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# Length-weight relationship and condition factor of brown trout (*Salmo trutta fario* L.) from River Asiganga, Uttarakhand (India)

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## Abstract

**The present study was performed to describe length-weight relationship of ecological and commercial important exotic fish brown trout (*Salmo trutta fario* L.) inhabited in River Asiganga, a tributary of River Bhagirathi. The knowing of length-weight relationship is important because it provides information on the life history of species and an input to the assessment of fishery resource of the region. The length-weight relationship was estimated as: Log W = 0.310 + 3.096 Log L for males, Log W = 0.291 + 3.040 Log L for females and Log W = 0.302 + 3.073 Log L for overall. The coefficient of correlation (r) for the length-weight relationship was estimated 0.985 which showed a high degree of positive correlation between the length and weight of the fish. The condition factor (K) value was estimated highest 1.473±0.694 for the male and 1.357±0.210 for the female sex during winter.**

***Keywords: Asiganga, brown trout, condition factor, Length-weight relationship***

## Introduction

The length-weight relationship is a very useful tool in fisheries assessment. It is usually easier to measure length than weight and weight can be predicted later on using the length-weight relationship. Furthermore, standing crop biomass can be estimated (Morey *et al*., 2003) and seasonal variations in fish growth can be tracked in this way (Richter *et al*., 2000). The length-weight relationship helps in predicting the condition, reproductive history and life history of fish species (Nikolsky, 1963; Wootton, 1992; Pauly, 1993) and in morphological comparison of species and populations (King, 1995; Goncalves *et al*., 1997). According to Lawson (2011) the investigation on the length-weight relationship studies is important in managing and conserving fish species in habitat. Meanwhile, the condition factors (K) of fish are actually considering the general well being and health of a fish in relation to environment. Brown trout (*S. trutta fario* L.) is an important game fish and is also preferred food by many due to its taste and high protein value. Brown trout belonging to family Salmonidae was initially introduced to suitable waters elsewhere for its sporting qualities (Moss, 1998). While, it was introduced in India in early part of the 19$^{th}$ century, mainly to provide an amateur sports fishery and delicious food. However, in Garhwal Himalayan region of Uttarakhand, brown trout was introduced in 1910. Even after a hundred year history in Garhwal scientific information on brown trout (*Salmo trutta fario* L.) is lacking. For the first time Rawat *et al*. (2011) documented the status of brown trout (*Salmo trutta fario* L.) in Garhwal Himalaya. The objective of present study was to provide baseline data on the length-weight relationship and condition factor of brown trout from River Asiganga in Uttarakhand (Fig. 1).

## Materials and Methods

A total of 253 specimens were studied for assessing length-weight relationship and condition factor during August 2007 and July 2009. After removing moisture from the body, measurements of fish length and weight were taken. The total length (cm) and weight (g) was measured for each individual fish. Season-wise the length-weight relationship of males and females was analyzed separately.

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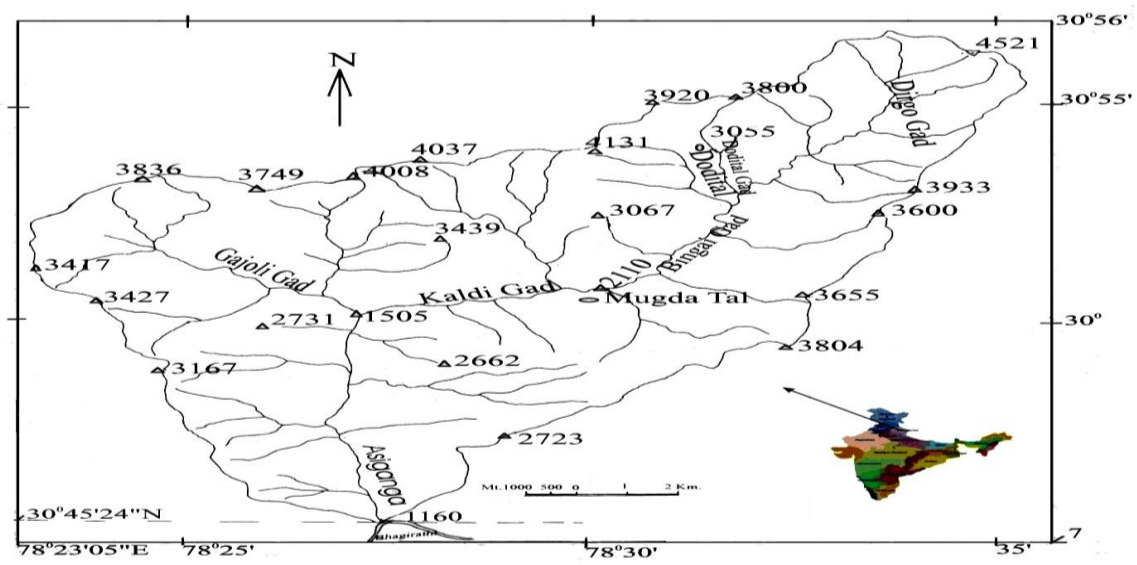



