EISSN 2602-473X

AQUATIC SCIENCES AND ENGINEERING

Aquat Sci Eng 2022; 37(4): 205-211 • DOI: https://doi.org/10.26650/ASE202221159748

Research Article

Seasonal Length-Weight Relationships and Condition Factors of *Mystus tengara* (Hamilton, 1822) in Two Habitats

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Cite this article as: Jana, A., Sit, G., Das, P., Chanda, A., & Sahu, K.S. (2022). Seasonal length-weight relationships and condition factors of *Mystus tengara* (Hamilton, 1822) in two habitats. *Aquatic Sciences and Engineering, 37*(4), 205-211. DOI: https://doi.org/10.26650/ASE202221159748

ABSTRACT

The aim of this study is to examine the relationship between length, weight, condition factor (K), and relative condition factor (Kn) of *Mystus tengara* (Hamilton, 1822), with special emphasis on seasonal variation of growth patterns, productivity, stocks, and conservation in two distinct ecosystems: pond and river. The results demonstrate that the species did not strictly adhere to the predicted cube law and had allometric growth patterns throughout the season.The condition factor (K) ranged from 0.33 to 1.49, the relative condition factor (Kn) varied from 0.44 to 1.77, and the 'b' values ranged from 2.00 to 3.29. The post-monsoon season saw the greatest average values for the regression parameter (b), condition factor (K), and relative condition factor (Kn). The r^2 values represent a significant relation between length and weight in two habitats and throughout all seasons. The Pearson's correlation indicates some positive and negative significant correlations among season, length, weight, condition factor, and relative condition factor in the study area ($P<0.01$ and $P<0.05$). The Post Hoc test indicates no significant habitat-based association between the same characteristics. However, there is a significant ($P<0.05$) seasonal link between relative condition factor, condition factor, weight, and length. As a result, these current findings will assist fisheries managers in creating efficient strategies for the long-term management of *M. tengara* in its habitats.

Keywords: Condition factor, Length, *Mystus tengara*, Season, Weight

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Submitted:
09.08.2022

Revision Requested:
17.09.2022

Last Revision Received:
18.09.2022

Accepted:
18.09.2022

Online Published:
10.10.2022

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INTRODUCTION

Length-weight interactions are important for both practical and fundamental comparative growth studies in fishery management (Moutopoulos & Sterigiou, 2002). Fish length-weight relationship (LWR) data are significant for assessing and managing the fish population (Martin-Smith, 1996). Fish biology focuses on the connection between length and weight for a number of reasons, such as finding out the yield, finding out the standing crop biomass, estimating the age of a fish based on its weight, determining the age structure and function of a fish population, observing growth, stock differentiation, ecological modelling, and doing acoustic surveys (Eduardo et al., 2019; Siddique et al., 2016; Ozaydin et al., 2007; Froese, 2006; Haimovici & Velasco, 2000). The length and weight relationship was selected to gather data on the condition of the fish and to assess if the somatic growth is allometric or isometric (Ujjania et al., 2012). According to the Cube law ($W=L^3$), fish frequently grow isometrically (Lagler, 1952). However, a deviation from Cube's rule in the length-weight relation is always viable due to the many factors of the environment that affect the physicochemical properties of the water in which individual fish species live. LeCren (1951) revised the Cube equation as $W=aL^b$ to calculate the data from weight and length measurements for their connection throughout the life cycle phases of fish.

