41 in pre-monsoon and post-monsoon season, respectively (Table 4; Figure 5). The average K_F value was found near to 1 only in post-monsoon.

Table 4: Seasonal variation of K_F value of *Glossogobius guiris* from the Bhutiyar *Beel*, southern Bangladesh.

Season	*n*	Fulton′s condition factor (K_F)			
		Min	Max	Mean±SD	95% CL
Pre-Monsoon	100	0.58	0.93	0.76±0.08	0.74-0.77
Monsoon	100	0.66	1.08	0.83±0.08	0.82-.85
Post-Monsoon	100	0.65	1.41	0.93±0.11	0.91-0.96

Discussion

Information regarding length-frequency distributions (LFDs) is crucial for detecting the recruitment pattern of a particular species (Hossain et al., 2006). Additionally, LFDs provide insights into the status of a particular fish stock, breeding period, mortality rate as well as river health (Sabbir et al., 2020a). Similarly, data on length-weight relationships (LWRs) are essential for evaluating the life history traits of a fish stock among different geographical arenas (Rahman et al., 2019). Likewise, knowledge about length-length relationships (LLRs) is a key component to recognize the growth pattern of a fish species (Sabbir et al., 2022). Moreover, a number of eco-physiological factors are reliant on LLRs (Hossain et al., 2006).

In this study, we encountered difficulties sampling fish smaller than 5.9 cm TL possibly due to the large mesh size of the fishing gears or fishermen failing to select the suitable locations where smaller specimens reside (Hossen et al., 2019). The recorded peak TL for the experimental specimen was 16.4 cm with body weights varying from 1.80 to 43.70 g.

However, Achakzai et al. (2014) recorded the TL ranged from 4.8 to 22.0 cm and BW varied from 2.1 to 125.1 g for pooled sample from Manchar Lake, Sindh, Pakistan. Similarly, Hossain et al. (2009) reported the TL ranged between 11.30 to 23.60 cm and BW deviated from 11.10 to 98.20 g from the Ganges River, northwestern Bangladesh. Further, Azad et al. (2018) stated that TL varied from 4.3 to 26.9 cm and BW ranged from 0.67 to 146.55 g for pooled data of *G. guiris* harvested from Gorai River Bangladesh. Likewise, Suwarni et al. (2022) recorded that TL ranged between 0.97 to 2.49 cm and BW differed from 0.90 to 7.00 g for pooled sample. The variation of growth rate might be occurred due to availability of food and feeding activities as well as difference in the ecosystems where the species inhabits (Suwarni et al., 2022). It is notable to mention that data regarding TL is indispensable to evaluate the

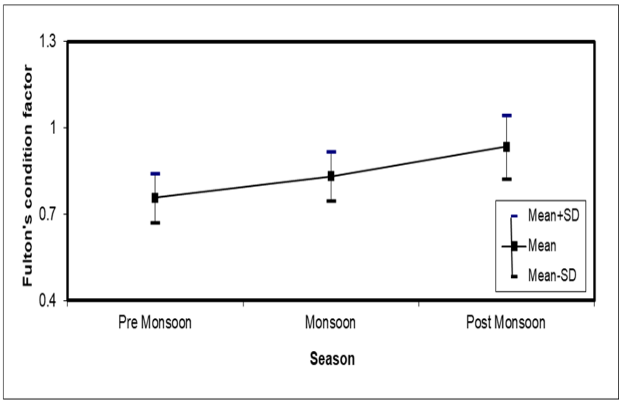

Figure 5. Average K_F value of *Glossogobius guiris* from the Bhutiyar *Beel*, southern Bangladesh.

asymptotic length as well as growth co-efficient of fishes in order to formulate proper fisheries management policy (Khan et al., 2023; Sabbir et al., 2020a).

