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Length Weight Relationship (LWR) and Condition Factor (K) of Brown Trout, *Salmo trutta fario*

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Abstract

Length-weight relationships and condition factor of *Salmo trutta fario* (Brown trout) at Kokernag trout fish farm, Anantnag, Jammu and Kashmir was estimated for a period of one year. During the present study the fish samples was within the range of 30cm to 45.8cm in length and 250g to 750g in weight were originally used to provide information on the condition of fish and to determine whether somatic growth was isometric or allometric. The relationship was analysed using the formula $W = a L^b$ which was further transformed into Log W = a + b log L. The equation obtained for females was log W= 1.61 + 3.33 logL and for males was log W = 1.81 + 3.22 logL. Females show 'b' value slight more than males. Studies on condition factor revealed that the fluctuations in K values can be attributed to the spawning cycle. The condition factor 'K' was above 1 indicating robustness or well being of the experimental fish.

Keywords: Condition Factor, Length-Weight Relationship, *Salmo trutta fario*

1. Introduction

Salmo trutta fario (brown trout) is one of the most important fish species which is a native of European waters and now it has become extensively distributed throughout many of the fresh waters of the world including Jammu and Kashmir. It was introduced in Jammu and Kashmir due to its high aquaculture potential, economic value, good taste and high nutritional value. Brown trout (*Salmo trutta fario*) and Rainbow trout (*Oncorhynchus mykiss*) constitute the trout fishery in the streams, Lakes and reservoirs in the Indian uplands[23]. Trout is highly nutritious and it contains omega-3 poly unsaturated fatty acid that is needed for the development of brain and retina in infants[2]. This fish prefers wild type of environment and accepts less amount of artificial feed which is a big challenge for its culture practice. Kokernag trout hatchery is doing lot of efforts for artificial propagation of this fish.

Length-weight relationship of fishes is an important aspect in fisheries and fish biology because it is used in estimation of the average weight of the fish of a given length group by establishing a mathematical relation between them[21,17,18]. The length weight data has two main purposes; it helps to express the relationships between length and weight, so that one of them can be converted into another. It helps to measure the variation of fish condition from the observed weight in relation to the length of the individual fish[11]. The length weight relationship can be extended for the estimation of fish condition assuming that heavier fish of a given length is in better condition[1].

The data on length-weight relationship of some fish species from Kashmir valley has also been reported by different workers[19,4,5,12,16]. Fulton's condition factor (K) is widely used in fisheries and fish biology studies. This factor is calculated from the relationship between the weight of a fish and its length, with the intention of describing the condition of that individual fish[10]. The condition factor is used for comparing the condition, fatness or wellbeing of fish, based on the assumption that heavier fish of a given length are in better condition[17]. As per existing literature, not so much work has been done on length-weight relationship and condition factor of a highly demanded fish *Salmo trutta fario*. Therefore, the study provides baseline

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information on this fish species, which may serve as a tool for management and culture practices.

2. Materials and Methods

2.1 Study Sites

Kokernag is located within geographical coordinates of 33.584721°N and 75.308601°E and is famous for its trout stream and trout hatchery where trout is reared. The study site was selected at Department of Fisheries Kokernag trout fish farm, Anantnag, Jammu and Kashmir. The species of trout fish which are bred as well as propagated are Rainbow trout (*Oncorhyncus mykiss*) and Brown trout *Salmo trutta fario*.

2.2 Collection and Identification of Specimens

The method for identification of fish was used as described earlier by Day 1878 and Kullander *et al*., 1999.

2.3 Collection of Fish for Measurement of Length-Weight Relationship (LWR)

The samples were randomly collected from the raceways. Total length (TL) was measured to the nearest 0.01 cm and the length of the fish was taken from the tip of snout (mouth closed) to the tip of the caudal fin and the weight was taken on digital electronic balance (Shimadzu UX320G) with 0.01g accuracy. The statistical relationship between these parameters of fishes was established using the parabolic equation as described by[9]:

$$W = aL^b$$

Where, W = weight of fish (g)
L = total length of fish (cm)
a = constant
b = an exponential expressing relation between length and weight

The relationship ($W=aL^b$) when converted into the logarithmic form gives a straight line relationship graphically

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Where b represents the slope of the line, Log a is a constant.

2.4 Condition Factor (K)

The coefficient of condition K was calculated by using Fulton[10], equation:

$$\text{Condition factor (K)} = (W/L^3) \times 100$$

Where, W = weight in grams, L = length in cm and 100 is a factor to bring the value of K near unity[9].