The condition factor, a quantitative index of health for fish that affects growth, reproduction, and viability, will decide the favourable outcome of current and future populations. The condition of a fish changes based on a complex interaction of physiological parameters, parasite diseases, and dietary conditions.The relative condition factor (Kn) can be used to determine the fitness of fish. A fish farmer can access the weight of fish to a calculated standard to decide whether the fish are in better or worse condition than the standard. Fish can be compared in terms of their general health, body mass index, and gonad development using the relative condition factor (Thomas, 1969). *Mystus tengara* (Hamilton, 1832) is a significant catfish belonging to the family Bagridae of the order Siluriformes, with strong nutritional and decorative characteristics. Prior to our studies, few scientists had investigated the length and weight relations and the condition factor in this species. The relation between length, weight and relative condition factor of *M. tengara* were researched by Kalita et al. (2017) in the Lechia-Pavomaribeel wetland of Dhemaji, Assam, India. Length-Weight relationships of *M. tengara* were reported by Gupta and Banerjee (2015) from Baruipur, South 24 Paraganas, West Bengal. However, no thorough investigation into the season and habitat effects on length, weight, condition factor and relative condition factor of *M. tengara* has yet been conducted. Therefore, this present study is the first to report the seasonally habitat-wise relationship among relative condition factor, condition factor, weight, and length of *M. tengara* in the Jhargram and Paschim Medinipur districts of West Bengal, India.

MATERIALS AND METHODS

Specimen collection & identification

Between June 2019 and May 2021, specimens were collected from two habitats (rivers and ponds) in two districts, Paschim Medinipur and Jhargram, throughout the pre-monsoon (March to June), monsoon (July to October)and post-monsoon (November to October) seasons. In total 64 specimens were collected from the study area during those seasons and from thetwo habitats. The specimens were identified based on existing literature (Jayaram, 2010).

Length (L) and weight (W) measurement

After identification, the length of each specimen was measured with a digital slide caliper (0.01 mm accuracy) and the weight by digital balance (0.01g accuracy) throughout different seasons and habitats.

Length and weight relation

Length and weight relationship was calculated using the formula **$W=aL^b$** (Le Cren, 1951)

Here,

W= Weight (g)

L= Length (cm)

a= Intercept or the initial growth index

b= Slope/ growth coefficient/ an exponent.

The logarithmic conformation of this equation is **LogW= Loga+ bLogL**

Condition factor (K)

The following formula was used to calculate Fulton condition factor of the species (**$K =100\times(W/L^3)$**) (Fulton, 1904)

Here,

W= Weight(g)

L= Length (cm)

Relative condition factor (Kn)

The following formula was used to estimate the Relative condition factor.

$Kn= W/aL^b$ (Le Cren, 1951)

Here,

W= weight (g)

L= Length (cm)

a & b=regression parameter

Data analysis

Finally, data were analysed with Pearson's Correlation, Regression, Post Hoc test used by Microsoft Excel-2019, SPSS-2021 and Originpro-2022 software system.

RESULT AND DISCUSSION

In the current study, the length and weight range of *M. tengara* was from 7.1 to 17.3 cm and 2.12 to 22.44 gm, respectively. The descriptive statistics of length, weight, 'K' and 'Kn'are presented in Table 1 and Figure 1. In contrast to the pre-monsoon and post-monsoon seasons, the monsoon season saw the maximum increases in length and weight (Figure 2). In the current study, table 6 shows the logarithmic and parabolic equations for the length-weight relationship. In the pond, the values 'b' and 'r^2' range from 2.28 to 3.29 and from 0.73 to 0.79, similarly from 2.01 to 2.69 and from 0.83 to 0.87 in the river, respectively (Table 2). The minimum 'b' value was seen in both habitats during the monsoon season, and the greatest was seen throughout the post- and pre-monsoon periods in the pond and river respectively. Pearson's correlation represents a significant correlation ($p<0.01$ & $p<0.05$) among season, length, relative condition factor, and condition factor; length has only a significant negative correlation with 'K', although weight has a positive correlation with 'Kn' ($p<0.01$) (Table 5 and Fig 4). The results of the Post Hoc test show that, except for the post monsoon and monsoon seasons, there is a seasonally significant ($p<0.05$) connection between length and condition factor but not between relative condition factor and weight (Table 6). The r^2 results show that length and weight are positively and strongly correlated throughout the year in both habitats (Table 2 and Figure 3). The value of 'b' only exhibits positive allometric growth in post-monsoon ponds and negative allometric growth in rivers and ponds throughout the other seasons. If the fish are not feeding well enough or if their environment, such as their physicochemical characteristics and/or their breeding season, is not conducive to their growth, negative allometric growth was observed (Deka &Bura Gohain,

Table 1. Descriptive statistics of length, weight of *M. tengara*.

