

Stock Assessment of Three Cyprinid Fishes Along the Potamon Zone of Thamirabarani River, Eastern Slope of Western Ghats, South India

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Authors' Contribution

RD carried out research work and drafted the manuscript. PJ narrated the work and executed the experiment. NJ critically reviewed the manuscript and condensed the matter and CS analysed the data. SKD had reviewed the manuscript and shared idea of analysis and interpretation part. ES aligned the manuscript and critically reviewed and checked grammatical mistakes and omitted repetitions in the manuscript. RS critically reviewed the manuscript and checked grammatical mistakes. PP checked corrections and gave broad ideas in field sampling. All authors interpreted the data and critically reviewed the manuscript and approved the final version.

Key words

Cyprinid fishes, Length frequency, LWR, Stock status, VBGF growth function, CPUE, Thamirabarani River basin, South India conservation

ABSTRACT

Effective management of inland capture fisheries requires information about size, growth and mortality parameters and catch per unit effort. The estimated slope b values for three cyprinids were found to be within the expected range and r^2 showed high degree of correlation. The estimated growth parameters of Mirgal, *Cirrhinus mrigala* (Hamilton, 1832) (L_{∞} 89.25 cm, K 0.8y⁻¹), Blackspot barb, *Dawkinsia filamentosa* (Valenciennes, 1844) (L_{∞} 22.05 cm, K 0.68y⁻¹) and Roho labeo, *Labeo rohita* (Hamilton, 1822) (L_{∞} 47.25 cm, K 0.71y⁻¹) and the mortality parameters of *C. mrigala* (Z 2.14 y⁻¹, M 1.22 y⁻¹ and F 0.92 y⁻¹), *D. filamentosa* (Z 2.42 y⁻¹, M 1.54 y⁻¹ and F 0.88 y⁻¹) and *L. rohita* (Z 2.87 y⁻¹, M 1.42 y⁻¹ and F 1.46 y⁻¹). The estimated exploitation ratios (E) for the three species were 0.43, 0.36 and 0.51, respectively. The mean CPUE was 0.9136 kg / hr / craft. This study would suggest good inland capture fishery management plan in the potamon zone of the river Thamirabarani.

INTRODUCTION

India is one among the 12 mega biodiversity hotspot areas in the world. It has vast inland fishery resources and contributes a good amount of capture fisheries production.

Rivers and associated open water bodies remained the mainstay of inland capture and culture fisheries production in India with its biodiversity consisting of 930 fish species belonging to 326 genera (IFSI, 2021).

India ranks number one in inland fisheries production achieves 1.8 million tonnes. In India, total inland fish production was estimated to be 10.437 MMT in 2019-20. Among the inland fish producing states, the Andhra Pradesh occupied first place in inland fish production with a record production of 3.61 MMT followed by West Bengal (1.619 MMT) and Uttar Pradesh (0.699 MMT), while in Tamil Nadu it was 0.174 MMT. Among the various inland fisheries resources, the production of Indian major carps (IMC) was estimated to be 5.95 MMT during 2019-20. However, IMC fish production was 0.054 MMT in Tamil

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Nadu (DoF, 2020).

Capture fisheries production from inland open waters, especially river system has either remained stagnant or shown a net decline over the years. The reasons for declining fish catch from inland capture fisheries are complex. There are critical gaps and constraints that are hampering the growth of the inland fisheries sector, which need to be addressed sooner. Important ones among them are decline in fish catch; depletion of natural resources; over-exploitation of natural fish stocks; lack of a reliable database; non-availability of suitable fish yield models for multi-species fisheries for inland open waters; weak multi-disciplinary approach; inadequate attention to environmental, economic, social and gender issues; poor technology transfer and anthropogenic interventions resulting in loss of biodiversity; pollution of open water bodies; introduction and spread of exotic invasive aquatic species; contamination of indigenous fish germplasm resources (IFSI, 2021). Tropical Asia has a rich ichthyofaunal diversity with cyprinids predominant, particularly carps in India (Jhingran, 1991; Welcomme, 1979).

Thamirabarani, a major east-flowing river with a catchment area of 5482 km² (CWC, 1987) is a medium sized river basin in India, but a major river system in southern Tamil Nadu. It originates from the Pothigai hills of southern Western Ghats at an altitude of 2074 m, meanders through a distance of 120 km (24 km in hilly terrain and 96 km in plains) in Tirunelveli and Thoothukudi districts of Tamil Nadu and drains into the Bay of Bengal (Selva *et al.*, 2012). The trend patterns (1980-2018) as well as temporal and spatial variability of rainfall and its river discharge clearly shows that the Thamirabarani river basin is under climatic impacts over the period of time. There are two major water polluting industries situated near to Thamirabarani River Namely M/s. Madura Coats Private Limited and M/s. Sun Paper Mill Limited (Malarvizhi and Ravikumar, 2021). In addition, the analysis of physico-chemical characteristics of this river water suggested that Thamirabarani River is contaminated with various effluents (Sheebha-Malar *et al.*, 2018).

