



Study On Length–Weight Relationship and Relative Condition Factor of Skipjack Tuna *Katsuwonus pelamis* (Linnaeus, 1758) Landed at Veraval Fishing Harbour, Northwest Coast of India

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ABSTRACT

The present study was carried out during the period from March, 2025 to February, 2026 at Veraval, Gujarat, India to investigate the length–weight relationship and relative condition factor of Skipjack tuna (*Katsuwonus pelamis*) landed. A total of 300 Skipjack tuna samples were collected, out of which 171 were males, and 129 were females. The total length of the sampled fish ranged from 41.0–71.5 cm, while body weight varied from 969–7340 g. The total length and body weight of each specimen were recorded and analyzed using the standard length–weight relationship equation, $W=aL^b$, where W represented body weight, L represented total length, a was the intercept, and b was the regression coefficient. The length–weight relation was established for both genders individually. In males, the length–weight relation was $W=0.0027 \times L^{3.4546}$ ($R^2=0.938$), while in females, it was $W=0.0023 \times L^{3.4975}$ ($R^2=0.939$). On pooling the values of both genders, the length–weight relation became $W=0.0026 \times L^{3.4649}$ ($R^2=0.9391$). The regression coefficient (b) was greater than 3, indicating positive allometric growth, suggesting that fish gained weight at a faster rate than length as they increased in size. The weighted mean relative condition factor (K_n) was 0.9999 ± 0.0883 in males and 1.0026 ± 0.0712 in females, indicating a generally stable and healthy condition in both sexes. The findings of the present study provide baseline information on the growth pattern and condition status of *K. pelamis* from the northwest Arabian sea.

KEYWORDS: *Katsuwonus pelamis*, length–weight relationship, relative condition factor, veraval

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, author have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

In 2025, India's marine fish landings increased to 3.57 Mt, a 3% rise over 2024 (3.47 mt). Gujarat contributed 6.43 lakh t, despite a 15% decline in landings, dropping to second among maritime states. Pelagic resources accounted for 54% of the total catch, with skipjack tuna (*K. pelamis*) contributing 21,028 t, underscoring its continued economic and fisheries importance (Anonymous, 2026). The skipjack tuna *K. pelamis* is among the most heavily exploited wild fish species worldwide, with an estimated annual catch of 3.06 Mt, contributing approximately 58% of the total global tuna landings (Anonymous, 2016; Anonymous, 2020). This species is characterized by its short lifespan, rapid growth, and high fecundity, and is widely distributed in the upper mixed layer of tropical and subtropical ocean waters (Kim et al., 2020). Skipjack tuna is a highly migratory pelagic species that supports major commercial fisheries throughout the tropical and subtropical oceans, making it one of the most economically important tuna species worldwide. (Chodriah et al., 2020). Studies on the length composition and reproductive biology of skipjack tuna provide valuable insights into stock structure, spawning potential, and growth characteristics, which are fundamental for effective fisheries assessment and conservation (Deepti and Sujatha, 2017). During 2023–24, India's tuna exports recorded a significant growth of 31.83%, with total exports reaching 51,626 t worth USD 87.96 million (Anonymous, 2024). India exports a wide variety of tuna fish products in both raw and processed forms, catering to international markets in Japan, Thailand, the Maldives, Sri Lanka, the United States, and the European Union. The main export items include frozen whole tuna, tuna loins, tuna steaks, and processed or canned tuna products such as tuna flakes, chunks, and slices in oil or brine (Anonymous, 2024). Among species, yellowfin tuna (*Thunnus albacares*) and skipjack tuna (*Katsuwonus pelamis*) dominate India's export share, followed by bigeye tuna (*Thunnus obesus*) and frigate tuna (*Auxis thazard*). In the raw product category, frozen yellowfin tuna and frozen skipjack tuna are the major items shipped, especially to Southeast Asian processing industries (Anonymous, 2024; Anonymous, 2023). The skipjack tuna is classified into the Scombridae family. Overall, 15 genera and about 50 species form this family, including mackerels, Spanish mackerels, bonitos and tunas, which are distributed throughout tropical and temperate waters of the world (Collette et al., 2001). *Katsuwonus pelamis* is the single species in the *Katsuwonus* genus. The name *pelamis* was established by Linnaeus in 1758 and gained in acceptance between 1890 and 1935 (Matsumoto et al., 1984). In English is also known as "Oceanic bonito", "White bonito", "Striped bonito", "Arctic bonito", "Bonito", "Watermelon" or "Skippy" (Matsumoto et al., 1984). Length–weight