3. Results

3.1 Length-Weight Relationship

The monthly data on length-weight relationship of female and male fish is given in Table 1 and Table 2, respectively. During the present study length weight relationship showed some variation throughout the year. The mean value of (b) in both sexes showed positive allometric growth i.e. b>3. In case of females the growth coefficient (b) was minimum in May (3.12) and maximum in November (3.79). The coefficient of determination (r^2) ranged from 0.72 in April to 0.96 in November in females. Whereas in case of males the growth coefficient (b) was minimum in May (3.00) and maximum in November (3.76). The coefficient of determination (r^2) ranged from 0.39 in October to 0.98 in January. The coefficients a, r^2 and b differs due to variations in the length classes. The values were obtained through SPSS statistical software by using linear regression. Length-weight relationship of females and males of *Salmo trutta fario* can be expressed by the equations: log W = 1.61 + 3.33logL and log W = 1.81+ 3.22logL respectively as shown in Table 1 and 2..

3.2 Condition Factor

The condition factor was calculated month-wise, it ranged from 0.99 ± 0.10 to 1.87 ± 0.08 in females. The highest condition factor (K) in case of females was reported in November i.e. 1.87 ± 0.08, while lowest condition factor was reported in January 0.99 ± 0.10 (Table 3). In case of males, it ranged from 0.98 ± 0.126 to 1.77 ± 0.40 with highest in the month of November 1.177 ± 0.40, whereas lowest was recorded in the month of January 0.98 ± 0.12.

Table 1. Monthly length-weight relationships of *Salmo trutta fario* female (Brown trout)

Months	Total Length (cm)		Total Weight (g)		Regression Parameters $W = aL^b$		r^2
	Min	Max	Min	Max	a	b	
January	22.5	42.3	104	760.3	1.61	3.21	0.95
February	21.9	40	154	650	0.79	3.20	0.94
March	22.5	34.5	120	480	1.67	3.16	0.81
April	24.7	34.4	157.2	440	1.47	3.22	0.72
May	24.7	41.1	157	646.2	1.96	3.12	0.94
June	24.7	43.8	166.4	840.4	1.67	3.24	0.95
July	23.2	38.2	108	420	1.83	3.41	0.90
August	26	38.1	140	410	1.58	3.61	0.89
September	23	43.5	166.4	840.4	1.31	3.33	0.95
October	23.5	39.5	120	535.2	1.86	3.43	0.89
November	24.2	43	124	840.4	2.11	3.79	0.96
December	26	42.8	42.8	182	1.79	3.24	0.91
Mean±SD	23.90±1.35	40.1±3.28	129.98±35.41	587.07±210.86	1.61±0.31	3.33±0.20	0.906±0.07

Table 2. Monthly length-weight relationships of *Salmo trutta fario* male (Brown trout)

Months	Total Length (cm)		Total Weight (g)		Regression Parameters $W = aL^b$		r^2
	Min	Max	Min	Max	a	b	
January	23	44.2	160	915.7	1.63	3.21	0.98
February	28	44	316	860	1.11	3.23	0.87
March	28	44	166.4	840.4	1.22	3.12	0.92
April	24.7	43.8	166.4	840.4	1.53	3.21	1.53
May	24.5	43	164	800	2.11	3.00	0.96
June	29.3	42.9	252	700	1.80	3.21	0.89
July	26	38.1	140	410	1.58	3.16	0.89
August	23	44.2	104	915.7	2.85	3.13	0.97
September	29.8	45	200	840	1.77	3.20	0.88
October	29	44	230	830	1.68	3.01	0.39
November	33	42	305	672	1.39	3.76	0.79
December	33	47	305	1030	2.70	3.48	0.90
Mean±SD	27.60±3.45	43.51±2.09	209.066±71.4	804.51±155.8	1.81±0.515	3.22±0.1	0.917±0.24

