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Diversity, temporal abundance, length-weight relationships and condition factors of Lutjanidae from central east coast of India

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Fifteen fish species from the family Lutjanidae were recorded from the Gopalpur fish landing centre, which includes one new record (*Lutjanus xanthopinnis* Iwatsuki, Tanaka & Allen, 2015) from the Southern Odisha, central east coast of India. This study reports length weight relationship for 11 lutjanid species and for *Lutjanus guilcheri* Fourmanoir, 1959, the LWR was recorded for the first time from the Indian coast. The '*b*' value ranges between 2.7 to 3.1. However, the seasonal analysis shows a lower '*b*' value for *L. johnii* during pre-monsoon (2.126) and monsoon (2.186), which is probably due to the high number of juveniles in the sample. The mean value of condition factor (K) ranged between 1.36 and 1.84. The comparative analysis of the '*b*' values of the studied species from different regions of the east coast of India suggests that the overall environmental parameters in the western Bay of Bengal are favourable for their growth.

[**Keywords**: Diversity, Ecosystem suitability, Growth, Odisha, Snappers]

Introduction

The fishes of the family Lutjanidae mainly inhibiting the reefs of tropical and subtropical region is represented by 138 valid species under 21 genera globally[1-4]. Some of the species are also found in mangroves, hypersaline lagoon and brackish water estuaries[1-2]. In Indian waters, the family is represented by 10 genera and 47 species[5-6]. Along the coast of Odisha, it is represented by 20 species[5,7].

Snappers have good market demand and achieve high market prices globally because of its good taste[8]. The members of this family are rich in good proteins, carbohydrates and lipids[9-11]. Some of the species are also considered as ornamental fishes and thus have good commercial value[12]. Because of their high market demand, abundance in landing of the species is also high globally. Sustainability of any species always depends upon the existing population and the environmental suitability. Length Weight Relationship (LWR) is an important tool used for assessing the environmental suitability of finfishes by understanding their life span, mortality, stock composition, growth and production[13-15]. LWR is used as a fishery management tool to understand fish population dynamics and also plays a significant role in comparing the morphological variations of same species from different geographical regions[16]. A number of studies have been conducted globally on LWR of the fishes of the family Lutjanidae to understand various dimensions of their growth in different geographical regions[17-23]. A few studies were conducted on certain species of Lutjanidae from Kochi and Southern Karnataka in the west coast[24,16] and Visakhapatnam, Gulf of Mannar, Chennai, Chilika lagoon, Cuddalore and Portonovo in the east coast of India[25-30]. The growth and environmental suitability of a species varies from one geographical location to another and this could be assessed from the LWR studies. The present study focuses to assess the diversity of lutjanid species from Gopalpur coast along with the LWR to check the environmental suitability.

Materials and Methods

A total of 2,444 specimens were randomly collected between February 2021 and January 2022 from the Gopalpur fish landing center, located on the central east coast of India (19°15'55.13" N, 84°55'04.56" E). Conversations with the fishermen revealed that they primarily use seine nets (100 mm), cast nets (25 – 35 mm), and hook and line for fishing in this area. Based on the availability, the fishes were categorized in to nine size groups (each with a range of 100 mm) ranging from < 100 mm to 900 mm.

A total of 15 species were collected during the study, while the LWR was studied for 11 species. Fish measurements were taken on field by a digital calliper with 0.1 mm accuracy and weight of the fish was measured by electronic weighing balance. The fish samples were collected and brought to the laboratory for identification. The fish specimens were identified up to the species level following standard identification manuals[2,5]. The LWR between fish specimens studied was calculated and expressed by the equation $W = aL^b$ (refs. 31, 32), where, '*L*' is the total length measured from snout to the top of the largest caudal ray (mm), '*W*' is the body weight (g), '*a*' is the intercept and '*b*' is the exponent. The suitability of the coastal waters of east coast of India for the growth of lutjanids is assessed by comparing the LWR reports from other regions of east coast of India. Fulton's condition factor was calculated using the equation $K = 100(W/L^3)$.

