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Population Dynamics of Freshwater Shark (*Wallago attu,* Bloach Schneider 1801) from Bhadar Reservoir of Gujarat, India

N.A. Pargi[1] and Hari Prasad Mohale[2*]

[1]College of Fisheries Science, Junagadh Agricultural University, Veraval (Gujarat), India.
[2]Department of Fisheries Biology and Resource Management
Fisheries College & Research Institute (TNJFU), Thoothukudi (Tamil Nadu), India.

(Corresponding author: Hari Prasad Mohale)*
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ABSTRACT: The current study focused on the *Wallago attu* (freshwater shark) population dynamics parameters and examined them using monthly length frequency data that were gathered from the Bhadar Reservoir in Gujarat, India, between July 2018 and February 2019. To assess the total length (TL) and weight (W) of *W. attu*, 328 specimens total were collected. The estimated TL and W ranged from 31.5 cm to 109.5 cm and 28g to 5200g, respectively. For both sexes, the length-weight association was W=0.001 L=3.299 with R2 = 0.987. The parameters for the von Bertalanffy growth function were L=96.39 cm and K=0.71 yr^{-1}. The growth performance indices for L_∞ and W_∞ were computed as Ø' = 3.819 and Ø=1.247 respectively. At an average yearly water surface temperature of 28°C, the natural mortality rate was 1.03 years per one. The overall instantaneous mortality was 1.00 $years^{-1}$, with a 95% confidence interval of 1.05 to 1.42 (r^2=0.987). The present exploitation ratio is -0.03yr^{-1}, and fishing mortality was -0.03yr^{-1}. The recruitment process continued all year, with a significant surge occurring in (June-July) at 17.22-18.90 percent. FiSAT-II examined the Beverton-Holt yield per recruit model; the maximum exploitation rate (E*max*) was 0.94, E 0.9's calculated value was 0.10. The degree of exploitation, which will cause a 50% drop in B/R compared to virgin biomass (E0.2), was 0.78. Gulland (1971) said that E values above 0.5 indicate the overfishing of a species in an area. The exploitation rate, E=0.59, was less than the E-*max* (0.94) and suggested the fish was under-harvested in the Bhadar reservoir.

Keywords: Fish, Bhadar reservoir, Asymptotic length, Growth, Mortality.

INTRODUCTION

One of the twenty megafishes on Earth is the Asian silurid catfish, *Wallago attu*, often known as the "Asian sheat catfish" or the "freshwater shark" (Rufus *et al.,* 2015). *W. attu* is a member of the Siluridae family and is found in freshwater environments in places like India, Pakistan, Burma, and the East Indian Archipelago. At least 3,407 species in over 37 families make up the catfish genus, which makes up about 10.8% of all fish species and 5.5 percent of all vertebrate species in the world (Jonathan, 2011). It has also recently been reported that it is transported from India as a native ornamental fish (Gupta, 2015). Major carp or catfish play a prominent role among freshwater fish due to their flavor, high market value, and commercial significance both at home and abroad (Ahmed *et al.,* 2003). In the aquaculture industry, eastern and north-eastern India generate the majority of the catfish (De, 2017).

A stock is a subset of a species that has distinctive morphometric characteristics, lives in a certain geographic region, and exhibits homogenous growth and mortality rates (Sparre and Venema 1998). The VPA calculates how many fish must have been in the water to account for that capture based on the observations of a number caught for each age/length group and also from independent assessments of the natural mortality. The trade-off between catching a lot of fish early in life and catching a smaller number of bigger fish later in life is examined through yield per recruit models (Gheshlaghi *et al.* (2012). The traditional Beverton and Holt (1957) yield per recruit model takes into account the relationship between yield and age at initial catch, growth, and fishing mortality.

MATERIALS AND METHODS

The current study was carried out at the Bhadar reservoir (location), which is near Bhukhi Village, Dhoraji, Taluka of the Rajkot district of Gujarat at 21°76′28"N 70°42′37"E. We used a site-developed multi-stage stratified random sampling technique for sampling. Every month, we randomly selected multistage-size sets of fish from various locations as part of this sampling strategy. Major samples of both sexes of *W. attu* were taken between July 2018 and February 2019 using commercial gill nets with a mesh size of 25 to 30 mm. Materials were collected, preserved in the field with a formalin solution containing 5%, and then evaluated in the laboratory. The von Bertalanffy growth function (VBGF) was used to estimate the growth parameters of L_∞ (asymptotic length) and K (growth coefficient) by the ELEFAN I routine

integrated with FiSAT II software (FAO, ICLARM stock assessment tool) (Gayanilo *et al.,* 2005; Gayanilo and Pauly 1997). A total of 328 specimens of *W. attu* were in the length range of 31.5 cm - 109.5 cm.