Habitat	Season	Total Length (cm)				Total Weight (g)			
		Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
POND	PREMONSOON	7.6	16.2	11.7797	±2.22198	3.96	22.31	14.1583	±5.25713
	MONSOON	8.1	17.1	12.8844	±2.0623	3.42	21.12	14.763	±4.63694
	POSTMONSOON	7.2	15.2	10.6688	±1.8253	2.12	19.08	11.8275	±5.42513
RIVER	PREMONSOON	7.8	16.9	11.6266	±2.43514	3.21	21.22	13.0022	±6.05971
	MONSOON	8.4	17.3	12.6625	±2.21076	3.8	22.44	15.2413	±4.49056
	POSTMONSOON	7.1	15.5	11.25	±2.17248	2.97	19.37	13.1564	±5.09321

N=64; Min=Minimum; Max=Maximum; SD=Standard Deviation

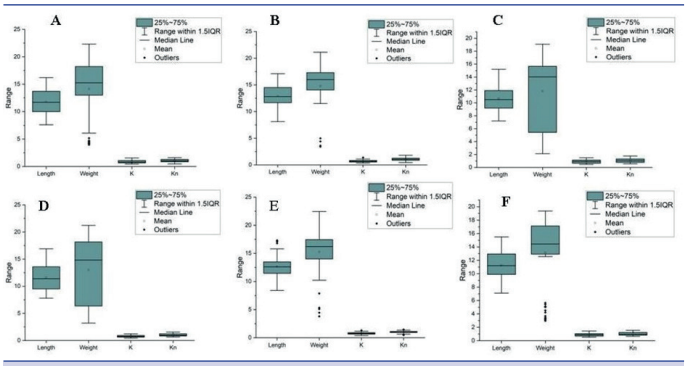

Figure 1. Length, Weight, K and Kn of *M. tengara*.
A-C= Pond; D-F= River; A & D= Pre-monsoon; B & E= Monsoon; C & F= Post-monsoon

Table 2. Regression parameters of *M. tengara*.

Habitat	Season	a	b	r^2
POND	PREMONSOON	0.0468	2.289146494	0.7855
	MONSOON	0.0296	2.407828679	0.7385
	POSTMONSOON	0.0043	3.293539607	0.7826
RIVER	PREMONSOON	0.0157	2.699501283	0.8798
	MONSOON	0.0905	2.005843224	0.8383
	POSTMONSOON	0.0248	2.56160902	0.8482

a=intercept; b=slope, R=coefficient correlation

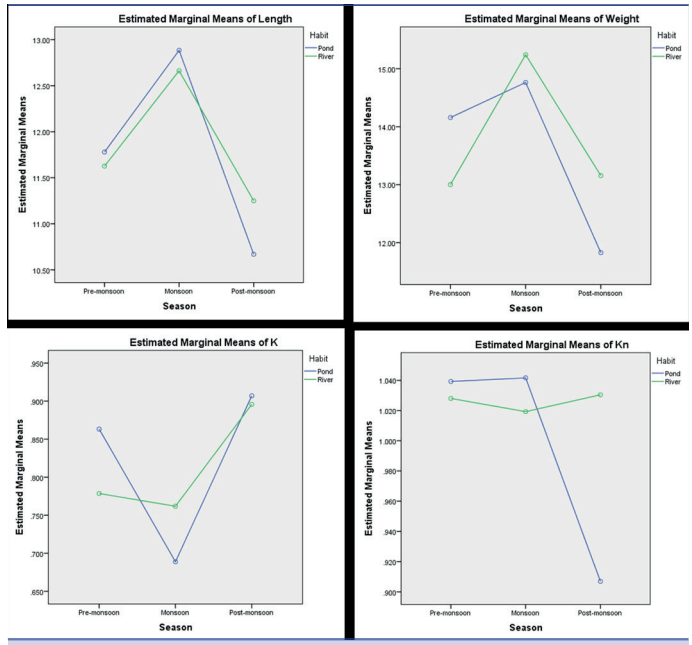

Figure 2. Seasonally changes length, weight, K, Kn of *M. tengara*.