Results

A total 2444 number of specimens were measured for LWR. During the study, 15 species belonging to three genus of the family Lutjanidae were recorded from the Gopalpur coast. Among the 15 species, landing of 11 species (*L. johnii*, *L. indicus*, *L. rivulatus*, *L. argentimaculatus*, *L. fulvus*, *L. fulviflamma*, *L. lutjanus*, *L. madras*, *L. xanthopinnis*, *L. guilcheri*, *Pinjalo pinjalo*) were recorded in a reasonable number and rest four species *L. quinquelineatus*, *L. vitta*, *L. lunulatus*, *Pristipomoides filamentosus* are recorded only in few numbers (Table 1). All the 15 species were recorded during winter (Win) (Dec-Feb) and only 13 species were recorded during post-monsoon (POM) (Oct – Nov). Seven species and four species, respectively were recorded during monsoon (MON) (Jun – Sep) and pre-monsoon (PRM) (Mar – May) season. *Lutjanus indicus* (n = 739) and *L. johnii* (n = 646) were found abundantly along the Gopalpur coast during all the four seasons. *Lutjanus fulvus* was recorded during all the seasons but less abundantly (n = 129) compared to *L. johnii* and *L. indicus.* *Lutjanus fulviflamma* (n = 87) and *L. lutjanus* (n = 37) were recorded during monsoon, post-monsoon and winter. *Pinjalo pinjalo* (n = 77) was recorded during pre-monsoon, post-monsoon and winter. *Lutjanus vitta* (n = 5) and *P. filamentosus* (n = 8) were recorded only during winter. *Lutjanus guilcheri* (n = 82), *L. madras* (n = 15), *L. xanthopinnis* (n = 20), *L. quinquelineatus* (n = 8) and *L. lunulatus* (n = 2) were recorded during post-monsoon and winter. *Lutjanus xanthopinnis* was recorded for the first time from the Odisha coast.

The size groups of 11 species studied for LWR are presented in Figure 1. The landings of *L. johnii* and *L. rivulatus* was observed in all size groups. Maximum landing was observed in the size group 300 – 400 mm for both the species (*L. johnii* n = 238, *L. rivulatus* n = 104). The size of *L. indicus* belonged to the groups 200 – 500 mm and the maximum landing was observed for the size group 300 – 400 mm (n = 655). The size groups of *L. fulvus* was found as 100 – 400 mm and maximum landing was observed for the group 200 – 300 mm (n = 87). The size group of *L. fulviflamma* was found as 200 – 400 mm and maximum landing was observed for the group 200 – 300 mm (n = 81). The size groups of *L. lutjanus*, *L. madras* and *L. xanthopinnis* was found to be 100 – 300 mm but for *L. lutjanus*, maximum landing

Table 1 — Seasonal availability of Lutjanidae along the Gopalpur coast

Sl. No.	Species	N	Seasons			
			Pre-monsoon	Monsoon	Post-monsoon	Winter
1	*Lutjanus johnii*	646	✓	✓	✓	✓
2	*Lutjanus indicus*	739	✓	✓	✓	✓
3	*Lutjanus rivulatus*	325	-	✓	✓	✓
4	*Lutjanus argentimaculatus*	287	-	✓	✓	✓
5	*Lutjanus fulvus*	129	✓	✓	✓	✓
6	*Lutjanus fulviflamma*	87	✓	✓	✓	✓
7	*Lutjanus lutjanus*	37	-	✓	✓	✓
8	*Lutjanus guilcheri*	82	-	-	✓	✓
9	*Lutjanus madras*	15	-	-	✓	✓
10	*Lutjanus xanthopinnis*	20	-	-	✓	✓
11	*Lutjanus quinquelineatus*	8	-	-	✓	✓
12	*Lutjanus lunulatus*	2	-	-	✓	✓
13	*Lutjanus vitta*	5	-	-	-	✓
14	*Pinjalo pinjalo*	77	✓		✓	✓
15	*Pristipomoides filamentosus*	08	-	-	-	✓

