

LENGTH-WEIGHT RELATIONSHIP AND CONDITION AND RELATIVE CONDITION PARAMETERS OF *LUTJANUS* SPECIES OF THE FAMILY LUTJANIDAE COLLECTED FROM KARACHI FISH HARBOR, PAKISTAN

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ABSTRACT

Length-Weight relationship and condition and relative condition factor parameters for the five species (*Lutjanus johnii*, *L. lutjanus*, *L. malabaricus*, *L. russellii*, and *L. fulvus*) of fishes belonging to the genus *Lutjanus* of family Lutjanidae were determined. The values of the exponent (b) for males, females and combined sexes belonging to same species were found to be different. Results of length-weight relationship studies showed the applicability of the cube law and a highly significant coefficient of correlation ($r = 0.9$) was found to occur between length and weight for all five *Lutjanus* species, indicating the validity of regression plots. In present study, *Lutjanus* species exhibited both positive and negative allometric pattern of growth. Condition factor (K) when analyzed against the total length and weight of these fishes appeared to be vary with increase in the length and weight. The average value of the relative condition factor (Kn) was found to be around 1 for all species except *L. russellii*, indicating that fishes were generally in good conditions.

Key words: Length-weight relationship, condition factor (K) and relative condition factor (Kn), *Lutjanus* species.

INTRODUCTION

Family Lutjanidae commonly known as “Snappers” is composed of 17 genera and 103 species. About 66 species of this family are included in genus *Lutjanus*. These are mostly reef associated marine fishes (Nelson, 1994). In Pakistan, local names of snappers are “*Gukur*”, “*Hiro*” and “*Mayyo*”. Qureshi, (1955), Khan and Majid (1992) reported only 6-9 species of family Lutjanidae on Sindh and Makran coasts. But Froese and Pauly (2000) have recorded about 32 species of this family from Pakistan Coast.

According to Lagler (1952), in fishes, the growth pattern follows the cube law and such relationship will be valid only if the fish grow isometrically, than in such cases the exponent /regression coefficient (b) value must be exactly 3.0. But in reality, the actual relationship between length and weight may depart from the ideal value (3.0) due to the environmental conditions or the condition of fish (Le Cren, 1951). Martin (1949) observed that the value of exponent (b) usually varies between 2.5-4.0 and the value of (b) remain constant at 3.0 for an ideal fish. But if the value of exponent (b) is greater or less than 3.0, than growth is allometric. If (b) value is less than 3.0 than the fish becomes lighter (negative allometric) and if (b) value is greater than 3.0 than fish becomes heavier (positive allometric) for their specific length (Wootton, 1998). This deviation in value of exponent (b) from ideal value 3.0 revealed that length-weight relationships of the species followed the cube law and might be affected by the general condition of environment, appetite and gonadal contents of the fish. The present study about Length-weight relationship (LWRs) is therefore, an important tool in fish biology, physiology, and ecology and fisheries assessment. It is for the first time that *Lutjanus* species are being studied from this point of view in Pakistan.

MATERIALS AND METHODS

Samples (172) of five species of the genus *Lutjanus* for study were collected from Karachi fish Harbor during the period June 2007 – November 2008. These five species included *L. johnii*, *L. lutjanus*, *L. malabaricus*, *L. russellii* and *L. fulvus*. Total length (TL) of all specimens was measured from tip of snout to longest axis of caudal fin, through measuring board. Wet weight (W) in grams of each individual was measured by using electronic balance.

Le Cren (1951) and Paul (1983) studied methods to estimate the Length-Weight relationship. The length-weight relationship (LWRs) was estimated by using model:

$$W = a \cdot L^b \text{----- (1)}$$

Where as: W= Wet Weight in grams. a = constant. b = growth parameter /exponent and L = Total length in centimeters.

As a general rule it is better to use the log transformation data than regression equation obtained from model 1, as the variability in weight for the different lengths of fishes did not seem nearly constant. So, a logarithmic transformation model was used to make this relationship linear:

$$\text{Log } W = \log a + \log b L \text{ ----- (2)}$$

Where **a** and **b** are estimated by linear regression models. For each species, a regression was used to estimate the intercept ($\log a$) and the regression co-efficient or slope or exponent (b) by using Minitab 14.1 (Statistical software).

The condition factor (K) (Lagler 1956) can be determined from the observed total weight as well as from the corresponding calculated weight by using following formula:

$$\text{The condition factor (K)} = W \times 100000 / TL^3 \text{ ----- (3)}$$

Where as W =total weight and TL =total length of fish.

The relative condition factor (K_n) (Le Cren 1951) has been estimated by dividing the observed weight (W_t) by calculated weight (W_e):

$$\text{Relative condition factor (K}_n\text{)} = W_t/W_e \text{ ----- (4)}$$

Condition (K) and relative condition factor (K_n) were calculated only for combined sexes.