**Figure 1. Location map of River Asiganga.**

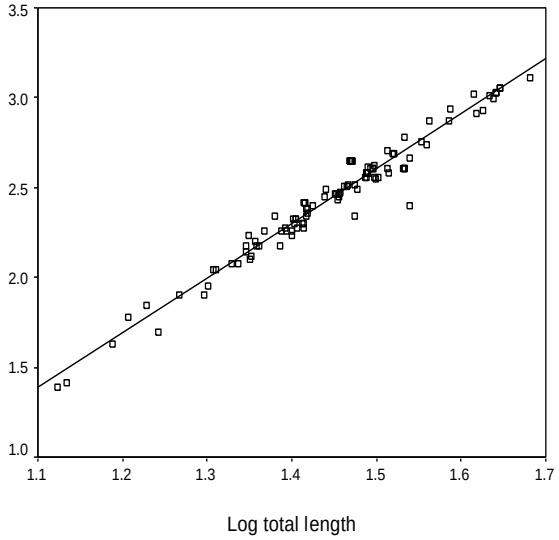
The equation for the length-weight relationship was computed by using the formula for general parabola $W = aL^b$ and in the logarithmic form Log W = log a + b log L (LeCren, 1951) where W = weight of fish, L = length of fish and a & b = constants.

One-way analysis of variance (ANOVA) was used to determine the effect of sex and season in the length-weight relationship with the help of SPSS 10.0. Condition factor (K) known as fitness coefficient, was calculated as LeCrean (1951): $K = (Wx100)/L^3$, Where K= condition factor, W = total body weight (g), L = total length (cm).