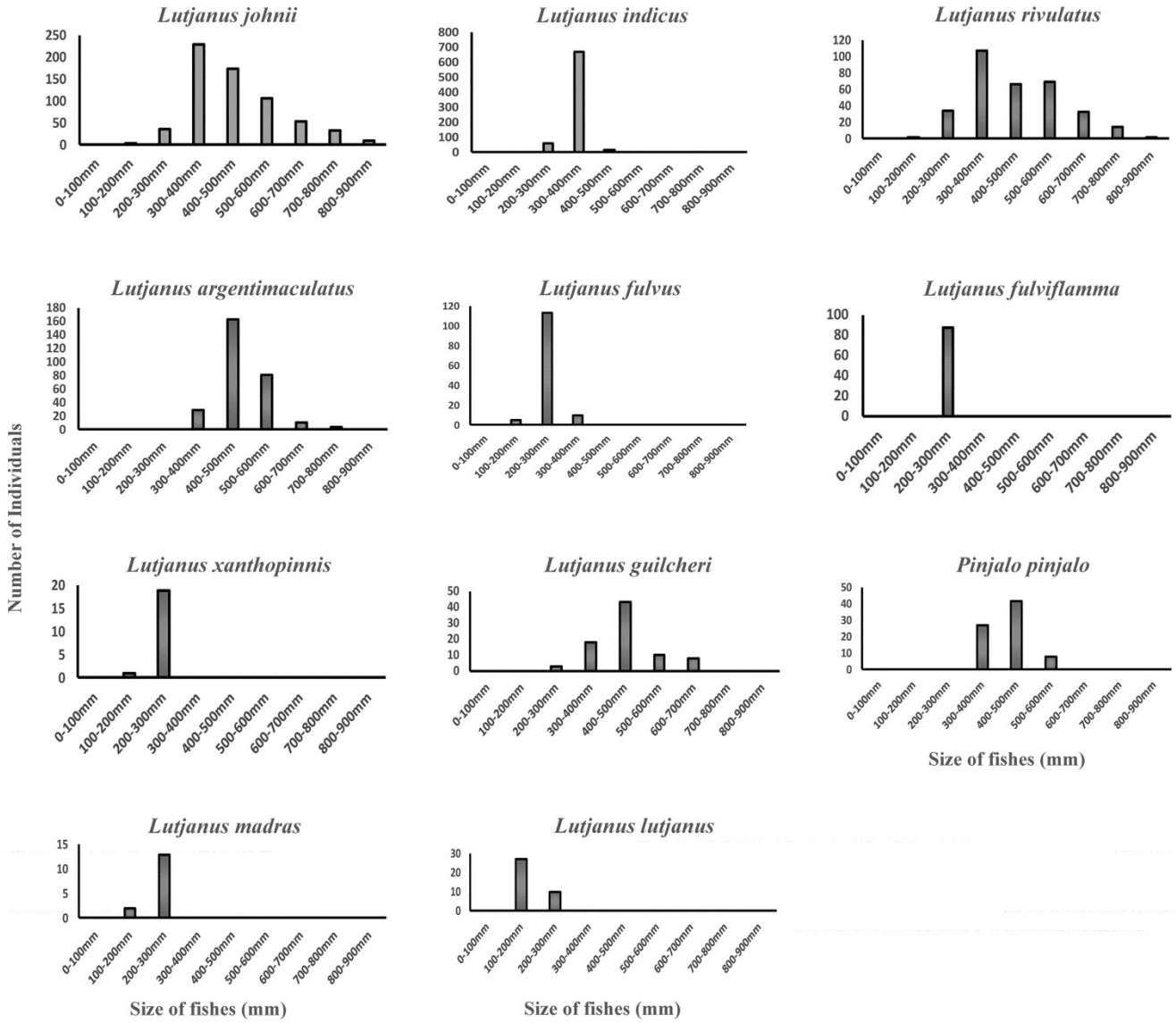

Fig. 1 — The size group of Lutjanidae landed at Gopalpur fish landing centre during February 2021 to January 2022

(n = 27) was observed in the group 100 – 200 mm, while for *L. madras* (n = 15) and *L. xanthopinnis* (n = 20) maximum landing was observed in the group 200 – 300 mm.