For estimating the length-weight relationship (LWR), the formula was modified as $W=aL^b$, Where *L* is the total length (cm), *W* is the body wet weight (gm), '*a*' is the intercept of the regression, and '*b*' is the regression coefficient. The equation $W=aL^b$ can be linearly represented as *Log W=Log a+b Log L*. The values of '*b*' and '*Log a*' in the equation were estimated using the least square regression method. The growth performance index was calculated from final estimates of Asymptotic length (L_∞) and Growth coefficient (K) Pauly & Munro (1984), using the formula: Phi (Ø) = LogK + 2 $\log L_\infty$, where, Phi (Ø) = growth performance index, L∞ = asymptotic length, and K= growth coefficient. Natural mortality (M) was calculated by formula, as M= - ln(0.01)/ t_{max} (Alagaraja, 1984). Total mortality (Z) was calculated from the length converted catch curve using FiSAT software. Fishing mortality (F) was estimated by the formula, F = Z - M; where, F = fishing mortality, Z = total mortality, and M = natural mortality.

To determine the fishing mortalities for each length class, FiSAT's length-structured virtual population analysis (VPA) was applied. The equations presented below (Narsimham, 1994) were used to determine the exploitation ratio (E) and exploitation rate (U) as follows: E = F/Z, where F is fishing mortality, Z is overall mortality, E is exploitation ratio, and U is F/Z. (1-e-z). E=F/Z=F/(F+M) was used to determine the exploitation ratio (E). According to FiSAT II, reverse projection on the length axis of the list of available length frequency data was used to establish the stock's recruitment pattern. To determine the fishing mortalities per length class, the length-structured Virtual Population Analysis (VPA) for *W. attu* was performed using the input values of the LWR parameters intercept (a), slope (b), asymptotic length (L), growth coefficient (K), and mortality parameters values of natural mortality (M) and fishing mortality (F). The length or age shown as Lc or tc is the length or age at which an animal is 50% vulnerable to capture and 100% susceptible to gear exploitation. It is a crucial element for the dynamic pool model developed by Beverton and Holt in 1957 when estimating the yield per recruit. To choose an appropriate approach, it is necessary to determine various probabilities of capture at 50% of the fish entering the gear.

RESULTS AND DISCUSSION

For determining the length-weight relationship, a total of 328 specimens were employed, of which 165 males and 162 females with lengths ranging from 31.5 cm to 109.5 cm were employed, with the results shown separately for combined males and females (Fig. 1). The result of the calculation was:

Male: BW = 0.001315 × (FL) $^{3.29}$ (r = 0.98)

Female: BW = 0.00094 × (FL) $^{3.38}$ (r = 0.98)

A combination association was found since there was no discernible difference between the slopes of males and females at the 5 percent level. According to the current study, *the W. attu* slope of the regression equation differed noticeably (5%) from the isometric value of 3, showing that the species has grown allometrically. While R^2 values demonstrated a strong linear association between length and weight, the weight of the two fish showed a significant difference (P<0.01/P>0.05) concerning time. The two metrics had a good association, with the correlation coefficient (r) being found to be 0.98. Rufus *et al.* (2015) reported similar findings on the relationship between length and weight B values from the rivers in central Kerala, India, ranging from 2.7 to 3.5 of *W. attu* from three tiny westward-flowing rivers of Peninsular India.

In *Garra gotyla gotyla* Das and Biswas (2016), discovered that the value of the exponent "b" was substantially larger in females than in males. Shendge (2009) discovered that the freshwater catfish *Clarias batrachus* from Bharamati, Pune, had a correlation coefficient (r) of 0.9824. In their 2013, study of *Nemacheilus moreh* Kharat and Khillare discovered that the coefficients of correlation for males and females, respectively, were r = 0.988 and r = 0.989, showing a positive connection between length and weight measures. In their study on length-weight relationships, Khristenko and Kotovska (2017), discovered that for females, males, and mixed sexes, respectively, $W=0.0094 \times SL^{3.2545}$ (R^2 = 0.9882), $W=0.0133 \times SL^{3.1318}$ (R^2=0.9832), and $W = 0.0106 \times SL^{3.2098}$ (R^2 = 0.9848) All samples from the Middle Dnieper, or Kremenchuk Reservoir, showed positive allometric growth (b>3).