relationship (LWR) is a fundamental tool in fisheries science that provides valuable information on fish growth patterns, condition, biomass estimation, and population dynamics. It facilitates the conversion of length data into weight and supports stock assessment, fisheries management, and conservation of aquatic resources (González-Acosta and Rábago-Quiroz, 2024). Studying LWR is fundamental for fish stock assessment and fisheries biology, as it enables the estimation of average weight for fish within a specific length group through a mathematical correlation between length and weight (Beyer, 1987). Since fish size is more influenced by ecological and physiological factors than age, it holds greater biological significance (Kalayci et al., 2007). Relative condition factor (*K_n*) reflects the physiological well-being and fitness of fish by comparing observed and expected weights, indicating environmental suitability and nutritional status (Kumari et al., 2023). Hence, the present study was carried out to investigate the length–weight relationship and relative condition factor of Skipjack tuna (*Katsuwonus pelamis*) landed.

2. MATERIALS AND METHODS

2.1. Study location

The study spanned from March, 2025 to February, 2026 at Veraval fishing harbour, Gujarat. Skipjack tuna (*Katsuwonus pelamis*) samples for this study were gathered from the Veraval fish landing centre (20°54'912" N, 70°21'355" E), located in Gujarat's Gir Somnath district, India.

2.2. Sampling design

Specimens of skipjack tuna (Figure 1), *Katsuwonus pelamis*, were collected from a gill netter landed at Veraval fishing harbour along the Saurashtra coast, Gujarat. Each month, 30 Samples were randomly obtained in every fortnight from different vessels of different sizes and weights to represent the actual populations. Specimens were brought to the College of Fisheries Science, Kamdhenu University laboratory for the length–weight analysis.



Figure 1: Specimen for study *Katsuwonus pelamis* (Source: Authors' analysis)

2.3. Biological procedure

The collected fish were washed and identified using standard taxonomic keys. For each specimen, the total length (TL) was measured from the tip of the snout to the end of the

caudal fin using a measuring board to the nearest 0.1 cm. The total body weight (TW) was recorded using a digital balance with an accuracy of 0.1 g.

2.4. Length-weight relationship (LWRs)

The length-weight relationship (LWR) was calculated using the allometric formula proposed by Le Cren (1951), separately for both sexes.

$$W = a L^b \text{ or } \log W = \log a + b \times \log L,$$

Where, W = Total body weight (g), L = Total Length (cm), a and b are the coefficients of the functional regression between W and L.

2.5. Relative condition factor (K_n)

The relative condition factor (K_n) of individual fish was estimated following Le Cren (1951) using the equation:

$$K_n = W_o / W_c$$

Where W_o represents the observed body weight, and W_c denotes the calculated (expected) weight derived from the length-weight relationship.

3. RESULTS AND DISCUSSION

3.1. Length and weight composition

In this experimental period, author collected total number of specimens collected was 300, which included 171 males and 129 females. The lengths of these specimens varied from 41.0 cm to 71.5 cm, while the weight ranged from 969 g to 7340 g. The maximum average length occurred in September (54.67 cm), while the minimum average length was observed in April (48.08 cm). The mean body weight was greatest in September (3104.7 g) and least in April (1787.02 g). The lowest weight (969 g) was recorded in May, whereas the highest weight (7340 g) was recorded in

December (Table 1).

Author obtained lengths between 45.0 and 48.0 cm were the most frequently recorded length, whereas those between 69.0 and 72.0 cm were recorded the least. In case of males, the largest population (53) belonged to the lengths 45.0–48.0 cm, whereas the smallest population (2) belonged to 65.0–68.0 cm lengths. Similarly, in the case of females, the highest population (38) was noted in lengths 49.0 to 52.0 cm, while the least population (1). In terms of weight, the maximum frequency occurred in the 1751–2550 g interval, whereas the minimum occurred in the 5751–6550 g and 6551–7350 g intervals. In terms of gender, most males (66) belonged to the 1751–2550 g category, whereas the least (1) belonged to the 6551–7350 g category. Most females (47) belonged to the 1751–2550 g category, whereas the least (1) belonged to the 5751–6550 g category (Table 2).