Martin *et al.* (2000) studied the ichthyofaunal diversity from Thamirabarani River based on principal component analysis and the diversity indices, the authors have observed and become evident that the anthropogenic activities in Thamirabarani river system have major impact on the species richness and abundance in this river. Diversity indices appear to be the most sensitive measures for assessing their response to pollution. Although influenced by river regulation and pollution at different points. The Thamirabarani River and its tributaries support a rich ichthyofaunal diversity compared to that

of other Indian rivers. In India, only a very few lesser stock assessment studies have been made in the riverine ecosystem particularly in the river Thamirabarani. In this context, the present study would pave the way to give an insight on length-weight relationship, growth and mortality characteristics, exploitation ratio, catch per unit effort and relative CPUE of three economically important species mirgal, *Cirrhinus mrigala* (Hamilton, 1832), blackspot barb, *Dawkinsia filamentosa* (Valenciennes, 1844) and roho labeo, *Labeo rohita* (Hamilton, 1822) occurring along the potamon zone of Thamirabarani River.

MATERIALS AND METHODS

The length-weight relationships (LWR) and stock status study was undertaken for one-year during November 2020-October 2021. Length, weight, length frequency (LF) data were collected fortnightly for three fish species viz., *C. mrigala*, *D. filamentosa* and *L. rohita* along the potamon zone of Thamirabarani river basin in Tirunelveli and Thoothukudi districts of Tamil Nadu. Map showing study areas in the Thamirabarani River is given in Figure 1.

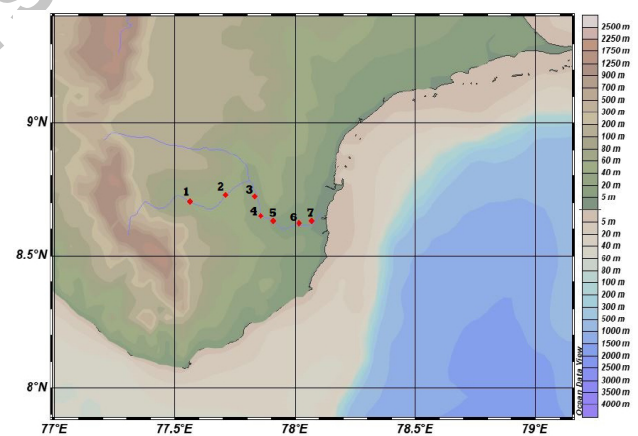


Fig. 1. Map showing study area along the potamon zone of Thamirabarani River in Tirunelveli and Thoothukudi districts. 1, Cheranmahadevi; 2, Vannarpettai; 3, Murappanadu; 4, Karungulam; 5, Srivaikuntam; 6, Eral and 7, Authoor.

Estimation of length weight relationship and growth parameters

The fish specimens were examined based on morphological features and fish identification was confirmed using the field guides developed by Talwar and Jhingran (1991), Jayaram (1994), Jhingran (1991), Menon (1999) and FishBase (Froese and Pauly, 2022). A digital

vernier caliper and ruler were used to measure the total length (TL) to the nearest 0.1 cm and analytical digital balance was used to record total body weight to the nearest 0.001 g.

The length and weight data were collected to estimate length-weight relationships (LWR) using the cube law $W = a * L^b$ (Le Cren, 1951).

The von Bertalanffy growth parameters (VBGF) growth parameters like asymptotic length (L_{∞}), growth coefficient (K) were estimated using the ELEFAN I developed by Pauly and David (1987) using FiSAT II software package (Gaynilo *et al.*, 2005).

The VBGF equation follows:

$$L_t = L_{\infty} [1 - \exp(-K * (t - t_0))]$$

The growth performance index (ϕ) was calculated from final estimates of asymptotic length (L_{∞}) and growth coefficient (K) (Pauly and Munro, 1984) using the formula as below:

$$\Phi(\phi) = \log K + 2 \log L_{\infty}$$

Estimation of mortality parameters

The total instantaneous mortality coefficient (Z) was estimated by length converted catch curve method using FiSAT software. The natural mortality coefficient (M) was estimated by Pauly's Equation (Pauly, 1984) considering the mean annual habitat temperature (29 °C), asymptotic length (L_{∞}) and growth coefficient (K) of VBGF growth equation. The coefficient of fishing mortality (F) was calculated using the following relationship:

$$Z = F + M$$

Exploitation ratio (E) was estimated from the following equation:

$$E = F/Z$$

Estimation of catch per unit effort (CPUE) and relative CPUE

To assess the standing stock, total annual stock, maximum sustainable yield and to optimize the catch per unit effort, the required data were collected during the

study period. The catch and effort data were collected using various fishing gears namely seine net, cast net, gill net of various mesh sizes viz., 70, 90, 120 and 180 mm, fish traps and poleand line in Thamirabarani river basin. Besides, number of active fishing hours per day, fishing days per month, craft and gear, total effort, data on monthly catch (kg), CPUE and relative CPUE were also assessed using Microsoft Office Excel data analysis. The catch of commercial fish species was recorded in a fishing day and was multiplied with effort in terms of hours in the day of observation to obtain the daily estimates. The daily catch estimates multiplied by the number of fishing days of the corresponding month were used to estimate the monthly catch. Total effort in fishing days was estimated by multiplying the mean monthly effort (Brema, 2018).