RESULT AND DISCUSSION

The data collected from 172 specimens of five species belongs to genus *Lutjanus* for length-weight relationship was analyzed for detection of cube law. The estimated coefficients of length-weight relationship and other details of statistical analysis are given in tables 1-5. Highly significant positive correlations values 'r' ($r > 0.9$) for males, females and combined sexes indicated that length and weight were highly correlated. The scatter diagram drawn using the untreated individual data showed a parabolic relation between length and weight indicating the applicability of general cube law to *Lutjanus* species. However, a straight line relationship was obtained when logarithmic values of length and weight were plotted (Figs. 1-15). LWRs (logarithmic) were calculated separately for both male, female as well as for combined sexes, used to check whether the growth was positive or negative allometric.

Table 1. Regression parameters of length-weight relationship of *L.johnii*.

Sex	Length range Max. – Min.	Weight range Max. – Min.	Regression equation: $W (\log) = \log a + b \log TL$	N	r	r ²
Males	39-20 cm in TL	2683-297g	$W (\log) = -1.09 + 2.79 \log TL$	30	0.925	94.6%
Female	37.5-21.5 cm in TL	3350-463.6g	$W (\log) = -1.76 + *3.31 \log TL$	14	0.958	98.6%
Combined sexes	39-18.75 cm in TL	2683.7-120 g	$W (\log) = -1.93 + *3.37 \log TL$	44	0.962	92.5%

TL = total length of body; *, b value shows positive allometric growth.

Table 2. Regression parameters of length-weight relationship of *L.lutjanus*.

Sex	Length range Max. – Min.	Weight range Max. – Min	Regression equation: $W (\log) = \log a + b \log TL$	N	r	r ²
Males	27.7 - 15.5 cm in TL	405.6 - 68.2g	$W (\log) = - 1.95 + *3.21 \log TL$	22	0.998	99.30%
Female	28.5 - 20 cm in TL	440.8 - 180g	$W (\log) = -1.02+2.53 \log TL$	22	0.960	87.60%
Combined sexes	28.5 - 15.5 cm in TL	440.8 - 68.2g	$W (\log) = -1.68+3.01 \log TL$	44	0.986	99.10%

*, b value shows positive allometric growth.

Length-Weight Relationship (LWRs) of *Lutjanus* species.

The data collected from 172 specimens of genus *Lutjanus* for LWRs (logarithmic) by using model 2 was calculated for both male, female as well as for combined sexes as follows (see Tables 1-5 & Fig. 1-15):

Table 3. Regression parameters of length-weight relationship of *L.malabaricus*.

Sex	Length range Max. – Min.	Weight range Max. – Min	Regression equation: W (log) = log a + b log TL	N	r	r ²
Males	29.5 - 22.5 cm in TL	596.8-217.4g	W (log) = - 2.84+*3.84 log TL	14	0.996	98.7%
Female	31.5 - 23.5 cm in TL	728.8-285.5g	W (log) = -2.14+*3.53 log TL	06	1.00	99.2%
Combined sexes	31.5-22.5 cm in TL	728-217.4 g	W (log) = -2.56+*3.63 log TL	20	0.993	98.60%

*, b value shows positive allometric growth.

Table 4. Regression parameters of length-weight relationship of *L.russelii*.

Sex	Length range Max. – Min.	Weight range Max. – Min	Regression equation: W (log) = log a + b log TL	N	r	r ²
Males	48.5- 17.5 cm in TL	1950 - 80g	W (log) = - 2.00+ *3.15 log TL	22	0.980	99.8%
Female	43.9 - 23.3 cm in TL	1520 - 215.5g	W (log) = -2.19+ *3.27 log TL	24	0.998	99.4%
Combined sexes	48.5-17.5 cm in TL	1950-80 g	W (log) = -2.04+ *3.17 log TL	46	0.996	99.20 %

*, b value shows positive allometric growth.

Table 5. Regression parameters of length-weight relationship of *L.fulvus*.

Sex	Length range Max. – Min.	Weight range Max. – Min	Regression equation: W (log) = log a + b log TL	N	r	r ²
Males	30 to 24 cm in TL	423.7 to 225.6g	W (log) = -1.19+2.58 log TL	10	0.994	96.9%
Female	27 to 22.5 cm in TL	325.6 to 187g	W (log) = -2.16+*3.27 log TL	08	0.996	98.3%
Combined sexes	30.0-22 cm in TL	423.7-187 g	W (log) = -1.56+2.84 log TL	18	0.980	97.20%

*, b value shows positive allometric growth.