2015; Weatherly, 1972; Soni & Kathal, 1953; Le Cren, 1951). Kalita et al. (2017) reported that the 'b' value was 2.07, and the Kn value ranged from 0.74 to 1.39 with 1.00±0.125 in *M. tengara* from Assam, India. Gupta and Banerjee (2015) reported that the 'b' values were 3.071, 3.119 and 2.941 for males, females, and mixed sex in the *M. tengara* from West Bengal, India. Hossain et al. (2006) represented b values of 2.96, 3.13, and 3.05 and also Victor et al. (2014) cited the same values of 2.732, 2.873 and 2.405 in

Table 3. Habitat-wise, seasonally parabolic and logarithmic values of *M. tengara*.

Habitat	Season	Parabolic Equation	Logarithmic equation
POND	PREMONSOON	W=0.0468L^2.289	LogW=-1.329+2.289logL
	MONSOON	W=0.0296L^2.407	LogW=-1.527+2.407logL
	POSTMONSOON	W=0.0043L^3.293	LogW=-2.363+3.293logL
RIVER	PREMONSOON	W=0.0157L^2.699	LogW=-1.803+2.699logL
	MONSOON	W=0.0905L^2.005	LogW=-1.043+2.005logL
	POSTMONSOON	W=0.0248L^2.561	LogW=-1.605+2.561logL

W= weight; L=length

combined sex, female, and male of the *M. vitatus*. For the combined sex of *M. vittatus*, Srivastava et al. (2013) and Hossain et al. (2009) recorded values of 'b' to be 2.88 and 3.27, respectively. For the combined sex of *M. cavasius*, 'b' values of 2.83, 2.91, 3.21, and 3.009 were recorded by Karna and Panda (2012), Hossain et al. (2012), Sani et al. (2010), Krishna Rao (2007), whereas Venkateshwarlu et al. (2007) had listed 'b' values of 2.7402 and 2.493 for the female and male in the same species. While Begum et al.

Table 4. Habitat-wise, seasonally condition factors of *M. tengara*.

Habitat	Season	Condition factor (Fulton, 1904)				Relative Condition factor (Le Cren, 1951)			
		Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
POND	PREMONSOON	0.44	1.56	0.8632	±0.27968	0.47	1.61	1.0393	±0.28107
	MONSOON	0.33	1.38	0.6888	±0.211	0.44	1.81	1.0416	±0.27624
	POSTMONSOON	0.47	1.49	0.9069	±0.27901	0.56	1.77	1.0482	±0.32389
RIVER	PREMONSOON	0.43	1.21	0.7785	±0.18885	0.65	1.56	1.028	±0.24416
	MONSOON	0.4	1.31	0.7618	±0.19177	0.47	1.45	1.0193	±0.18244
	POSTMONSOON	0.52	1.44	0.8958	±0.2384	0.65	1.56	1.028	±0.24416

N=64; Min=Minimum; Max=Maximum; SD=Standard Deviation

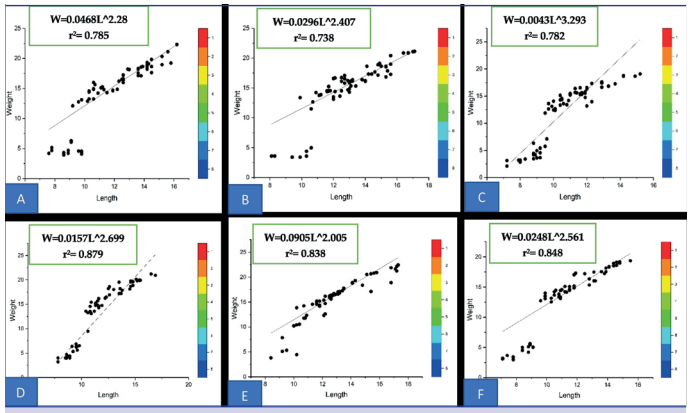

Figure 3. Length-Weight relationship of *M. tengara*.
A-C= Pond; D-F= River; A & D= Pre-monsoon; B & E= Monsoon; C & F= Post-monsoon