RESULTS

LWR and relative condition factor

The LWR is a practical index which is being used for studying mathematical relationship between two variables, length and weight of finfish for general understanding of science or enhancing knowledge on survival, growth, maturity, reproduction and general wellbeing of fish (Haniffa *et al.*, 2006). The results of LWR and relative condition factor values inclusive of sample size, Bayesian estimates and regression statistics are provided in Table I.

In the present study, the slope b value was found to deviate from 3 (2.8850) indicating negative allometric growth in length is higher compared to growth in weight. The linear regression curve for *C. mrigala* is shown in Figure 2A. The estimated LWR for this species is $W = 0.02699 \text{ TL}^{2.8850}$.

In the present study, the slope b value was found to be less than 3, indicating negative allometric growth (2.57756) meaning that fish become slimmer with increasing length. The linear regression curve for *D. filamentosa* is shown in Figure 2B. The estimated LWR for this species is $W = 0.01137 \text{ TL}^{2.5757}$.

Table I. LWR estimates for three cyprinid species, *C. mrigala*, *D. filamentosa* and *L. rohita* of the river Thamirabarani.

Species	N	TL (cm)	TW(g)	Kn	Regression parameters				
		Range	Range		a	95% CI a	b	95% CI b	r ²
<i>Cirrhinus mrigala</i> (Hamilton, 1822)	36	6.2-65.0	3.20-3800	1.2285	0.02699	0.0089-0.08	2.8850	2.5565 - 3.2135	0.9505
<i>Dawkinsia filamentosa</i> (Valenciennes, 1844)	79	2.9-18.4	0.05-13.30	1.0222	0.01137	0.0089-0.01	2.5757	2.4638 - 2.6875	0.9646
<i>Labeo rohita</i> (Hamilton, 1822)	110	5.1-49.0	3.20-3080	1.1237	0.00795	0.0053-0.01	3.1494	3.0020 - 3.2967	0.9427

N, sample; TL, total length; TW, total weight; a, intercept; b, slope of the linear regression; CI, confidence limits; r², coefficient of determination.

In the present study, the slope b value was found to be 3.1494, showing positive allometric growth indicating optimum conditions for growth. The linear regression curve for *L.rohita* is shown in Figure 2C. The estimated LWR for this species is $W = 0.0795 \text{ TL}^{3.1494}$

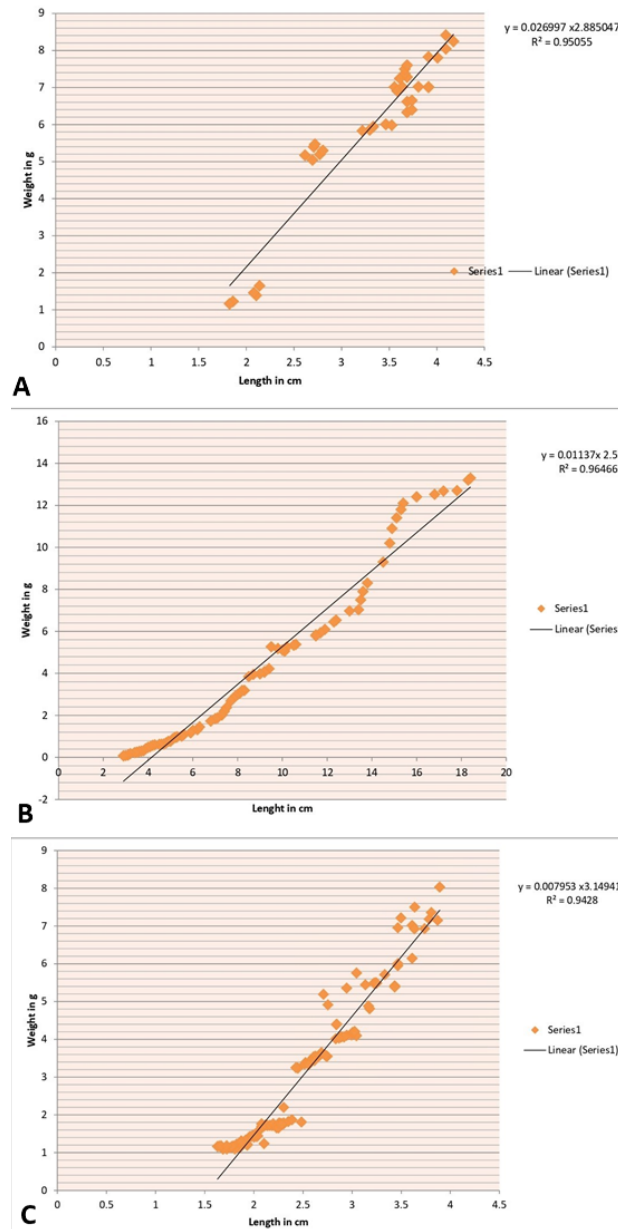


Fig. 2. Length weight relationship of *Cirrhinus mrigala* (A), *Dawkinsia filamentosa* (B) and *Labeo rohita* (C).