Various investigations into *K. pelamis* have been conducted around the globe. In one investigation carried out by Deepti and Sujatha (2017), the fish was found northern Andhra Pradesh, central eastern coast of India. It was discovered that there were 233 male individuals with a body length between 35 and 69.8 cm and weighing 720.0–5420.0 g, along with 354 female specimens measuring 38–66 cm long and weighing 720.0–3880.0 g. There were also 547 juvenile specimens. Mohan and Kunhikoya (1985) described 440 specimens collected from Minicoy waters, comprising 220 male specimens having lengths of 36 to 66 cm (FL) and 220 female specimens with lengths between 36 to 67 cm (FL). Grande et al. (2010) conducted a study on *K. pelamis* from the western Indian Ocean involving 1,269 fish. Their samples consisted of 488 male fish whose fork lengths ranged from 37 to 67 cm and 704 female fish whose fork lengths ranged from 32 to 68 cm.

Table 1: Monthly range and mean of total length and total weight of *K. pelamis*

Month	No. of fish observed	Body length (cm)		Body weight (g)	
		Range (cm)	Mean (cm)±SD	Range (g)	Mean (g)±SD
Mar-25	30	41.0–67.0	49.13±6.45	1190–5300	2014.3±1094.74
Apr-25	30	42.5–65.0	48.08±5.36	1014–4812	1787.02±853.54
May-25	30	42.0–71.5	51.3±6.87	969–5877	2280.8±1146.18
Aug-25	30	44.0–64.0	52.72±5.81	1292–3973	2390±813.01
Sep-25	30	43.5–64.0	54.67±5.26	1759–4855	3104.7±828.95
Oct-25	30	45.0–59.0	49.48±4.33	1318–3684	2025.43±738.15
Nov-25	30	42.5–62.0	49.52±6.06	1128–3856	2109.31±979.02
Dec-25	30	45.5–66.0	53.65±5.67	1411–7340	2721.17±1302.59
Jan-26	30	45.5–61.0	50.72±4.63	1549–4359	2270.63±881.48
Feb-26	30	45.0–60.0	51.52±5.16	1416–3774	2285.93±880.37
Total	300	41.0–71.5	51.08±5.56	969–7340	2298.93±951.803

Table 2: Length-weight frequency distribution in *K. pelamis*

Length intervals (cm)	Frequency (count)			Weight intervals (g)	Frequency (count)		
	Male	Female	Total		Male	Female	Total
41.0–44.0	23	3	26	951–1750	64	36	100
45.0–48.0	53	36	89	1751–2550	66	47	113
49.0–52.0	48	38	86	2551–3350	15	15	30
53.0–56.0	16	21	37	3351–4150	19	23	42
57.0–60.0	21	19	40	4151–4950	4	4	8
61.0–64.0	8	7	15	4951–5750	2	3	5
65.0–68.0	2	4	6	5751–6550	0	1	1
69.0–72.0	0	1	1	6551–7350	1	0	1

3.2. Length-weight relationship

For this study, a sample size of 300 was used, consisting of 171 male fish and 129 female fish, where the length ranged from 41.0 cm to 71.5 cm, and the weight varied between 969 g and 7340 g.

For males (Figure 2), the relationship was:

Parabolic equation: $W=0.0027 \times L^{3.4546}$ ($R^2=0.938$)

Logarithmic equation: $\log W=-2.56864+3.4546 \log L$

For females (Figure 3), the relationship was:

Parabolic equation: $W=0.0023 \times L^{3.4975}$ ($R^2=0.939$)

Logarithmic equation: $\log W=-2.63827+3.4975 \log L$

Since there was no significant difference ($p<0.05$) between the male and female relationships, the data were combined (pooled), resulting in:

Pooled data (Figure 4):

Parabolic equation: $W = 0.0026 \times L^{3.4649}$ ($R^2 = 0.9391$)

Logarithmic equation: $\log W=-2.58503 + 3.4649 \log L$

In the present study, author found the length-weight relationship of Skipjack tuna indicated positive allometric growth, as the b values were greater than 3 in males ($b=3.4095$; $R^2=0.9286$), females ($b=3.4975$; $R^2=0.9390$), and pooled data ($b=3.4649$; $R^2=0.9391$). The high coefficient of determination values indicated a strong relationship between length and weight in the species. Similar results were reported by Mohan and Kunhikoya (1985) from Minicoy waters, where the pooled equation showed a b value of 3.39301, while males and females recorded b values of 3.35566 and 3.46279, respectively, also indicating positive allometric growth. Kumar et al. (2019) from Tuticorin waters, Tamil Nadu, reported a pooled equation with $b=3.33$ and a high coefficient of determination ($R^2=0.9649$), supporting the strong correlation between length and weight observed in the present study. Likewise, Deepti and Sujatha (2016) reported positive allometric growth