The results of LWR, the Total Length (TL) range (min. and max.), Weight (W) range (min. and max.), the intercept of the regression curve (*a*), the regression coefficient (*b*) and the coefficient of determination (r^2) derived from the regression analysis are described in Table 2. The LWR of all species are reported for the first time from the marine waters of the studied region. The '*b*' value of all the species ranged from 2.703 – 3.123. The regression coefficient shows that among the 11 species, isometric growth was recorded only for *L. lutjanus* (b = 3.004) and positive allometric growth was recorded for *P. pinjalo* (b = 3.123). For rest of the species, the growth was negatively allometric (b < 3). The 'r^2' value ranged from 0.757 for *L. xanthopinnis* to 0.957 for *L. rivulatus* and *L. lutjanus*.

The seasonal comparison of 'r^2' and '*b*' values is presented in Figure 2. During pre-monsoon season, highest 'r^2' value (0.990) was recorded for *L. fulviflamma* and lowest 'r^2' value (0.294) was recorded for *L. fulvus*. The highest '*b*' value (3.687) was recorded for *L. fulvus* and lowest '*b*' value (2.126) was recorded for *L. johnii*. In the Monsoon season, highest 'r^2' value (0.999) was recorded for

L. fulviflamma and lowest 'r^2' value (0.790) was recorded for *L. johnii*. The highest '*b*' value (4.005) was recorded for *L. fulviflamma* and lowest '*b*' value (2.186) was recorded for *L. johnii*. During Post-monsoon season, highest 'r^2' value (0.961) was recorded for *L. lutjanus* and lowest 'r^2' value (0.791) was recorded for *L. indicus*. The highest '*b*' value (3.175) was recorded for *P. pinjalo* and lowest '*b*' value (2.585) was recorded for *L. indicus*. While in Winter season, highest 'r^2' value (1.00) was recorded for *L. madras* and lowest 'r^2' value (0.445) was recorded for *L. lutjanus*. The highest '*b*' value (3.142) was recorded for *P. pinjalo* and lowest '*b*' value (1.074) was recorded for *L. madras*.

The mean value of the condition factor (K) was ranged between 1.36 to 1.84. The highest condition factor (K) was recorded as 1.84±0.24 for *L. fulvus* and lowest 1.36±0.14 for *P. pinjalo*.

The '*b*' value and 'r^2' value of these 11 species were compared with the values reported from other regions of the east coast of India (Table 3). The *b*' value of these 11 species were recorded between 2.5 to 3.5 from all regions of the east coast except for *L. rivulatus* which was recorded as 1.62 from the Gulf of Mannar[25].

Discussion

Fifteen species of Lutjanidae were recorded during the present study from the Gopalpur coast. According to the earlier studies, the Lutjanidae family is represented by 20 species from the Odisha coast[5,7]. The present study recorded *L. xanthopinnis* for the first time from the Odisha coast thus increasing the total number of species to 21. The species was earlier reported from Andaman[6] and Andhra Pradesh[29]. Seasonal analysis of data showed that all 15 species are available along the Gopalpur coast during post-monsoon and winter. Earlier studies have described that the coastal waters of Gopalpur region remains highly productive during post-monsoon and winter which in turn attracts many species to this region[33-34]. The high productivity of the region is the probable reason behind availability of all 15 species during post-monsoon and winter season. Occurrence of *L. johnii*, *L. indicus*, *L. fulvus* and *L. fulviflamma* were recorded during all the seasons. However, the availability of the rest of the species along this region is seasonal. The species availability during the present study was low during pre-monsoon. This is because the fishing in this region is banned during April and May due to breeding season of the fishes. Moreover, during this period the fishermen do not go for fishing regularly because of the high wind factor which makes fishing more difficult as well as risky. The data represented for pre-monsoon season is collected only during the month of March, 2021, and hence, the species count is low.