Growth and mortality parameters

The VBGF plot, growth performance index and length converted catch curve method for *C. mrigala* are shown in Figure 3A. The estimated growth, mortality parameters,

exploitation rate and growth performance index are shown in Table II.

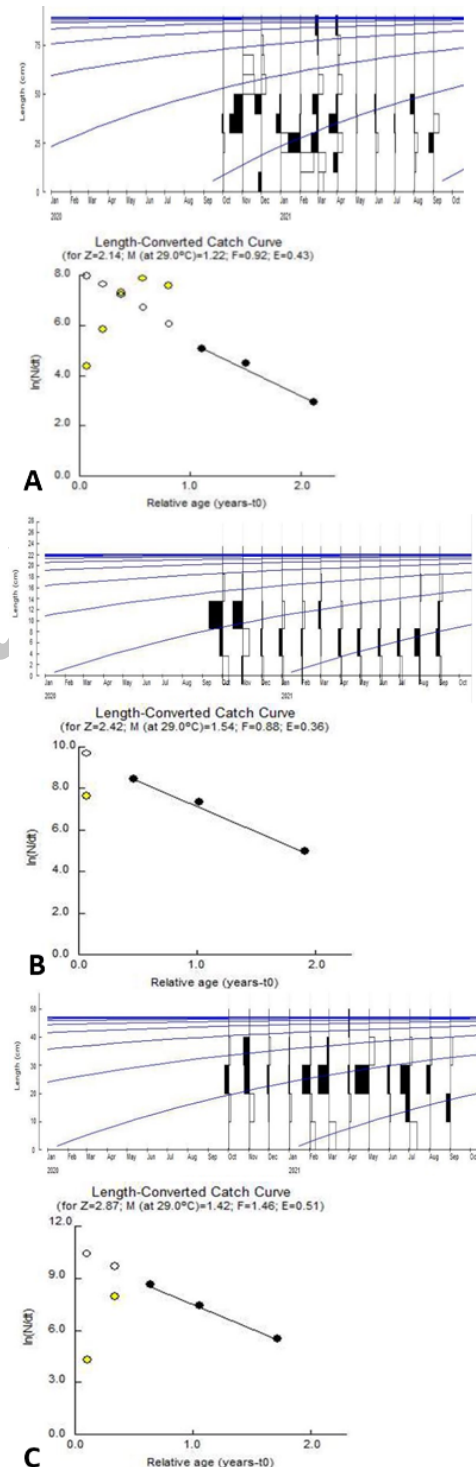


Fig. 3. Length converted catch curve of *Cirrhinus mrigala* (A), *Dawkinsia filamentosa* (B) and *Labeo rohita* (C).

Table II. Growth, mortality parameters, exploitation rate and growth performance index of three cyprinid fish species based on ELEFAN – I.

Species	L_{∞} (cm)	K (y^{-1})	Phi (ϕ)	
<i>Cirrhinus mrigala</i>	89.25	0.80	6.17997	
<i>Dawkinsia filamentosa</i>	22.05	0.68	4.51932	
<i>Labeo rohita</i>	47.25	0.71	5.46979	
	M (y^{-1})	F (y^{-1})	Z (y^{-1})	E (y^{-1})
<i>Cirrhinus mrigala</i>	1.223	0.92	2.14	0.43
<i>Dawkinsia filamentosa</i>	1.540	0.88	2.42	0.36
<i>Labeo rohita</i>	1.420	1.46	2.87	0.51

The natural mortality M was estimated to be higher ($1.223 y^{-1}$) than fishing mortality F ($0.92 y^{-1}$). The calculated E value was 0.43. The mean K was found to be $0.8 yr^{-1}$ indicating faster growth rate.

The VBGF plot, growth performance index and length converted catch curve method for *D. filamentosa* are shown in Figure 3B. The estimated growth, mortality parameters, exploitation rate and growth performance index are shown in Table II.

The natural mortality M was estimated to be higher ($1.54 y^{-1}$) than fishing mortality F ($0.88 y^{-1}$). The calculated E value was 0.36. The mean K was found to be $0.68 yr^{-1}$.

The VBGF plot, growth performance index and length converted catch curve method for *L. rohita* are shown in Figure 3C. The estimated growth, mortality parameters, exploitation rate and growth performance index are shown in Table II.

The natural mortality M was estimated to be lower ($1.42 y^{-1}$) than fishing mortality F ($1.46 y^{-1}$). The calculated E value was 0.51. The mean K was found to be $0.71 yr^{-1}$.