In Table 1, values of (b) for females (3.31) and combined sexes (3.37) of *L.johnii* shows that the exponent (b) values were little more than that of ideal value 3.0; whereas the (b) value of males was (2.79), which was lower than the ideal value 3.0. So, Males exhibited negative allometric pattern of growth but females and combined data exhibited positive allometric showing exceptionally high growth. This high value of (b) may be due to suitable environmental conditions for these fishes. The values of 'r' (r = 0.9) for male, female and combined sexes of *L.johnii* was highly significant and indicated that length and weight were highly correlated. The values of coefficient of determination 'r²' 92.5% for combined sexes, 94.6% for male and 98.6% for female, were also highly significant. The higher 'r²' values indicating that the regression plots for LWRs of *L.johnii* were valid. Likewise, the remaining four species of genus *Lutjanus* also indicated very high value of coefficient of correlation "r" and coefficient of determination "r²" (Table 2-5). Females of *L.lutjanus* exhibited negative allometric (Table 2) and the males exhibited positive allometric growth, but in case of combined sexes, the 'b' value 3.01 was not significantly different from ideal value 3.0 (the slope for an ideal fish) indicating that these fishes growing isometrically in relation to their length.

Table 6. Condition (K) and relative condition factor (Kn) values of the five species of the genus *Lutjanus*.

Name of Species	No. of Specimens (N)	Total length (TL) range (cm)	Observed weight Range (g)	Expected weight Range (g)	Condition Factor (K) Range	Mean (K) value	Relative condition Factor (Kn) Range	Mean (Kn) value
<i>L. johnii</i>	22	39.0-18.7	2683.7-12.0	2301.9-14.4	4797.8-1820.4	4076.2	8.35-0.69	1.46
<i>L. lutjanus</i>	22	28.5-15.5	440.8-68.2	440.2-50.4	2485.0-1551.7	2164.3	1.35-0.69	1.01
<i>L. malabaricus</i>	10	28.5-22.5	537.2-217.2	547.5-206.7	2497.7-1908.6	2252.3	1.05-0.96	1
<i>L. russellii</i>	23	48.5-17.5	1950.0-80.0	1712.5-(-192.3)	1875.8-1441.3	1639.9	1.00- (-0.02)	0.44
<i>L. fulvus</i>	9	30.0-22.5	423.7-187.0	419.2-183.3	1797.1-1523.6	1628.2	1.07-0.93	1

Condition factor (K) and relative condition factor (Kn) of *Lutjanus* species:

Condition (K) and the relative condition factor (Kn) were calculated only for combined sexes of each species of genus *Lutjanus* as follows (Table 6-10):

For the observed weight, the condition factor (K) of the species *L. johnii* of combined sexes was found to be varying from 4797.67 (in 36.2 cm in TL) to 1820.44 (in 18.75 cm in TL) with a mean average value of 4076.24. The relative condition factor Kn of species *L. johnii* was found to be vary from 8.35 (in 18.75 cm TL) to 0.69 (in 33.5 cm in TL) with an average value of 1.46 (combined sexes) shows that these fishes are in good condition. The computation of relative condition factors has provided the useful information in variety of situations especially in hatchery to detect heavy parasitic infections in fishes (Swingle, 1965). For the observed weight, the condition factor (K) of the species *L. lutjanus* of combined sexes was found to be vary from 2485.0 (in 22 cm in TL) to 1551.7 (in 23 cm in TL) with an mean average value of 2164.34. The two distinct peaks were observed at sizes 21.5 cm and 23 cm. This peak at sizes 21.5 and 23 cm, followed by sudden falls in (K) values at sizes 27.5cm, 28 cm and 28.5 cm. This sudden fall in (K) values may an indication of the sizes at which the fish spawned. The average value of relative condition factor Kn of species *L. russellii* was found to be less than 1.0 (0.44). So, these fishes are in poorer condition.

CONCLUSIONS

In present study, all the variations in the values of the exponent (b) for the males, females and combined data have been reported for the five species of genus *Lutjanus* (Table 1-5). Such variations in (b) values is only due to influences of various factors such as; changes in water conditions, sexual stages, availability of food and physical condition of fishes at the time of caught. Condition factor (K) of each species appears to be varying with increase in size and weight of fishes in present study. Wootton (1990) condition factor may vary when average weight of a fish is in direct proportional to the cube of its length. Therefore, according to the Javaid and Akram (1972) when the value of exponent (b) is 3.0 than condition factor (K) would remain constant. But when weight is increasing more rapidly than cube of its length than the value of condition factor (K) would increase with increase in length of fish. If weight value increases less than cube of its length than condition factor (K) tend to decreases with increase in the length of fish. The average value of the relative condition factor (Kn) of all five species of genus *Lutjanus* was found to be one (except *L. russellii*) indicating the validity of the calculated weight of fishes.

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