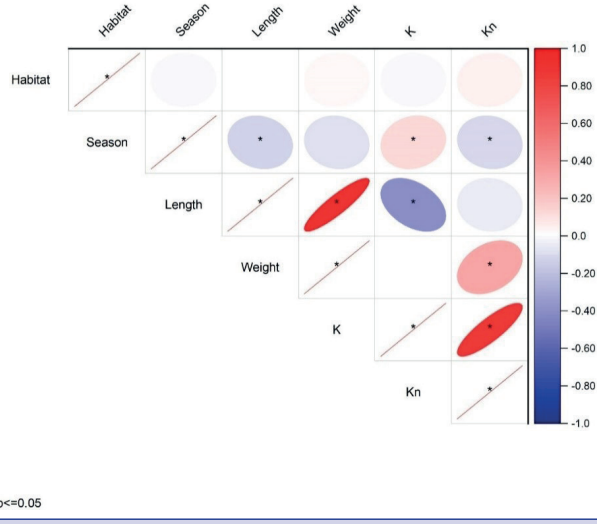

Figure 4. Correlation of *M. tengara*. (*p≤0.05).

Table 5. Pearson's correlation of *M. tengara*.

		Habitat	Season	Length	Weight	K	Kn
Habit	Pearson Correlation	1	.000	.015	.021	-.016	.058
	Sig. (2-tailed)		1.000	.768	.688	.762	.256
Season	Pearson Correlation	.000	1	-.133**	-.084	.134**	-.103*
	Sig. (2-tailed)	1.000		.009	.099	.009	.044
Length	Pearson Correlation	.015	-.133**	1	.895**	-.415**	-.058
	Sig. (2-tailed)	.768	.009		.000	.000	.257
Weight	Pearson Correlation	.021	-.084	.895**	1	.012	.336**
	Sig. (2-tailed)	.688	.099	.000		.814	.000
K	Pearson Correlation	-.016	.134**	-.415**	.012	1	.848**
	Sig. (2-tailed)	.762	.009	.000	.814		.000
Kn	Pearson Correlation	.058	-.103*	-.058	.336**	.848**	1
	Sig. (2-tailed)	.256	.044	.257	.000	.000	
	N	384					

*: Correlation is significant at the 0.05 level (2-tailed); **: Correlation is significant at the 0.01 level (2-tailed).

Table 6. Post Hoc test seasonally of *M. tengara*.

Dependent Variable	(I) Season	(J) Season	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Length	Pre-monsoon	Monsoon	-1.0703*	.27032	.000	-1.7064	-.4343
		Post-monsoon	.7438*	.27032	.017	.1077	1.3798
	Monsoon	Pre-monsoon	1.0703*	.27032	.000	.4343	1.7064
		Post-monsoon	1.8141*	.27032	.000	1.1780	2.4501
	Post-monsoon	Pre-monsoon	-.7438*	.27032	.017	-1.3798	-.1077
		Monsoon	-1.8141*	.27032	.000	-2.4501	-1.1780
Weight	Pre-monsoon	Monsoon	-1.4219	.64831	.074	-2.9473	.1036
		Post-monsoon	1.0883	.64831	.215	-.4372	2.6137
	Monsoon	Pre-monsoon	1.4219	.64831	.074	-.1036	2.9473
		Post-monsoon	2.5102*	.64831	.000	.9847	4.0356
	Post-monsoon	Pre-monsoon	-1.0883	.64831	.215	-2.6137	.4372
		Monsoon	-2.5102*	.64831	.000	-4.0356	-.9847
K	Pre-monsoon	Monsoon	.09555*	.029309	.003	.02659	.16452
		Post-monsoon	-.08048*	.029309	.017	-.14945	-.01152
	Monsoon	Pre-monsoon	-.09555*	.029309	.003	-.16452	-.02659
		Post-monsoon	-.17604*	.029309	.000	-.24500	-.10707
	Post-monsoon	Pre-monsoon	.08048*	.029309	.017	.01152	.14945
		Monsoon	.17604*	.029309	.000	.10707	.24500
Kn	Pre-monsoon	Monsoon	.00320	.031928	.994	-.07193	.07833
		Post-monsoon	.06496	.031928	.105	-.01016	.14009
	Monsoon	Pre-monsoon	-.00320	.031928	.994	-.07833	.07193
		Post-monsoon	.06176	.031928	.130	-.01336	.13689
	Post-monsoon	Pre-monsoon	-.06496	.031928	.105	-.14009	.01016
		Monsoon	-.06176	.031928	.130	-.13689	.01336