The range of allometric co-efficient (*b*) of the LWRs should vary between 2.0 to 4.0 as suggested by Carlandar (1969). On the other hand, Froese (2006) claimed that the value of '*b*' should be ranged from 2.5 to 3.5 in case of teleost fish species. In the current research, the value of slope '*b*' was deviated between 2.63 (pre-monsoon) to 3.16 (monsoon). Therefore, our result is comparable with the findings of Froese (2006). Further, the overall *b* value (2.72) indicated negative allometric growth pattern ($b < 3.00$) for *G. giuris* inhabiting in Bhutiyar *Beel* wetland ecosystem. Similarly, Achakzai et al. (2014) reported negative allometric growth pattern for male, female and combined sex from Manchar lake, Sindh, Pakistan. Hossain et al. (2009) reported isometric growth pattern (b=3) for the combined sex of *G. giuris* collected from Padma River, northwestern Bangladesh. On the other hand, Azad et al. (2018) documented negative allometric growth pattern (b=2.91) for the experimental species sampled from Gorai River, southwest Bangladesh. The variation of the regression parameter '*b*' may be occurred in the same species populating different habitats due to season, gonadal development, availability of feed, pH, dissolved oxygen, physiological condition and age (Tesch, 1968; Hossain et al., 2015; Sabbir et al., 2023). Further, the LLR (TL *vs.* SL) was documented strongly correlated ($r^2 = 0.967$) for the sampled specimens. But literature regarding LLR of *G. giuris* is insufficient elsewhere and we did not make any comparison with other research. that data regarding TL is indispensable to evaluate the asymptotic length as well as growth co-efficient of fishes in order to formulate proper fisheries management policy (Khan et al., 2023; Sabbir et al., 2020a).

Form factor ($a_{3.0}$) typically indicates the shape of body of teleost fish species in a particular aquatic ecosystem. The form factor ($a_{3.0}$) was estimated 0.0068 for *G. guiris* population indicated eel- like body shape (Froese, 2006). However, we found no previous literature to compare our findings.

In recent decade, fish is considered the main protein source for the global population. Consequently, the physical status of a particular fish species should be exposed in an aquatic ecosystem in order to execute successful conservation program. Typically, the condition factor index is used to denote the wellbeing of fish in its wild habitat (Ahmed et al., 2012; Sabbir et al., 2020b). Condition factor denotes the real condition of fish health including fitness level, sexual maturity and survival (Richter, 2007). Fulton's condition factor is used frequently to detect the status of fish health in a natural ecosystem (Rahman et al., 2023). The higher condition value denotes that the fish inhabit in a good environment with healthier condition (Hossain et al., 2017; Sabbir et al., 2023). Our study is the first effort to explain the Fulton's condition factor (K_F) of *G. guiris* sampled from Bhutiyar *Beel*, southern Bangladesh. During the study period, the Fulton's condition factor was found higher (1.41) in post-monsoon and lower (0.58) in pre-monsoon. The mean K_F value was found well below 1 indicated an unhealthy condition of *G. guiris* sampled from the Bhutiyar *Beel*, southern Bangladesh. We found no reference about the K_F elsewhere, making it difficult to compare our findings with other studies.

Conclusion

The overall *b* value revealed negative allometric growth pattern. Further, form factor denoted eel-like body shape and the K_F index indicated an unhealthy status for *G. guiris*. Finally, our findings would be helpful and effective to conduct further stock assessment program of *G. guiris* population in the Bhutiyar *Beel*, southern Bangladesh.

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Conflict of Interest

The authors declare no conflict of interest.

References

Achakzai, W.M., Achakzai, S.W.M., Baloch, W.A., Qambrani, G.R., & Soomro, A.N. (2014). Length-weight relationship and condition factor of tank goby *Glossogobuis giuris* (Hamilton and Buchannan, 1822) from Manchar Lake District Jamshoro, Sindh, Pakistan. *Sindh University Research Journal*, *46*(*2*), 213-216.

Ahmed, Z.F., Hossain, M.Y., & Ohtomi, J. (2012). Condition, length-weight and length-length relationships of the silver hatchet Chela, *Chela cachius* (Hamilton, 1822) in the old Brahmaputra River of Bangladesh. *Journal of Freshwater Ecology*, *27*, 123-130.

Alam, M.F. & Thomson K.J. (2001). Current constraints and future possibilities for Bangladesh fisheries. *Food policy*, *26*, 297-313.

Allen, G.R. (1991). Field guide to the freshwater fishes of New Guinea. Publication, no. 9. 268 p. Christensen Research Institute, Madang, Papua New Guinea.

Azad, M.A.K., Hossain, M.Y., Khatun, D., Parvin, M.F., Nawer, F., Rahman, O. & Hossen, M.A. (2018). Morphometric relationships of the Tank goby *Glossogobius giuris* (Hamilton, 1822) in the Gorai River using multi-linear dimensions. *Jordan Journal of Biological Sciences*, *11*(*1*), 81-85.

Carlander, K.D. (1969). Handbook of freshwater fishery biology, Vol. 1. The Iowa State University Press, Ames, IA.