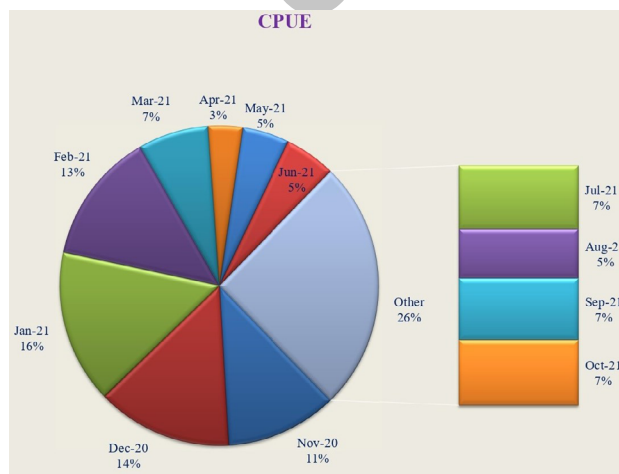


Fig. 4. The calculated CPUE.

Catch per unit effort (CPUE) and relative CPUE

The gear-wise fishing contribution was observed to be gill net (41%), cast net (11%), seine net (2%), fish traps (43%) and pole and line (3%) (Fig. 4) and the month wise fish catch contribution were found to be high during Dec 2020, January 2021 and February 2021 (Fig. 5). However, a minimum fish catch was observed during April 2021. The present mean CPUE is found to be 0.9136 kg/h/craft. In this present study, five major gears were recorded among which fish traps (43%) contributes major fish species followed by gillnet (41%), cast net (11%), pole and line (3%) and seine net (2%) respectively from the potamon zone of Thamirabarani River (Fig. 6).

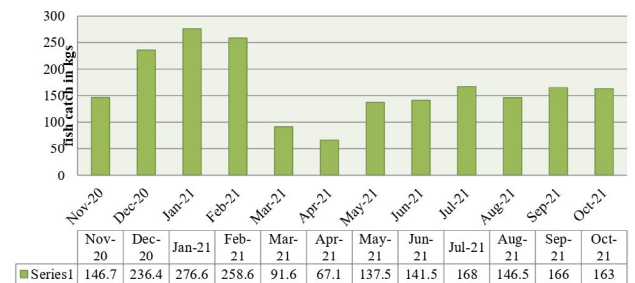


Fig. 5. Month-wise fish catch details.

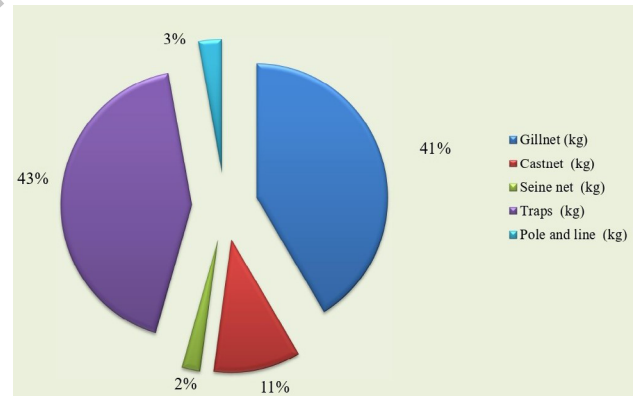


Fig. 6. Gear-wise fish catch composition.

DISCUSSION

LWR for *C. mrigala* (Mrigal)

Ritesh *et al.* (2019) reported a correlation coefficient 'r' value of 0.94 for *C. mrigala*. The value of exponent was observed to be 3.11 for *C. mrigala* that revealed positive allometric growth. The mean values of computed condition factor for all specimens of *C. mrigala* was 1.91 which indicated that good health condition in Sutiapat reservoir situated in Kabirdham district in Chhattisgarh. Nazir and Khan (2017) reported positive allometric growth

pattern ($b = 3.32$) for *C. mrigala* caught from Narora site of the river Ganga. Das *et al.* (2015) reported a slope value of 3.355 for *C. mrigala* from peninsular rivers of India. Mathialagan *et al.* (2014) established length-weight relationship of *C. reba* collected from Lower Anicut, Tamil Nadu and reported negative allometric growth ($b < 3$). In this study, the slope value of b showed negative allometric growth for *C. mrigala* and relative condition factor value for this species is above 1 indicating that well-being is satisfactory, attributed to that of the large sized fish catch was observed in Thamirabarani river. The similar finding was reported for *C. reba* from Lower Anicut (Cauvery river), Tamil Nadu.

LWR for *D. filamentosa* (Blackspot barb)

Sabaridasan *et al.* (2015) reported the better slope value 3.74 for *D. filamentosa* caught from Gundar River and 3.37 in Iluppaiyar River but the lowest slope value 2.13 obtained in Gadana river in southern Western Ghats, India. Thankam *et al.* (2018) observed an interesting variation in the slope b value with regard to lentic system in Pothundi, a manmade impoundment and a lotic system in Ayalampuzha in Palakad district of Kerala for *D. filamentosa*. The slope b value of 3.116 was recorded in the brackishwater lentic system indicating allometric growth pattern. However, the said value was 2.3184 in the manmade impoundment indicating a negative allometric growth. Renjithkumar *et al.* (2021) reported a slope b value of 2.944 for *D. filamentosa* indicating proximity towards isometric growth from the Chalakudy River, Western Ghats, India. This present study showed a negative allometric growth (2.575) and relative condition factor with r^2 (1.0222) was found to be significant (0.96) caught from the lower stretch of the Thamirabarani River. Similar findings were also obtained with the slope b value 2.3184 for the said species from Pothundi, a manmade impoundment in Palakad district of Kerala (lentic system) and the lowest slope value 2.13 obtained in Gadana river, southern Western Ghats, India and The b value of 2.246 for *P. Sarana* from Thamirabarani river showed negative allometric growth (Pon Saravana Kannan *et al.*, 2016).