(2010) showed 'b'values of 1.468 and 1.388 for female and male in the same species, Karna and Panda (2012) reported the 'b' value of 3.032 for mixed sex of *M. gulio*. According to Naeem et al. (2012), the "b" values for *M. bleekeri's* combined sexes, female, and male were 2.62, 2.70, and 2.64, respectively. The 'b' values (ranging from 2.00 to 3.29) in the present study are closer to the previous studies of Kalita et al. (2017) and Gupta & Banerjee (2015). Till now, in seasonal and habitat-wise studies, no information has been found about the length, weight, 'K', and 'Kn' relationship of *M. tengara*. Therefore, it is impossible to comprehensively contrast the present result with previous data. In the current study, the 'K' and 'Kn' values were 0.33-1.56 and 0.92-1.17, respectively (Table 4). The peak average 'K' and 'Kn' values for this species in both environments occur post-monsoon. Kalita et al. (2017) reported values of 0.74-1.39 with a mean SD of 1.00±0.125; this result shows 'Kn' values greater than the present study. The majority of the fish had 'Kn' values greater than 1, indicating that they were in good health. The relative condition component, however, was seen to be more or less unchanging from lighter to heavier fish, plainly indicating the well-being and status of the fish to be healthy. In their investigation, Bhatta & Goswami (2014) noted a reversal situation where the high'Kn' value was found in the medium-sized *Channa aurantimaculata* fish. Rahaman et al. (2015) and Das et al. (2015) reported that male-*Heteropneustes fossilis* and female *Anabas testudineus* showed a trend where 'Kn' decreased from smaller fish exhibiting the small value at medium fish and then fixedly increased to get the peak value in bigger fishes, but the current study indicates that the highest 'Kn' value occurs during the post-monsoon season and that during this season the weightand length of the species were less than during the monsoon and pre-monsoon season.

CONCLUSION

According to the current study, *M. tengara* from both habitats (pond and river) in the Jhargram and Paschim Medinipur districts of West Bengal exhibit an allometric growth pattern with a 'b' value less than 3. Therefore, it might be said that this species did not strictly abide by the intended cube law. The species show a strong relationship between length and weight in both habitats in all seasons. There is a significant seasonal relationship among weight, length, 'K' and 'Kn'of *M. tengara*, but there is no significant habitat-based relationship between the same parameters. Seasonally, the 'K' and 'Kn' were discovered to be in a typical position to maintain the health of the fish species. This study

achieved its aims, and the data acquired may be helpful in advising on how to design subsequent biometric studies for fish taken from the study area. As a result, the current findings will assist fisheries managers in creating efficient strategies for the long-term management of *M. tengara* in its habitats.

Acknowledgements: The authors would like to express their deep sense of gratitude to the Principal of Raja N. L. Khan Women's College (Autonomous) and to the departmental faculty and staff members of PG Zoology for their constant inspiration and help to conduct sustainable research work for the benefit of science and society.

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