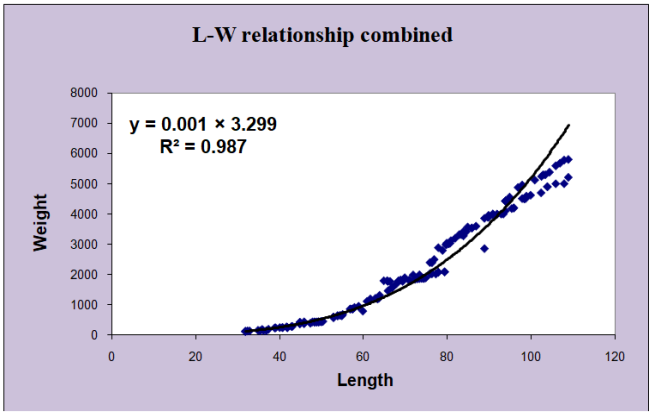

Fig. 1. Length – Weight relationship of *W. attu* (Male & Female).

Table 1: Estimated key parameter of growth, mortality, exploitation, and yield of *W. attu* from Bhadar reservoir, Gujarat from July 2018 to February 2019.

Population parameters	*W.* attu from Bhadar reservoir, Gujarat
Intercept (*a*)	0.001315
Exponent (*b*)	3.29921
Coefficient of determination (*R2*)	0.98
Asymptotic length ($L\infty$)	96.39 cm
Growth coefficient (*K*)	0.71 yr-1
Total mortality (*Z*)	1.00 1.24yr-1 *CI 95%* of 1.05–1.42 (*r*2=0.987)
Natural mortality (*M*)	1.03 yr-1
Fishing mortality (*F*) *F=Z-M=*	-0.03 yr-1
Exploitation ratio (*E*) *E=F/Z=*	-0.03
Mean water temperature	28 °C
GPI *Ø′* ($L\infty$)	3.819
GPI *Ø* ($W\infty$)	1.247
Sample size (n)	328
Size range	31.5-109.5cm

To create the ideal growth curve, ELEFAN-I, a component of the FiSAT package, employed the initial extreme length value shown in Fig. 2a. The growth coefficient (K) for the VBGF was 0.7171yr^{-1}. The ELEFAN I routine's goodness fit index (Rn) was 0.544, making it the best option for combining the growth parameters L_∞ (asymptotic length) and K (growth coefficient) of 96.39 cm and 0.71 yr^{-1}. The von Bertalanffy growth parameters of L_∞ and *K* were used to estimate the growth performance indices (phi prime or index *Ø′ and Ø*) for *W. attu* of the reservoir of Gujarat as *Ø* '= 3.819 and *Ø*=1.247 respectively (Fig. 2b). The VBGF curve through graphical representations is shown in Fig. 3.

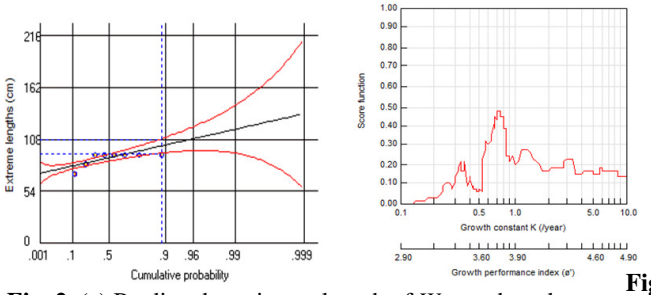

Fig. 2. (a) Predicted maximum length of *W. attu* based on extreme value theory with a 95% confidence interval, obtained from the intersection of overall maximum length. (b): Ks can routine for determining the best growth curvature which gives the best value of asymptotic length with growth performance indices *Ø′* for *W. attu* from Bhadar reservoir, Gujarat.