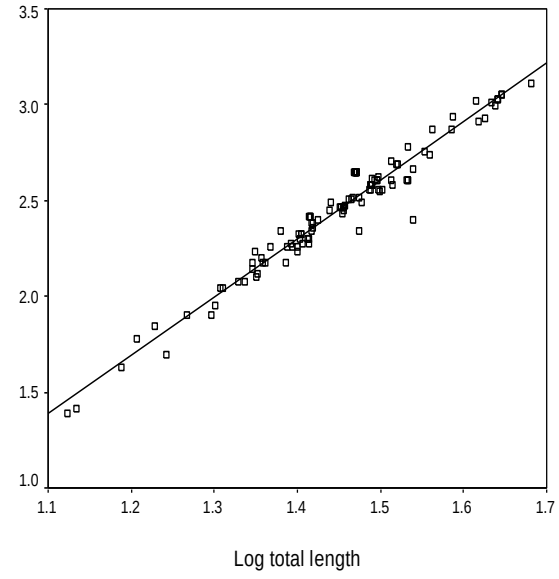
## Results and Discussion

The relationship between fish length and weight of the fish's body presents great importance in fisheries biology studies (Sparre *et al*., 1989) being used broadly with different purposes, namely to estimate the mean weight of fish based on a known length value (Beyer, 1987)**,** to convert growth equations in length into the equivalent one in weight, to compare interspecific and intrapopulation morphometry and to determine the index of well-being of individual fish (Bolger and Connolly, 1989). In the present study brown trout (*Salmo trutta fario* L.) specimen collected from River Asiganga, ranged from 12.8 to 45.9 cm in male and 13.3 to 48.0 cm in female**;** while the weight was measured in between 20.61 to 1180 g in male and 24.37 to 1280 g in female. Earlier, Behnke (2002) reported that brown trout found in small streams of North America reached sizes of 25 to 30 cm and 227 to 340 g, whereas those in rivers and lakes reached sizes of 35 to 76 cm and 0.45 to 5.4 kg. Ozvarol *et al*. (2010) reported the longest and heaviest samples for brown trout from different streams of Turkey were 38.7 cm and 683.13 g for Kocun Bogazi stream, 22 cm and 110.4 g for Cenker stream, 23.3 cm and 153.12 g for Sirakonaklar stream. All these study showed the length and weight of brown trout (*S. trutta fario* L.) varied according to the habitat and altitude. The length and weight data were analyzed statistically to obtain their average values which were then subjected to regression analysis. Length-weight relationship equation were calculated as Log W = 0.310 + 3.096 Log L for males; Log W = 0.291 + 3.040 Log L for females and, Log W = 0.302 + 3.073 Log L overall. Seasonal length-weight equation was calculated as Log W = 0.321 + 3.122 Log L (monsoon); Log W = 0.278 + 3.005 Log L (winter); Log W = 0.301 + 3.072 Log L (spring); and Log W = 0.308 + 3.091 Log L (summer).The sex-wise regression coefficient was calculated 3.096 for the males (r = 0.958), 3.040 for females (r = 0.940) and 3.073 for overall (r = 0.985) (Fig. 2a & b). Season-wise, it was 3.122 (r = 0.925) (monsoon); 3.072 (r = 0.954) (winter); 3.005 (r = 0.956) (spring) and 3.091 (r = 0.966) in summer **(**Fig. 3a - d). In the equation, the value of b is greater for males, showing that the rate of growth in weight per unit growth in length is greater in males

than in females. The **b** value in the length-weight relationship of fish can be used as an indicator of food intake and growth pattern and may differ according to such biotic and abiotic factors as water temperature, food availability, and habitat type (Wootton, 1992). When **b** is equal to 3, it indicates that fish grows isometrically (Amin *et al*., 2008; Rahim *et al*., 2009). Tesch (1971) revealed that most fishes in aquatic ecosystem have b values between 2 to 4, and number of factor influence the length-weight relationship in fishes, including growth phase, season, degree of stomach fullness, gonad maturity, sex, size range *etc*. Froese (2006) recommended that the exponent **(b)** of length-weight relationship should fall within the expected range of 2.5 to 3.5. Based on the length-weight relationship of brown trout from Coruh Basin, Turkey Arslan *et al.* (2004) reported the **b** value of 2.97. Similarly, Ahmet *et al.* (2005) reported the value of exponent **b** in the length-weight relationship of *Salmo trutta macrostigma* as 2.971 for females and 3.009 for males in Firniz stream of the River Ceyhan, Turkey. Moreover, the length-weight relationships for a single species of fish may differ substantially from one study to the next Kimmerer *et al*. (2005). The value of **b** differ not only between species but sometimes also between the stock of the same species due to sex, maturity, seasons and even time of day because of changes in stomach fullness (Bagenal, 1978). The one-way analysis of variance (ANOVA) was calculated seasonally between length and weight for different sexes of brown trout inhabited in River Asiganga and presented in Table 1. There was no significant difference in terms of body length ($F = 0.03$, $P = 0.86$, $df = 1, 251$) and body weight ($F = 0.29$, $P = 0.59$, $df = 1, 251$) of both the sexes. However, analysis of variance indicated that length-weight relationship varied seasonally. The highly significant relationship was between length ($F = 10.39$, $P = <0.0001$, $df = 3,249$) and weight ($F = 9.49$, $P = <0.0001$, $df = 3,249$).The value of condition factor (K) was calculated for each fish and the average monthly K value for different sexes is depicted in Table 2. The maximum value was recorded, *i.e*., 1.451 ± 0.419 and 1.430 ± 0.203, respectively for male and female. While seasonally it was maximum during winter being 1.473 ± 0.694 and 1.357 ± 0.210 for male and female respectively (Table 3). Kumar *et al*. (1979) reported ponderal index (K) in the streams of Kashmir in the range of 1.19-1.31 and highest values of K were registered both for males and females in October. LeCrean (1951) maintained that the condition factor is affected by length as well as several other factors like environment, food supply and degree of parasitism.