Considering the size of different species, it is found that only *L. johnii* and *L. rivulatus* were landed in all size groups. The largest individual recorded was of *L. johnii* which was 876 mm followed by *L. rivulatus* (811 mm). During the study, the maximum total length of *L. indicus* was recorded as 432 mm and standard length as 347 mm. According to Fish Base, the maximum standard length of *L. indicus* recorded so far is 226 mm[(ref. 3)]. The present standard length of 347 mm of *L. indicus* recorded during the present study constitutes a new size record for the species. It is further noticed that, the large sized species such as *L. johnii*, *L. rivulatus*, *L. guilcheri*, *L. argentimaculatus*

Table 2 — Estimated parameters of LWR of Lutjanidae from the Gopalpur coast

Species name	N	TL (min – max) mm	Mean±SD	W (min – max) g	Mean±SD	K	*a*	*b*	r^2	Growth type
Lutjanus johnii	646	112-876	456±129	29-7920	1788±1520	1.60±0.51	0.00009	2.703	0.914	-A
Lutjanus indicus	739	212-432	336±28	146-1074	538±136	1.38±0.15	0.00003	2.859	0.844	-A
Lutjanus rivulatus	325	145-811	449±131	56-9640	2061±1819	1.83±0.31	0.00003	2.917	0.957	-A
Lutjanus argentimaculatus	287	317-730	482±68	513-5460	1760±823	1.48±0.21	0.00003	2.910	0.900	-A
Lutjanus fulvus	129	179-318	265±27	118-699	351±113	1.84±0.24	0.00005	2.808	0.843	-A
Lutjanus fulviflamma	87	208-299	255±20	128-385	254±59	1.50±0.12	0.00002	2.914	0.898	-A
Lutjanus lutjanus	37	153-281	198±43	54-390	141±102	1.59±0.21	0.00002	3.004	0.957	I
Lutjanus guilcheri	82	275-628	450±79	298-3753	1422±828	1.44±0.26	0.00004	2.851	0.880	-A
Lutjanus madras	15	188-248	214±15	110-257	159±34	1.59±0.11	0.00005	2.803	0.920	-A
Lutjanus xanthopinnis	20	197-249	223±12	119-234	178±31	1.60±0.14	0.00004	2.831	0.757	-A
Pinjalo pinjalo	77	325-585	426±56	420-2523	1115±512	1.36±0.14	0.000006	3.123	0.931	+A

Note: -A: Negative allometric, +A: Positive allometric, and I: Isometric

and *P. pinjalo* were represented by size group of 300 to 500 mm which indicates that the site of fishing is dominated by the adult population. The small size species such as *L. fulvus*, *L. fulviflamma*, *L. madras* and *L. xanthopinnis* landed were belonged to the size group of 200 – 300 mm, which is the maximum growing size for the species[35]. Furthermore, it has been observed that the fishermen prefers to keep the