LWR for *L. rohita* (Rohu)

Soni and Ujjania (2017) reported that a value b of 3.049 was obtained for *L. rohita* and showed positive allometric growth. The condition factor (K) and relative condition factor (Kn) estimated revealed the well-being of fish was good from Vallbhsagar reservoir, Gujarat, India. Ujjania *et al.* (2013) observed the slope value b as 2.98, 2.97 and 3.14 at three water bodies of southern Rajasthan for *L. rohita*. The value of Fulton's body condition factor ranged from 2.01-2.21 in the three water bodies revealing

the negative and positive allometric growth. Veerpal *et al.* (2019) reported that LWR on *L. rohita* (Hamilton) from the pond near Kalayat in Kaithal, Haryana, showed a negative allometric growth pattern with 'b' value 2.263. Sabinamol *et al.* (2019) reported slope 'b' value of 2.9087 for *L. rohita* caught from Cauvery River, Peninsular India. Ritesh *et al.* (2019) reported the slope value of 3.04 for *L. rohita* revealing isometric growth. The mean value of computed condition factor of *L. rohita* was 2.12 which indicated a good health condition in Sutiapat reservoir situated in Kabirdham district in Chhattisgarh. Das *et al.* (2015) reported from the peninsular rivers of India the slope b value of *L. rohita* was 3.313 and *L. fimbriatus* was 2.732. Renjithkumar *et al.* (2021) reported the slope b value of 2.49 for *L. dussumieri* indicating negative allometric growth from the Chalakudy River, Western Ghats, India. Compared with above findings, this present study obtained the slope b value of 3.1494 for *L. rohita* indicating positive allometric growth and often caught more with gill net in this Thamirabarani river as economically important cyprinid fish species. LWR estimates for three cyprinid fish species are presented in Table 1. The slope value b remained within the expected range from 2.5 to 4.0 (Hile, 1936; Martin, 1949). The r^2 was calculated to be 0.9505 (*C. mrigala*), 0.9646 (*D. filamentosa*) and 0.9428 (*L. rohita*) showing high degree of significance and reduces the ambiguity in the given specimens. The average relative condition factor value for combined sexes was found to be 1.2285 for *C. mrigala*, 1.0222 for *D. filamentosa* and 1.1237 for *L. rohita* revealing that overall well-being of these three studied indigenous freshwater fish species are satisfactory. Similar studies showed a slope b value of 2.1655 for *L. calbasu* and 2.8185 for *L. fimbriatus* from the river Thamirabarani (Brema, 2018). This basic biological information can be useful towards conservation and management of these economically important cyprinid fishes along the potamon zone of Thamirabarani river, South India.

Growth and mortality parameters of *C. mrigala*

Stock assessment involves the use of various statistical and mathematical calculations to make quantitative predictions about the reactions of fish populations to alternative management choices (Hilborn and Walters, 1992). Length data are generally much easier and cheaper to collect than age data. In many cases, age data are simply not available. Consequently, much attention has been paid in recent decades to the development of length-based stock assessment methods, often promoted as suitable for tropical fish stocks and data-limited fisheries (Sparre *et al.*, 1989; Sparre and Venema, 1998). The FAO FiSAT software package (Gayaniilo *et al.*, 1995) is dominated by

length-based methods, having evolved from two previous length-based tools: FAO's LFSA package and ICLARM's Compleat ELEFAN (Hoggarth *et al.*, 2006).

It is also interesting to note that K value was found to be high in *C. mrigala* and the same was less in *D. filamentosa*. However, K value was found to be intermediate in *L. rohita*. On comparing with M, the K value was found to be high in *C. mrigala* while M was found to be less on comparing with *D. filamentosa* and *L. rohita*. Such an inverse relationship was evident in *D. filamentosa*. Similar findings of inverse relationship were also observed in similar type of fish and other freshwater fish species viz., *L. rohita*, *O. niloticus* and also *C. mrigala* (Dwivedi and Nautiyal, 2012; Mayanak and Dwivedi, 2016; Ahmed *et al.*, 2004).

Ahmed *et al.* (2004) studied in Kaptai Lake, Bangladesh using the LF data with FiSAT software and found that the *C. mrigala* fishes are harvested at a lower level than the optimum fishing mortality. This fishing pressure should be reduced to near 1.02 from the present average level of mortality 1.21 / yr to obtain MSY of 31.49 tons. Wright *et al.* (2020) found that there is a similar growth and mortality rates between regions and VBGF L_{∞} = 447 and K = 0.320 for riverine golden perch (*Macquaria ambigua*) whereas in the present study it was observed that the maximum L_{∞} was 89.25 cm and K = 1.90 y^{-1} for *C. mrigala* among studied fishes.