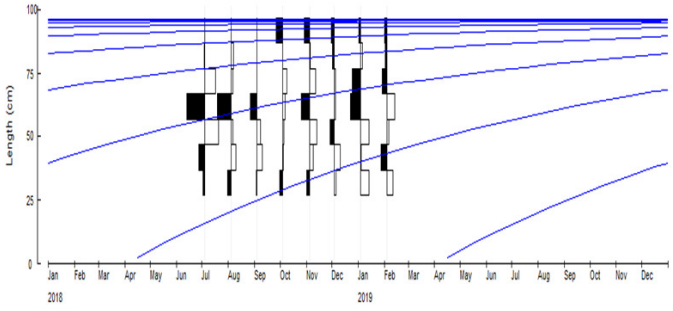

Fig. 3. ELEFAN–I assessment revealed the growth curves for *W. attu* where L_∞ *and K* were 96.39cm, 0.71yr^{-1}, respectively.

According to the input values of the VBGF growth parameters (L_∞ and K) in the length converted catch curve model, the total mortality (Z) was 1.00 year-1 with a CI 95 percent of 1.05-1.42 (r^2 = 0.987) (Fig. 4 and Table 1). A 1.03 year^{-1} natural mortality (M) was recorded. As a result, fishing mortality (F) was calculated as the natural mortality divided by total mortality (F=Z-M) as F =-0.03 year^{-1}, and exploitation ratio (E) as E = -0.03. Through input values of VBGF growth parameters, the recruitment pattern (Fig. 5) displays a single yearly peak recruitment each year.

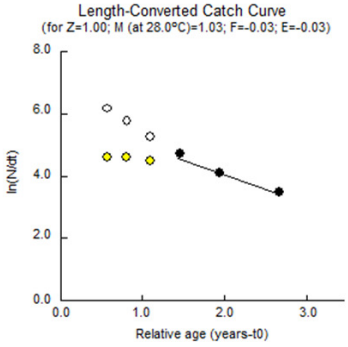

Fig. 4. Mortality parameters *viz. M. F*, *Z* and *E* of *W. attu* applying growth parameter (L_∞ = 96.39 cm and *K*=0.71yr^{-1}).

The recruitment of migrant breeding stock is likely what caused the highest peak (June–July) of 17.22–18.90 percent. The type of net used for fishing (commercial gill nets) was utilized to determine the probability of capture.

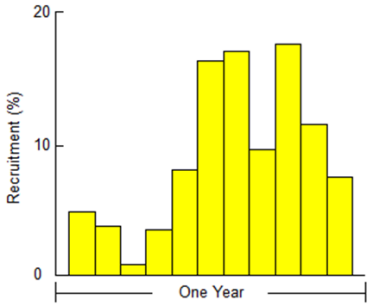

Fig. 5. Recruitment pattern of *W. attu* from Bhadar reservoir, Gujarat.

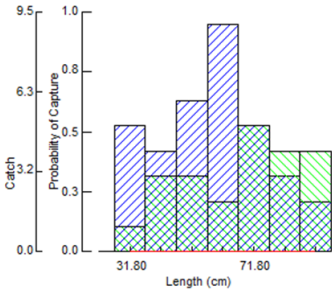

Fig. 6. Length at capture *(L50)* of *W. attu* from Bhadar reservoir, Gujarat.

For the *W. attu* from Bhadar reservoir, Gujarat, the von Bertalanffy growth parameters (L∞ and K), natural mortality (M), terminal F/Z (Ft) considered to be 0.5, and length-weight relationship factors (a and b) were utilized to create the length structured virtual population analysis. FiSAT-II performed a cohort analysis to produce visualizations for LVPA (Fig. 7). The greater fishing mortality was measured at a length between 80 and 90 cm.

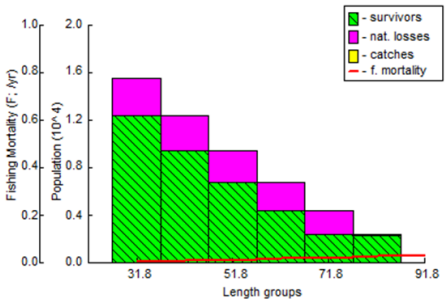

Fig. 7. Length-Structured Virtual Population Analysis (LVPA) of *W. attu.*

A population's response to fishing mortality on a per-recruit basis depends on natural mortality (M), fishing mortality (F), growth rate (K, from the von Bertalanffy growth equation), age at first recruitment (tr), and age (tc) at first capture. Yield per recruitment was estimated using the Beverton-Holt yield equation (depends on gear selectivity). Using the knife edge approach of FiSAT II, the relative Y/R and B/R analyses of *W. attu* were calculated (Fig. 8a). Isopleths that were carefully chosen to represent fishing activities displayed (Fig. 8b) at their best L50/L∞ of 0.2 and M/K of 1.00 served as the analysis's input parameters.