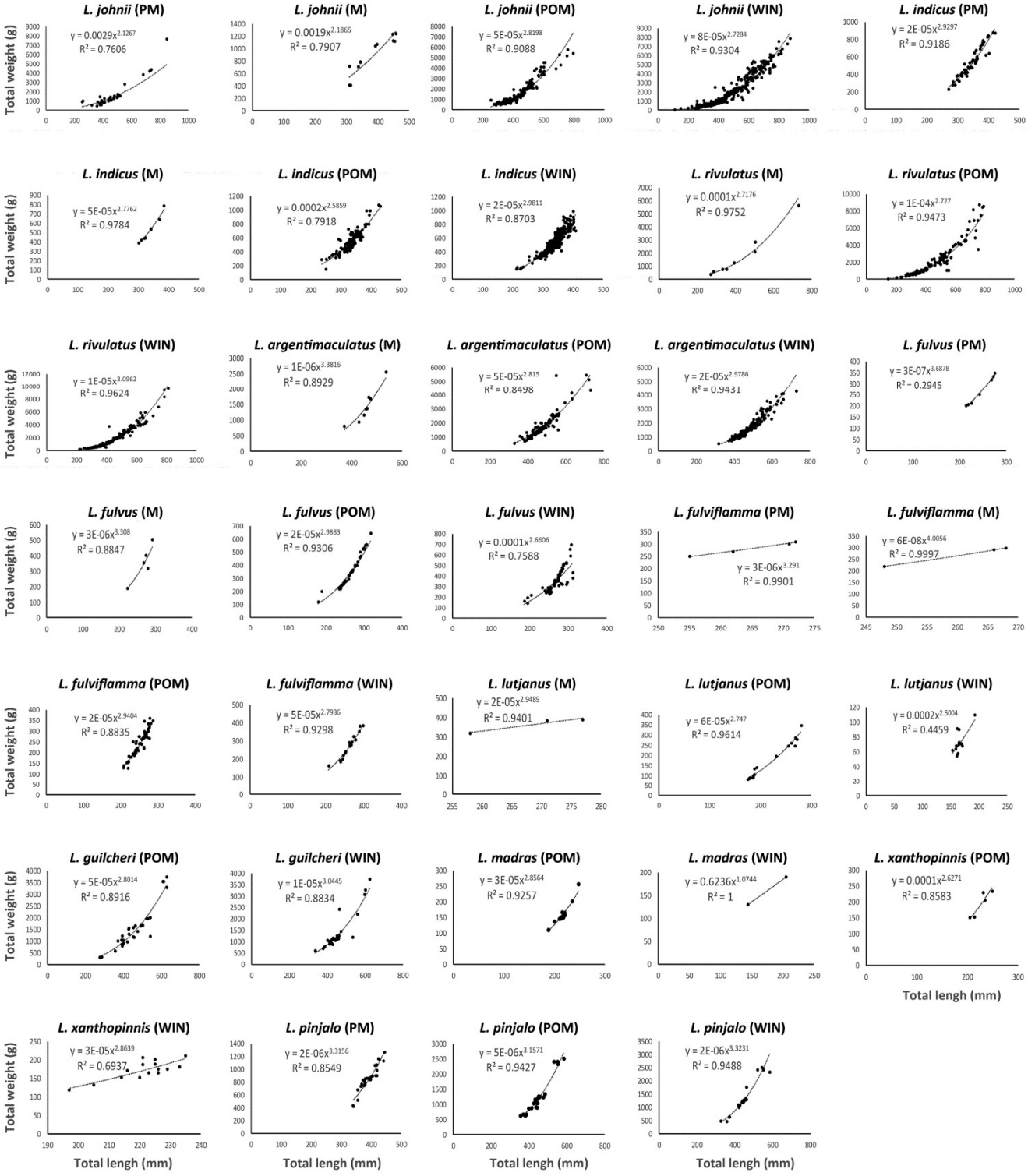

Fig. 2 — Seasonal LWR of Lutjanidae from the Gopalpur coast (PRM: Pre-monsoon, MON: Monsoon, POM: Post-monsoon, and WIN: Winter)

Table 3 — Comparative analysis of LWR studies of Lutjanidae from the east coast of India