DoF (Department of Fisheries). (2023). National fish week, compendium (in Bengali). Dhaka: Department of Fisheries, Ministry of Fisheries and Livestock, Government of Bangladesh.

Froese, R. (2006). Cube law, condition factor and weight length relationship: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, *22*, 241-253.

Fulton, T.W. (1904). The rate of Growth of Fishes, 22nd Annual Report, part III. Edinburg: Fisheries Board of Scotland.

Hossain, M.Y., Ahmed, Z.F., Leunda, P.M., Islam, A.K.M.R., Jasmine, S., Oscoz, J., Miranda, R., & Ohtomi, J. (2006). Length-weight and length-length relationships of some small indigenous fish species from the Mathabhanga River, southwestern Bangladesh. *Journal of Applied Ichthyology*, *22*(*4*), 301-303.

Hossain, M.Y., Ohtomi, J., Ahmed, Z.F., Ibrahim, A.H.M., & Jasmine, S. (2009). Length-weight and morphometric relationships of the Tank Goby *Glossogobius giuris* (Hamilton, 1822) (Perciformes: Gobiidae) in the Ganges of Northwestern Bangladesh. *Asian Fisheries Science*, *22*, 961-969.

Hossain, M.Y., Sayed, S.R.M., Rahman, M.M., Ali, M.M., Hossen, M.A., Elgorban, A.M., Ahmed, Z.F., & Ohtomi, J. (2015). Length-weight relationships of nine fish species from the Tetulia River, southern Bangladesh. *Journal of Applied Ichthyology*, *31*, 967–969.

Hossain, M.Y., Hossen, M.A., Khatun, D., Nawer, F., Parvin, M.F., Rahman, O., & Hossain, M.A. (2017). Growth, condition, maturity and mortality of the Gangetic leaf fish *Nandus nandus* (Hamilton, 1822) in the Ganges River (Northwestern Bangladesh). *Jordan Journal of Biological Sciences*, *10*, 57-62.

Hossen, M.A., Paul, A.K., Hossain, M.Y., Ohtomi, J., Sabbir, W., Rahman, O., Jasmin, J., Khan, M.N., Islam, M.A., Rahman, M.A., Khatun. D., & Kamruzzaman. Sk. (2019). Estimation of biometric indices for Snakehead *Channa punctata* (Bloch, 1973) through Multi-model inferences. *Jordan Journal of Biological Sciences*, *12*, 197-202.

Hussain M.G. & Mazid. M.A. (2001). Genetic improvement and conservation of carp species in Bangladesh. Bangladesh Fisheries Research Institute and International Center for Living Aquatic resource Management. p.74.

Ilah, N.E.F., Abedin, M.J., Alice, E.J., Laboni, T.A., Khatun, M.S., Sarmin, M.S., Rahman, M.A., Rahman, O., Islam, M.A., Siddquy, M.A.F., & Hossain, M.Y. (2023). Growth and conditions appraisal of *Atropus atropos* (Carangidae) in the Bay of Bengal. *Sarhad Journal of Agriculture*, *39*(*4*), 823-831.

IUCN (2022). The IUCN Red List of Threatened Species. Version 2022-2. Downloaded 10 Feb, 2023.

Khan, M.N., Tissa, I.J., Sabbir, W., Mahfuj, S., Asadujjaman, M., & Das, A. (2023). Population structure of Indian river shad, *Gadusia chapra* (Hamilton, 1822) from the Rupsha River, south-west Bangladesh. *Bangladesh Journal of Fisheries*, *35*(*1*), 43-56.

Kibria, G., & Ahmed, K.K.U. (2005). Diversity of selective and nonselective fishing gear and their impact on inland fisheries in Bangladesh. *NAGA, Worldfish center newsletter*, *28*, 43-48.

King, M. (2007). Fisheries Biology, Assessment and Management. 2nd edition, Oxford Press, London, pp. 382.

Mac Gregoer, J.S. (1959). Relation between fish condition and population size in the sardine (*Sardinops cacrulea*). U.S. Fishery Wild Servic. *Fishery Bulletin*, *60*, 215-230.

Manacop, P.R. (1953). The life history and habits of the goby, *Sicyopterus extraneus* Herre (Anga) Gobiidae with an account of the goby-fry fishery of Cagayan River, Oriental Misamis. *The Philippine Journal of fisheries*, *2*(*1*):1-60.