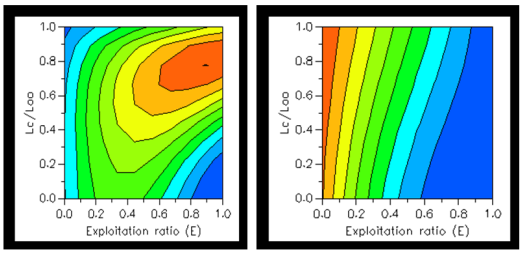

Fig. 8. (a) Stock status of *W. attu* using Beverton and Holt's relative Y/R analysis using knife edge; 8(b) Isopleths estimated by selection ogive, showing optimum fishing activity both in terms of fishing effort and size of first capture (depicted with a star in the central curve) for *W. attu.*

Knife edge selection was used to estimate the relative Y/R and B/R analyses of *W. attu,* and the results showed that the maximum exploitation rate (E*max*) was 0.94. E 0.9's calculated value was 0.10. The degree of exploitation, which will cause a 50% drop in B/R compared to virgin biomass (E0.2), was 0.78 (Fig. 8b). Gulland (1971) said that E values above 0.5 indicate the overfishing of a species in an area. The exploitation rate, E=0.59, was less than the E-*max* (0.94) and suggested the fish was under-harvested in the Bhadar reservoir.

In Gujarat's Bhadar Reservoir, the current study marks the first attempt to analyze the population dynamic parameters of the *W. attu* near threatened catfish species. According to the study, *W. attu* had asymptotic lengths of 96.39 cm and growth rates of 0.71 yr^{-1} for both pool sexes. According to Thella *et al.* (2018), the asymptotic length (L_∞) and growth coefficient (K) in the state of Kerala in southern India were 99.75 cm and 0.98 yr^{-1}, respectively. The VBGF characteristics of *W. attu* at the Bhadar reservoir in Gujarat have never been documented before.

According to Rabby *et al.* (2022), *Plotosus canius* asymptotic length (*L*∞) and growth rate (K) are 93.25 mm and 0.28 $year^{-1}$, respectively.

According to Beverton and Holt (1957), longevity and the length of the asymptotic (*L*∞) are inversely correlated with the coefficient of natural mortality (M), which is proportional to the growth coefficient K of a fish. According to the current study, *W. attu* overall mortality, natural mortality, and fishing mortality were each 1.00 yr^{-1}, 1.03 yr^{-1}, and -0.03 yr^{-1} per individual, respectively. Roshni *et al.* (2020) found that total mortality (Z), natural mortality (M), and fishing mortality (F) of African catfish *Clarias gariepinus* were 1.34 yr^{-1}, 1.43 yr^{-1}, and 0.50 yr^{-1} respectively. According to the results of the current study, fishing mortality was lower than the natural mortality rate in the Bhadar reservoir. Predation, senility, stress from the environment, parasite effects, and disease make up the majority of the elements that determine the natural death rate.

There are many variables involved in comparing growth rates, including the growth rate (K) and asymptotic length (*L*∞). It is simple to express the little difference between the growth performance index (*Ø′*) and other alternative indicators as the growth performance index (*Ø′*) response to von Bertalanffy's growth parameter requirements. The growth performance index, GPI (*Ø′*), was 3.66 in the Western Ghats hotspot in India, according to Roshni *et al.,* (2020). According to the current study, composite sex had a GPI (L_∞) value of 3.81, which is deemed to be slow growth. According to Pauly and Munro (1984), the parameter Phi prime (*Ø′*) serves as a gauge for the consistency of the projected growth parameters for stocks belonging to the same or closely related species. Higher numbers indicate higher growth. GPI compares the growth performance of the fish species with different populations of the same or other environmental fish populations.