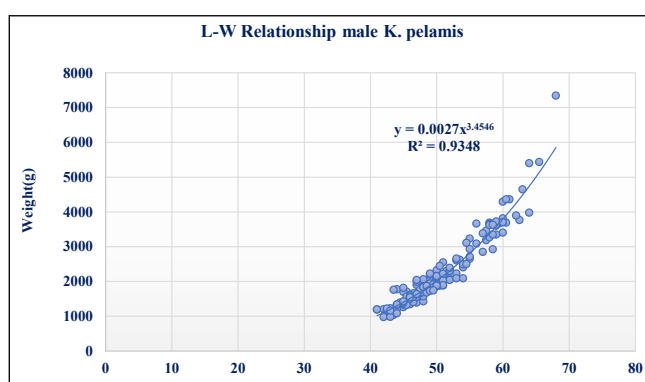


Figure 2: Length-weight relationship of male *K. pelamis*

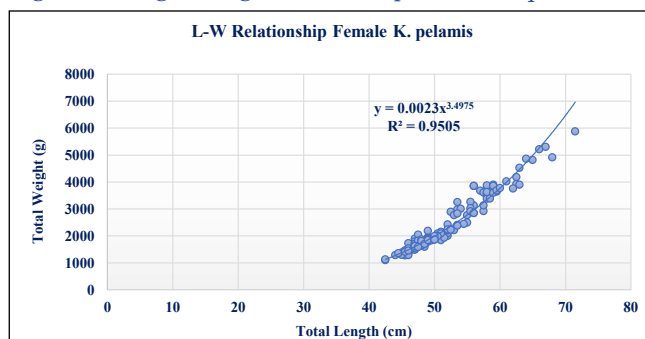


Figure 3: Length-weight relationship of female *K. pelamis*

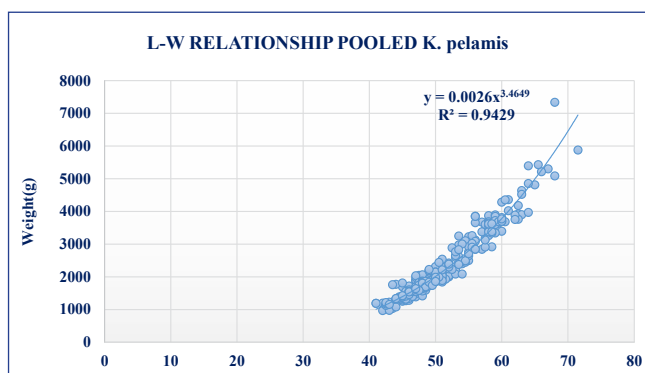


Figure 4: Length-weight relationship of pooled *K. pelamis*

in pooled samples ($b=3.1869$) and males ($b=3.166$) from the Andhra Pradesh coast, although females exhibited comparatively lower growth ($b=2.5471$), indicating slight variation in growth pattern between sexes. Chodriah et al. (2020) also observed positive allometric growth in skipjack tuna from Toli-Toli waters, Indonesia, with b values of 3.318 in males and 3.3049 in females, along with high R^2 values, indicating a strong length–weight relationship. The variations in b values among different studies might be attributed to differences in environmental conditions, food availability, maturity stage, fishing season, sampling size, and geographical location. Overall, the present findings confirmed that skipjack tuna exhibited positive allometric growth, where body weight increased at a faster rate than body length.

3.1. Relative condition factor (K_n)

3.3.1. Monthly variation in relative condition factor (K_n) of *K. pelamis*

During his study, author founded that fish condition was stable throughout the study period, with K_n values ranging from 0.972 (April) to 1.04 (December). Most months showed values near 1.00, and the overall mean of 1.003 ± 0.0787 confirmed consistently good physiological condition with low variability (Table 3). The mean K_n values of male and female groups have been obtained for different months (mean $\pm$ SD) and presented in Table 4 and Figure 5. In the male group, the highest value of K_n appeared during the month of October (1.039786 ± 0.11868), while the lowest value appeared during the month of May (0.902463 ± 0.051237). On the other hand, in the female group, the highest and lowest values of K_n appeared during the month of April (1.03465 ± 0.050336) and February (0.968214 ± 0.028476). The weighted average of K_n values for