In this present study, it was observed that the M is greater than F and reported under exploited and also recorded large sized fish catch of this species in this region. The E was recorded less than 0.5 showed near to optimum fishing pressure on this species. The L_{∞} was found to be more for *C. mrigala* and indicated near to optimum exploitation attributed to large size catch of this species.

Growth and mortality parameters of *D. filamentosa*

Pon Saravana Kannan *et al.* (2016) reported the growth parameters of *P. sarana* as L_{∞} 40.8 cm; K= 0.49 y^{-1} ; M/K = 1.86; and t_0 = - 0.53 and mortality parameters such as M = 0.91; F = 0.24; Z = 1.16 and E = 0.21. It is stated that the natural mortality was found to be high for *Puntius sarana* and concluded that as less exploited fishery. A similar finding was obtained from this study that the M was relatively more for *D. filamentosa* (1.54) and concluded that as under exploited fishery. It is evident that the E value 0.36 showing less exploited fishery in this region. The local fisher reported that it is often caught as bycatch or discard and high natural mortality indicated that more suitable habitat for this species.

Growth and mortality parameters of *L. rohita*

The von Bertalanffy's growth parameters, asymptotic

length (L_{∞}), growth coefficient (K) and age at zero length (t_0) for *L. fimbriatus* were 323.22 mm, 0.108 per year and -0.3241 years, respectively and for *L. calbasu* these values were 548.94 mm, 0.247 per year and -0.4241 years, respectively (Brema, 2018). Ahmed *et al.* (2005) revealed from his study in Kaptai Lake, Bangladesh that the *L. rohita* fishery is harvested at a higher level than the optimum fishing pressure. Dwivedi and Nautiyal (2012) reported that stocks of *L. rohita*, and *L. calbasu* from the Ken, the Paisuni and the Tons rivers in the Vindhyan region. Asymptotic length was maximum in *L. rohita* (946, 833 and 962 mm) and minimum in *L. calbasu* (567, 612 and 692 mm). The growth coefficient and total mortality was found to be maximum in *L. rohita* compared to *L. calbasu*. Fishing mortality was maximum in *T. tor* (2.46, 2.73 and 2.33) and minimum in *L. calbasu* (0.51, 1.21 and 1.18) while natural mortality was maximum in *L. rohita* (0.74, 0.94 and 1.86) and minimum in *L. calbasu* (0.47, 0.65 and 0.68). Natural mortality indicated that the habitat was more suitable for *L. calbasu*. Comparatively, fishing pressure was very high in *T. tor* than *L. rohita* and *L. calbasu*. Exploitation rate was maximum in *L. rohita* (0.77, 0.74 and 0.56) compared to in *L. calbasu* (0.52, 0.65 and 0.63). Similar studies were reported that the E value for *L. fimbriatus* was 0.62 and *L. calbasu* was 0.33 and indicated that *L. calbasu* was under exploited but in the case of *L. fimbriatus* reaches exploitation stage along the lower stretches of Thamirabarani River (Brema, 2018). In compared with the above mentioned studies, the E value of 0.51 for *L. rohita* indicated that exploited near to optimum fishing pressure. It was found that L_{∞} was maximum in *C. mrigala* (89.25 cm) and minimum in *D. filamentosa* (22.05 cm). However, the L_{∞} was found to be intermediate for *L. rohita* (47.25 cm). The K was maximum in *C. mrigala* (0.8 y^{-1}) and minimum was in *D. filamentosa* (0.68 y^{-1}) and Z was maximum in *L. rohita* (2.87) compared to *C. mrigala* (2.14) and for *D. filamentosa* (2.42).

Catch per unit effort (CPUE) and relative CPUE

CPUE is a useful index of the abundance and exploitation of fishery resources to determine the number of fishing units of a sustainable fishery. It is well known that the CPUE is a measure of stock density, physical and financial productivity, and an indicator of the efficiency of a fishing operation. The CPUE is expected to be proportionate to the fish population that is utilized as the relative abundance index (Ghosh and Biswas, 2017). The maximum average CPUE 4.59 $\pm$ 3.46 kg of all gears and minimum average CPUE 1.09 $\pm$ 1.18 kg of all gears was recorded during April and August 2018, respectively. Highest CPUE was recorded from seine net 5.2 $\pm$ 1.72 kg in Gongaramkhali Ghat of Gorai River and lowest 0.0135