	Gopalpur		Cuddalore (Jayaprabha *et al.*[26])		Chilika (Karna *et al.*[30])		Chennai (Martin *et al.*[27])		Gulf of Mannar (Rejitha & Pillai[25])		Visakhapatnam (Velamala *et al.*[29])	
Species name	*b*	r^2	*b*	r^2	*b*	r^2	*b*	r^2	*b*	r^2	*b*	r^2
Lutjanus johnii	2.703	0.914	-	-	2.98	0.99	-	-	2.64	0.80	2.74	0.97
Lutjanus indicus	2.859	0.844	2.91	0.98	2.96	0.99	-	-	-	-	2.72	0.96
Lutjanus rivulatus	2.917	0.957	-	-	-	-	-	-	1.62	0.05	3.12	0.98
Lutjanus argentimaculatus	2.910	0.900	-	-	-	-	-	-	-	-	3.08	0.97
Lutjanus fulvus	2.808	0.843	-	-	-	-	2.91	0.83	-	-	3.07	0.99
Lutjanus fulviflamma	2.914	0.898	2.96	0.97	-	-	-	-	-	-	3.31	0.98
Lutjanus lutjanus	3.004	0.957	-	-	-	-	-	-	2.81	0.94	3.13	0.96
Lutjanus guilcheri	2.851	0.880	-	-	-	-	-	-	-	-	-	-
Lutjanus madras	2.803	0.920	-	-	-	-	-	-	-	-	3.00	0.98
Lutjanus xanthopinnis	2.831	0.757	-	-	-	-	-	-	-	-	2.71	0.96
Pinjalo pinjalo	3.142	0.947	-	-	-	-	-	-	-	-	2.59	0.96

smaller fish for consumption immediately after their catch. Consequently, the LWR data has been derived only for the available smaller specimens.

The '*b*' value recorded during the study for all species ranged between 2.7 to 3.1. The acceptable range of '*b*' value is 2.5 to 3.5[ref. 32]. The '*b'* value for all 11 species examined fell within the acceptable ranges, which suggest their good growth and the environmental suitability. The earlier studies conducted in the east coast of India also highlighted that the '*b*' value of some of the species from various locations ranged between 2.6 to 3.3[refs. 25-27, 29-30]. The findings of the present study and earlier studies indicate that the environmental variables along the east coast of India are suitable for the good growth of lutjanids. However, the seasonal analysis during the present study shows that the '*b*' value of *L. johnii* is < 2.5 during pre-monsoon (n = 40) and monsoon (n = 12) which may be due to highly variable sized fishes (254 − 850 mm) during these seasons. The lower 'r^2' value (0.294) and higher '*b*' value (3.687) of *L. fulvus* during pre-monsoon is probably due to lower 'n' value (n = 7). Similarly, higher '*b*' value (4.005) of *L. fulviflamma* during monsoon is also attributed to lower 'n' value (n = 3). As the value of the condition factors was more than one for all the species, it is further considered that the overall environmental conditions of the region are suitable for the good growth of all the 11 species studied. This is also well supported in a comparison of '*b'* value of studied species with earlier studies from the east coast of Inida, which reported '*b*' values between 2.5 to 3.5. However, as described in the present study there can be a possibility of seasonal impact on their growth.

Conclusion

This is the first hand study on the LWR of Lutjanidae from the Gopalpur coast. A significant numbers of LWR studies have been conducted along the east coast of India and result of these studies suggests that the '*b*' value remains between the acceptable ranges of 2.5 to 3.5, indicating the environmental suitability of east coast for lutjanids. However, there are certain species for which the LWR has not been carried out yet along the east coast. The LWR of Lutjanidae from west coast of India is still unexplored. The study claims for a detailed observation on the LWR of lutjanid fishes as well as other commercial fishes in order to develop a sustainable fishery management plan.

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Conflict of Interest

The authors declare no conflict of interest directly or indirectly with respect to the study reported in this communication.

Ethical Statement

The organisms under the study are not under schedule list/protection categories, thus ethical clearance certification is not applicable.

Author Contributions

RS: Field survey, data collection, interpretation and manuscript preparation. SP: Data collection and

interpretation. SK & AM: Field survey, data collection. LN: Critical review of manuscript. SP & AM: Study design, review of manuscript.

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