Table 3: Monthly variation in the relative condition factor of *K. pelamis*

Months	Relative condition factor (K_n) $\pm$ standard deviation (SD)
Mar-25	0.996 ± 0.0878
Apr-25	0.972 ± 0.0842
May-25	1.002 ± 0.0738
Aug-25	1.006 ± 0.1065
Sept-25	1.0023 ± 0.073
Oct-25	1.00073 ± 0.1008
Nov-25	1.00008 ± 0.0872
Dec-25	1.04 ± 0.0701
Jan-26	1.015 ± 0.0615
Feb-26	0.991 ± 0.0417
Mean	1.003 ± 0.0787

Table 4: Monthly variation in the relative condition factor of male and female *K. pelamis*

Month	Male		Female	
	No. of fish	$K_n \pm SD$	No. of fish	$K_n \pm SD$
Mar-25	17	1.00153 ± 0.092725	13	1.004692 ± 0.083809
Apr-25	18	1.023053 ± 0.102397	12	1.03465 ± 0.050336
May-25	20	0.902463 ± 0.051237	10	1.000007 ± 0.047256
Aug-25	15	1.004916 ± 0.100937	15	0.999569 ± 0.098393
Sept-25	14	1.004137 ± 0.084613	16	1.000846 ± 0.046336
Oct-25	18	1.039786 ± 0.11868	12	1.002563 ± 0.078644
Nov-25	16	1.001595 ± 0.037853	14	1.025517 ± 0.11332
Dec-25	21	1.031329 ± 0.070748	9	0.983329 ± 0.062633
Jan-26	20	1.01214 ± 0.061637	10	1.017921 ± 0.049603
Feb-26	12	0.976868 ± 0.054228	18	0.968214 ± 0.028476
Weighted average	171	0.999922 ± 0.08832	129	1.00255 ± 0.07122

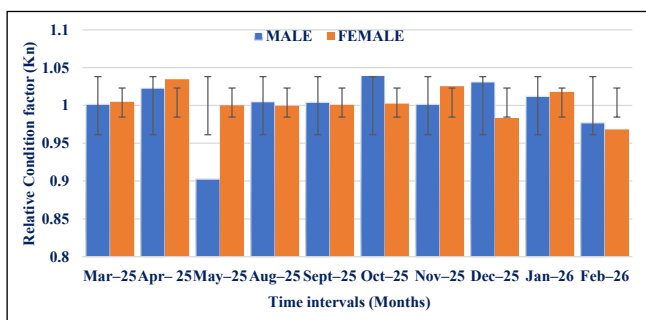


Figure 5: Monthly variation in the relative condition factor of male and female *K. pelamis*

various months was not significantly. In the present study, the relative condition factor (K_n) of Skipjack tuna indicated that the fish remained in stable physiological condition throughout the study period. The K_n values ranged from 0.972 in April to 1.04 in December, with most monthly values remaining close to 1.00. The overall mean K_n value of 1.003 ± 0.0787 further confirms good condition and low variability among individuals during the study period. The weighted average of K_n values among different months did

not show significant variation, indicating relatively stable environmental and feeding conditions (Source: Authors' analysis). Similar observations were reported by Agustina and Sulistyaningsih (2022) for Kawakawa from West Sumatra, Indonesia, where the K_n values ranged from 1.08 to 1.27, with the highest value in December and the lowest in April. Their study also suggested that the condition factor remained relatively stable throughout the year despite minor monthly fluctuations. In contrast, Jatmiko et al. (2016) observed distinct seasonal variation in the relative condition factor of Yellowfin tuna at Benoa Port, Indonesia, with higher K_n values recorded between September and April, the highest being in March (0.89) and the lowest in August (0.82). They suggested that such seasonal changes were associated with variations in food availability, environmental conditions, and reproductive activity. Compared with these studies, the present findings indicate that skipjack tuna maintained a comparatively stable condition throughout the year, possibly due to continuous feeding activity and favorable environmental conditions in the study area.

4. CONCLUSION

Analysis showed positive allometry in males, females, and both genders combined where body weight increased faster than body length. High coefficients of determination (R^2) verified the reliability of predicting body weight using body length. The relative condition factor (K_n) remained constant throughout the year at almost one, indicating good health among fish.

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