The von Bertalanffy growth parameters (L_∞ and K) support this index as well because it makes the program

between the species and growth easier (Mehanna and Salem 2011). Apart from the genetic structure, determining the growth potential of a species, overfishing, dietary patterns, and their utilization in terms of the growth performance of a specific species. One of the fundamental components to support the level of fishery utilization is the exploitation ratio (Kaunda *et al.,* 2003). When fishing mortality rates are equal to natural mortality rates, utilization is at its highest level (Gulland, 1971). According to Roshni *et al.* (2020), *C. gariepinus* has an exploitation level (E) of 0.37. According to Gulland (1971), when the exploitation ratio surpasses 0.5, the stock is deemed to have been overfished or overexploited.

The current study's calculation of the exploitation rate, 0.94, suggested that the *W. attu* stock was overexploited, and if we do not take action soon, it may be endangered or on the verge of extinction (Panhwar and Liu 2013). Fisheries resource conservation and management increasingly frequently employ the degree of fishing fatality. The most typical application of F*max* is in fisheries management (Tesfaye and Wolff 2015). Knife edge selection was used to estimate the relative Y/R and B/R analyses of *W. attu,* and the results showed that the maximum exploitation rate (E*max*) was 0.94. E 0.9's calculated value was 0.10; the degree of exploitation, which will cause a 50% drop in B/R compared to virgin biomass (E0.2), was 0.78. Gulland (1971) said that E values above 0.5 indicate the overfishing of a species in an area. The exploitation rate, E=0.59, was less than the E-*max* (0.94) and suggested the fish was under-harvested in the Bhadar reservoir.

CONCLUSIONS

Using monthly length frequency data that were collected from the Bhadar Reservoir in Gujarat, India, between July 2018 and February 2019, the current study focused on the *Wallago attu* (freshwater shark) population dynamics factors and investigated them. 328 specimens in total were gathered to measure the total length (TL) and weight (W) of *W. attu.* The estimated TL and W ranged from 31.5 cm to 109.5 cm and 28g to 5200g, respectively. For both sexes, the length-weight association was W= 0.001 L= 3.299 with R2 =0.987. The parameters for the von Bertalanffy growth function were L= 96.39 cm and K= 0.71 yr-1. The growth performance indices for L∞ and W∞ were computed as Ø'= 3.819 and Ø= 1.247 respectively. At an average yearly water surface temperature of 28°C, the natural mortality rate was 1.03 years. The overall instantaneous mortality was 1.00 years-1, with a 95% confidence interval of 1.05 to 1.42 (r^2= 0.987). The present exploitation ratio is -0.03 yr^{-1}, and fishing mortality was -0.03 yr^{-1}. The recruitment process continued all year, with a significant surge occurring in (June-July) at 17.22-18.90 percent. FiSAT-II examined the Beverton-Holt yield per recruit model; the maximum exploitation rate (E*max*) was 0.94 and, E 0.9's calculated value was 0.10. The degree of exploitation, which will cause a 50% drop in B/R compared to virgin biomass (E0.2), was 0.78. Gulland (1971) said that E values above 0.5 indicate the overfishing of a species in an area. The exploitation rate, E=0.59, was less than the E-*max* (0.94) and suggested the fish was under-harvested in the Bhadar reservoir.

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REFERENCES

Ahmed, K. K. U., Amin, S. M. N., Haldar, G. C. and Dewan, S. (2003). Population dynamics and stock assessment of *Catla catla* (Hamilton) in the Kaptai Reservoir, Bangladesh. *Asian Fisheries Science*, *16*(1), 121 - 132.

Alagaraja, K. (1984). Simple methods for estimation of parameters for assessing exploited fish stocks. *Indian Journal of Fisheries*, *31*(2), 177-208.

Beverton, R. J. H. and Holt, S. J. (1957). On the dynamics of exploited fish populations. *Fish Investigation Sciences, 11*(19), 533.

Das, K. and Biswas, S. P. (2016). Length-Weight Relationship and Condition Factor of a Hillstream Fish *Garra gotyla gotyla* (Gray) From Noa-Dihing River, Arunachal Pradesh. *International Journal of Engineering and Technology, 3*(6), 8-16.

De Jong, J. (2017). Aquaculture in India. Rijksdienst voor Ondernemend Nederland *(Interprise Agency), Netherlands*.

Gayanilo, F. C. and Pauly, D. (1997). FAO ICLARM stock assessment tools (FiSAT), References Manual*, FAO Computerized Information Series (Fisheries), 8,* 262.

Gayanilo, F.C., Sparre, P. and Pauly D. (2005). The FAO-ICLARM Stock Assessment Tool (FiSAT) User's Guide. *FAO Computerized Information Series (Fisheries),* FAO, Rome: Worldfish Center, 1-168.