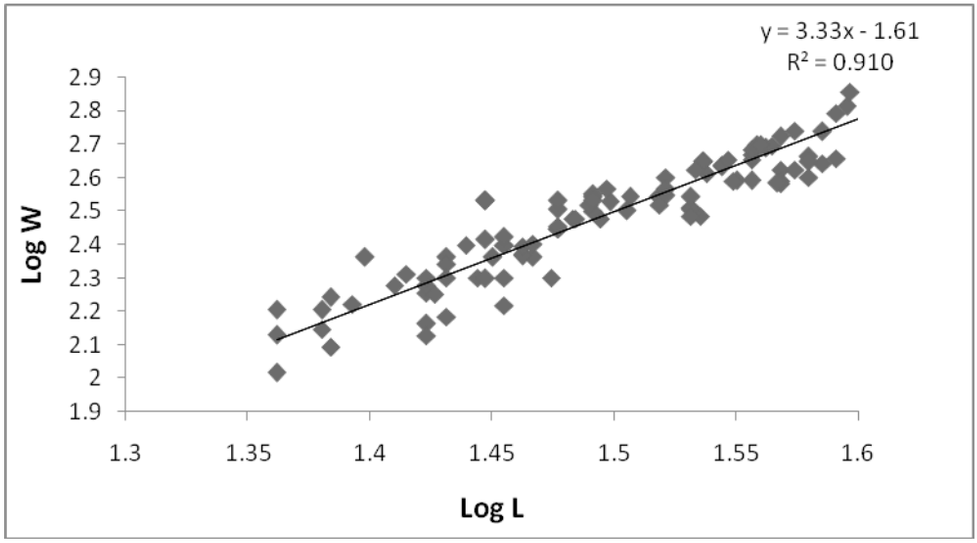

Figure 1. Showing regression line for (LWR) of female fish *Salmo trutta fario.*

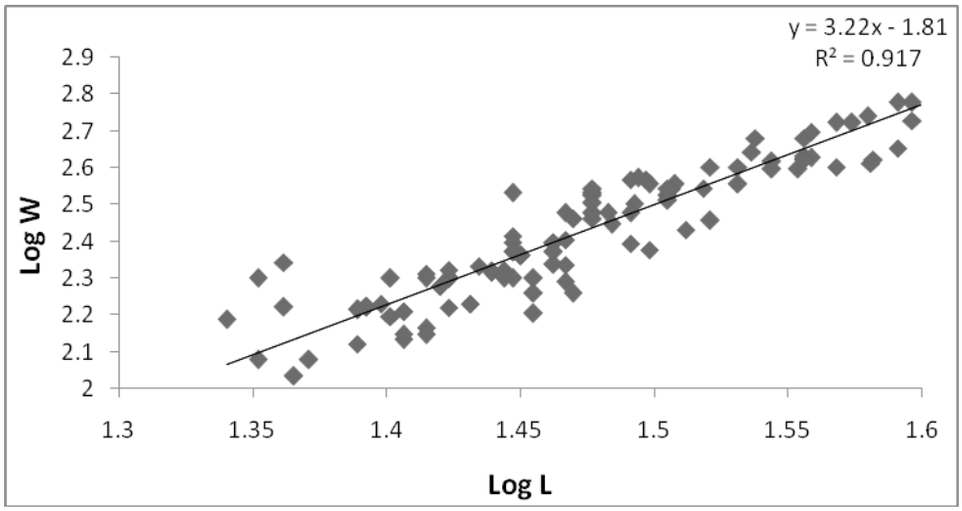

Figure 2. Showing regression line for (LWR) of male fish *Salmo trutta fario.*

Table 3. Month wise condition factor of female and male of *salmo trutta fario* (Brown trout)

Months	Females K±SD	Males K±SD
January	0.99±0.10	0.98±0.12
February	1.02±0.06	1.16±0.12
March	1.05±0.14	1.14±0.40
April	1.07±0.14	1.08±0.12
May	1.08±0.09	1.04±0.11

June	1.09±0.06	1.03±0.13
July	1.10±0.08	1.09±0.41
August	1.21±0.13	1.11±0.31
September	1.41±0.12	1.32±0.23
October	1.62±0.10	1.51±0.21
November	1.87±0.08	1.77±0.40
December	1.72±0.11	1.62±0.12

4. Discussion

Studies on the length weight relation of fishes constitutes an important tool in fishery biology and it helps to determine whether somatic growth was isometric or allometric[15,13]. It is useful in fish stock and population assessment[12]. The parameter length-weight relationships (LWR) is affected by a series of factors viz. season, habitat, gonad maturity, sex, diet, stomach fullness, and health[22,3,7]. The length-weight relationship (LWR) is obtained monthly throughout a complete annual cycle and hence was followed same way in present study for appropriate results. The growth coefficient (b) estimated in the present study was within the range of 3.12-3.79 in case of females, where as in case of males it was found to be in range of 3.00-3.76. The b value was found slight higher in females as compared to males. The higher b value in female implies that the females gain weight at a faster rate in relation to its length[15]. Similar results were also reported by Rawat *et al.* (2014) on *salmo trutta fario* from river Asiganga and found b value 3.04 in females and 3.09 in case of males. Whereas Bagenal and Tesch (1978) also reported that the 'b' value fluctuates between 2 to 4. Similar results were observed by Dar *et al* (2012) in *Schizopyg esocinus.* According to Le Cren (1951) ecological conditions of the habitat, temperature, food supply, spawning, sex, age or variation in the physiology of the animals are responsible for growth rate variations in the same species in different months of a year. The b values observed in the present study were above 3 which mean that *salmo trutta fario* in Kokernag trout fish farm exhibit positive allometric growth.

Condition indices have been widely used as indicators of relative health and robustness (Brown and Murphy, 1991). The condition factor is also used for comparing the condition, fatness, or well being of fish, based on the assumption that heavier fishes of given length are in better condition[1,17]. It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem. Condition factor can also be affected by factors like sex, season, age and maturity stages of fish[8].

In the present study the condition factor of *Salmo trutta fario* showed variation in different months. In case of females it ranged from 0.99 ± 0.10 to 1.87 ± 0.08, with its peak value in November and minimum in the month of January. Similarly in case of males it ranged from 0.98 ± 0.126 to 1.77 ± 0.40, and the highest value of K was recorded in the month of November and the lowest value was again recorded in the month of January. Finally, the length weight relationship and condition factor presented here will prove useful information for fisheries management, research and fish population dynamic studies.

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