± 0.0015 kg from hook and long line in Matikata Ghat (Tikadar *et al.*, 2021). In the present study, mean CPUE is found to be 0.9136 kg/h/craft. Highest CPUE was recorded from fish traps (43%) and gill net (41%). However, the lowest was recorded in seine net (2%). Pon Saravana Kannan *et al.* (2016) reported the catch per unit effort (CPUE) was found to be high during the month of January and February. From this study the calculated CPUE and Relative Catch per unit effort was found to be maximum 26% during Jul-Oct 2021 but highest found (16%) during Jan 21 (15.25 kg/day/craft) followed by 14% during Dec 20 (14.76 kg/day/craft) and 13% during Feb 21 (13.37 kg/day/craft). However, a minimum CPUE was found as 3% during Apr 21 (2.79 kg/day/craft). Renjithkumar *et al.* (2021) stated from the study in the river Bharathapuzha that Gill net, cast net, seine net and hook and line were the major fishing gears used in the river. The CPUE recorded in gill net for major species were *Pseudotropheus maculatus* (0.75 kg h⁻¹), *Devario aequipinnatus* (0.5 kg h⁻¹), *L. rohita* (0.38 kg h⁻¹), *D. filamentosa* (0.20 kg h⁻¹) and *S. sarana* (0.18 kg h⁻¹). The highest CPUE recorded in cast net was for *Hypseobarbus kurali* (0.51 kg h⁻¹), *Hyporhamphus xanthopterus* (0.50 kg h⁻¹), *Mystus vittatus* (0.38 kg h⁻¹) and *W. attu* (0.29 kg h⁻¹). In seine net high CPUE was recorded in *Channa striata* (0.17 kg h⁻¹), *L. rohita* (0.16 kg h⁻¹) and *Etroplus suratensis* (0.13 kg h⁻¹). Renjithkumar *et al.* (2011) reported that about 77% of exploited fishery was accounted from gillnet followed by seine net (19%), castnet (3%) and hook and line (1%). Highest catch per unit hour (CPUE) was recorded in seines (2.40 kg unit⁻¹). In the present study a similar finding was obtained about 43 % fish catches in fish traps followed by 41% in gillnet. Highest CPUE was recorded (16%) during Jan 21 (15.25 kg/day/craft). The CPUE was found to be high in the month of June and July 2017 for the both species and the second peak on CPUE was observed during the month of September and October 2017 for *L. calbasu* whereas for *L. fimbriatus* second high peak on CPUE was observed during month of August, 2017 and February, 2018 (Brema, 2018). From this study, the month-wise fish catch contribution was found to be high during Dec 2020 (14%), January 2021 (16%) and February 2021 (13%). However, a minimum fish catch was observed during April 2021 (3%). Saberlin *et al.* (2018) recorded a total of 19 types of fishing gear in the Old Brahmaputra River from April 2011 to March 2012. Among which seine net showed the highest CPUE of 5.56 kg gear⁻¹ day⁻¹ with fishing effort 0.0224 gear⁻¹ haul⁻¹ day⁻¹ followed by push net and lift net. From this study, the major fish species were caught in gillnet, cast net, seine net, fish traps and pole and line were, *Gibelion catla*; *Labeo rohita*; *Cirrhinus mrigala*; *Puntius* spp; *Devario malabaricus*; *Labeo* spp.; *Dawkinsia*

spp; *Anguilla bengalensis*; *Lepidocephalichthys thermalis*; *Channa* spp; *Oreochromis* spp; *Clarias garipinnus*; *Mystus* spp; *Hyporhamphus limbatus*; *Ehirava fluviatilis*; *Xenentodon cancila* etc., The fish catch composition was recorded in fish traps (43%) followed by gill net (41%). However, the lowest was recorded in seine net (2%). The average CPUE was found to be 0.9136 kg/hr/craft.

In general, stock assessment of tropical fishes shows cumbersome particularly in riverine ecosystem. Nevertheless, it is highly essential to study the stock status of an economically important fishes in the natural riverine ecosystem. The Thamirabarani is the perennial river and enjoys both monsoons and covered more catchment areas in the Western Ghats which is the UN World Heritage site and has rich fish biodiversity ever. The river originates from the eastern slope of Western Ghats and drains into the Gulf of Mannar which also the World Heritage site in the Tiruchendur taluk of Thoothukudi. The present study was carried out between November 2020 and October 2021 in the potamon zone (downstream stretch) of Thamirabarani River. There are various fishing gears viz., gill net, cast net, seine net, pole and line and fish traps have been employed to exploit the freshwater fishery resources. It was observed that a positive allometric growth was evident for *L. rohita*. Further, a negative allometric growth was obtained for *C. mrigala* and *D. filamentosa* attributed to that of length in growth showed was increased in growth increment than weight in growth. The present study reveals that optimum fishing pressure for *L. rohita* (0.51) and natural mortality was relatively more for *D. filamentosa* (1.54) and *C. mrigala* (1.223). The study reports that large sized fish catch of *C. mrigala* and *D. filamentosa* as by-catch or discard while catching other targeted species. It is also evident from the study, further exploitation could be made to achieve the optimum MSY for *C. mrigala* and *D. filamentosa* as the exploitation ratio is less than 0.5 and for *L. rohita*, the present fishing could be sustained as the exploitation ratio is optimal (0.51). The highest CPUE was recorded during Jan 2021 (16%), followed by Dec 2020 (14%) and Feb 2021 (13%) owing to heavy rain recorded during North East Monsoon during the study period. In this purview, the present paper gives an insight on LWR, stock status and CPUE for three economically important cyprinid fish species along the potamon zone of Thamirabarani river basin, South India to undertake the suitable measures to conserve these fish stocks.

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Data availability statement

The prime data that supports the findings of this study are available from the corresponding author upon reasonable request.

Statement of conflict of interest

The authors have declared no conflict of interest.

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