Gheshlaghi, P., Vahabnezhad, A., Taghavi Motlagh, S. A. (2012). Growth parameters, mortality rates, yield per recruit, biomass, and MSY of *Rutilus frisii* using length frequency analysis in the Southern parts of the Caspian Sea. *Iranian Journal of Fisheries Sciences, 11*(1), 48-62.

Gulland, J.A. (1971). Estimation of mortality rates. Annex to Artic fisheries working group report. *ICESC. M. Doc*. 3 (a) (mimeo), *46*(10), 1986-1995.

Gupta, S. (2015). *Wallago attu* (Bloch and Schneider, 1801), a threatened catfish of Indian waters, *5*(4), 140 - 142.

Jonathan, A. W. (2011). Global Catfish Biodiversity.*In*: *American Fisheries Society Symposium*, *77*(1), 15-37.

Kaunda Arara, B., Rose, G. A., Muchiri, M. S. and Kaka, R. (2003). Long-term trends in coral reef fish yields and exploitation rates of commercial species from coastal Kenya. *Western Indian Ocean Journal of Marine Science*, *2*(2), 105-116.

Khristenko, D. S. and Kotovska, G. O. (2017). Length-Weight Relationship and Condition Factors of Freshwater Bream *Abramis brama* (Linnaeus, 1758) from the Kremenchug Reservoir, Middle Dnieper. *Turkish Journal of Fisheries and Aquatic Sciences*, *17*(1), 71-77.

Mehanna, S. F. and Salem, M. (2011). Population dynamics of round sardine Sardinella aurita in El-Arish waters, southeastern Mediterranean, Egypt. *Indian Journal of Fundamental and Applied Life Sciences*, *1*(4), 286-294.

Narasimham, K.A. (1994). Fishery and population dynamics of the ribbon fish *Trichiurus lepturus* Linnaeus off Kakinada. *Journal of marine Biological Assosociation*. India, *36*(1), 23-27.

Panhwar, S.K. and Liu, Q. (2013). Population statistics of the migratory hilsa shad, *Tenualosa ilisha*, in Sindh, Pakistan. *Journal of Applied Ichthyology*, *29*(5), 1091-1096.

Pauly, D. and Munro, J. I. (1984). Once more on the comparison of growth in fish and invertebrates. *Fish Byte*, *2*(1), 21-23.

Rabby, A. F., Haque, M. A., Islam, M. A., Hasan, S. J., Rahman, M. A. and Mahmud, Y. (2022). Population dynamics of Gray eel catfish (Plotosus canius Hamilton, 1822) at mangrove estuary in Bangladesh. *Iranian Journal of Fisheries Sciences*, *21*(1), 247-263.

Roshni, K., Renjithkumar, C.R., Raghavan, R., Dahanukar, N. and Kutty, R. (2020). Population dynamics and management strategies for the invasive African Catfish *Clarias gariepinus* (Burchell, 1822) in the Western Ghats hotspot. *Journal of Threatened Taxa*, *12*(10), 16380-16384.

Rufus, T., Eldho, P. S., Anvar Ali, N. D. and Raghavan, R. (2015). Length-weight relationship and condition factor of a large predatory catfish, *Wallago attu* (schneider, 1801) from the rivers of central Kerala, India. *Journal of Aquatic Biology & Fisheries 3*(1), 105 - 110.

Shendge, A. N. (2009). Length-weight relationship in freshwater cat fish *Clarias batrachus* (Linn.). *Journal of the Indian Fisheries Association*, *36*(1), 21- 24.

Sparre, P. and Venema, S. C. (1998). Introduction to tropical fish stock assessment. Part 1. Manual. FAO fisheries technical paper. No. 306.1, Rev. (2) FAO. Rome, 1-407.

Tesfaye, G. and Wolff, M. (2015). Stock assessment of fishery target species in Lake Koka, Ethiopia. *Revista de biologia Tropical*, *63*(3), 755-770.

Thella, R., Dahanukar, N., Eldho, P. S., Ali, A. and Raghavan, R. (2018). Population dynamics of Wallago attu (Bloch and Schneider 1801) (Osteichthyes, Siluridae) in three small rivers of Southern India. *Asian Fisheries Science*, *31*(1), 172-178.

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