Mawa, Z., Hossain, M.Y., Hasan, M.R., Rahman, M.A., Tanjin, S., & Ohtomi, J. (2022). Life history traits of *Mystus vittatus* in the Ganges River, Bangladesh: recommendation for its sustainable management considering climate change. *International Journal of Biometeorology*, *66*, 927-943.

Rahman, A.K.A. (2005). Freshwater fishes of Bangladesh (2nd edition). Zoological society of Bangladesh. Department of Zoology, University of Dhaka, Bangldesh. 333 p.

Rahman, M.A., Hasan, M.R., Hossain, M.Y., Islam, M.A., Khatun, D., Rahman. O., Mawa, Z., Islam, M.S., Chowdhury, A.A., & Khatun, H. (2019). Morphometric and meristic characteristics of the Asian stinging catfish *Heteropneustes fossilis* (Bloch, 1794): A key for its identification. *Jordan Journal of Biological Sciences*, *12* (*4*), 467-470.

Rahman, M.A., Manon, M.R.K., Ullah, M.R., Alam, A., Islam, M.J., Siddik, M.A.B., & Iqbal, M.M. (2023). Biometric indices, growth pattern, and physiological status of captive-reared indigenous Yellowtail brood catfish, *Pangasius pangasius* (Hamilton, 1822). *Environmental Science and Pollution research*, *30*(*35*): 1-13.

Rainboth, W.J. (1996). Fishes of the Cambodian Mekong. FAO species identification field guide for fishery purposes. FAO, Rome, 265 p.

Richter, T.J. (2007). Development and evaluation of standard weight equations for bridge-lip suckers and large-scale suckers. *North American Journal of Fisheries Management*, *27*, 936-939.

Sabbir, W., Hossain, M.Y., Rahman, M. A., Hasan, M.R., Khan, M.N., Mawa, Z., Tanjin, S., Sarmin, M.S., Rahman, O., Nima, A., & Habib, K.A. (2020a). Growth pattern of the Hooghly Croaker *Panna heterolepis* Trewavas, 1977 in the Bay of Bengal (Bangladesh) in relation to eco-climatic factors. *Egyptian Journal of Aquatic Biology and Fisheries*, *24*(*7*), 847-862.

Sabbir, W., Hossain, M.Y., Rahman, M.A., Hasan, M.R., Mawa, Z., Tanjin, S., Hasan, H.Ul., & Ohtomi, J. (2020b). First report on condition factor of *Panna heterolepis* (Trewavas, 1977) in the Bay of Bengal (Southwestern Bangladesh) in relation to eco-climatic factors. *Egyptian Journal of Aquatic Biology and Fisheries*, *24*(*2*), 591-608.

Sabbir, W., Rahman, M.A., Hossain, M.Y., Hasan, M.R., Mawa, Z., Rahman, O., Tanjin. S., & Sarmin, M.S. (2021). Stock assessment of Hooghly Croaker *Panna heterolepis* in the Bay of Bengal (Southern Bangladesh): implication for sustainable management. *Heliyon*. https://doi.org/10.1016/j.heliyon.2021.e07711

Sabbir, W., Hossain M.Y., Khan, M.N., Rima, F.A., Sarmin, M.S., & Rahman, M.A. (2022). Biometric indices of Flathead Sillago, *Sillaginopsis panijus* (Hamilton, 1822) from the Bay of Bengal (Southern Bangladesh). *Thalassas: An International Journal of Marine Sciences*. https://doi.org/10.1007/s41208-022-00421-9

Sabbir, W., Rahman, A., Asadujjaman, M., Mahfuj, S., Khan, M.N., & Meraz, M.M. (2023). Sex ratio and biometric indices of Pama Croaker, *Otolithoides pama* (Hamilton, 1822) from the Bay of Bengal, south-west Bangladesh. *Khulna University Studies, 20*(*2*), 46-57.

Suwarni., Kadir, F.N., Tresnati, J., Kudsiah, H., & Rahim, S.W. (2022). The length weight relationship and condition factors of Tank Goby *Glossogobius giuris* Hamilton, 1822 in Lapompakka Lake, Wajo Regency, South Sulawesi. *IOP conference series: Earth and Environmental Science*, **DOI** 10.1088/1755-1315/1119/1/012026

Talwar, P.K., & Jhingran, A.G. (1991). Inland Fishes of India and Adjacent Countries, Vol. I, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi-Calcutta. pp. 136-137.

Tesch, F.W. (1968). Age and Growth. In: Methods for assessment of fish production in Freshwaters. Edited by Ricker, W. E. Oxford: Blackwell Scientific Publications.