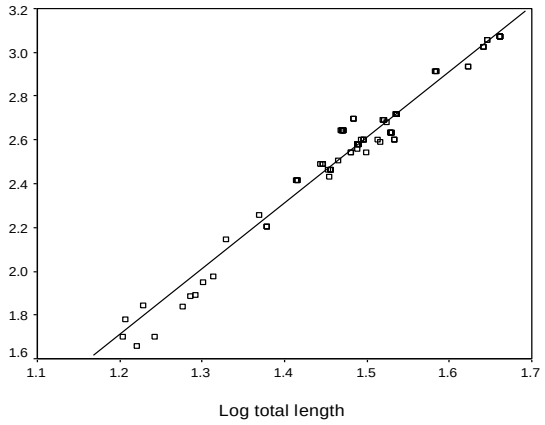



**a) Male**

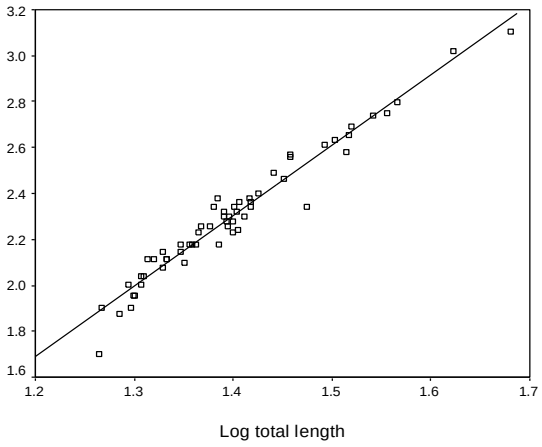



**b) Female**

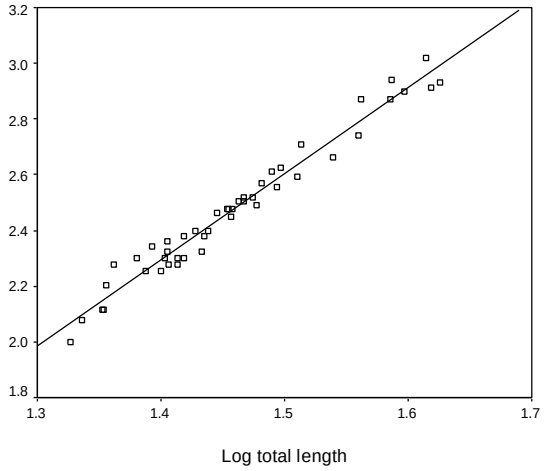
**Fig. 2. Length-weight relationship in male and female *S. trutta fario* L.**



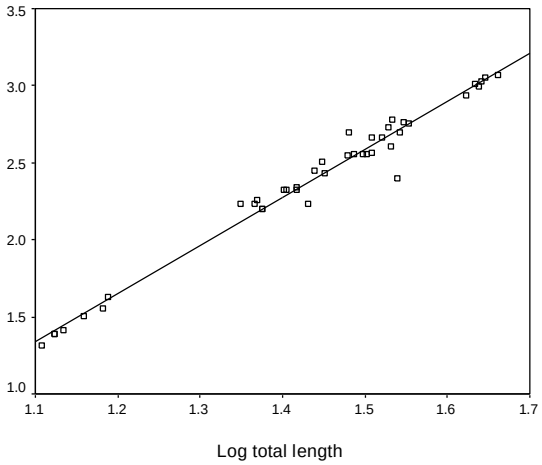

a) **Winter**




d) **Spring**




c) **Summer**




**e) Monsoon**

**Figure 3 (a-d). Length-weight relationship of *S. trutta fario* L. during different seasons**

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**Table 1. One way ANOVA (analysis of variance) between sex and season**

| | df | F value | P | |
|---|---|---|---|---|
| **Sex** | | | | |
| Length | 1,251 | 0.03 | 0.86 | NS |
| Weight | 1,251 | 0.29 | 0.59 | NS |
| **Season** | | | | |
| Length | 3,249 | 10.39 | 0.0001 | S |
| Weight | 3,249 | 9.49 | 0.0001 | S |

**S=Significant, NS = not significant**

**Table 2. Monthly variation in the condition factor (K) of male and female *S. trutta fario* L**

| Months | Male | Female |
|---|---|---|
| Aug. | 1.242 ± 0.075 | 1.290 ± 0.091 |
| Sep. | 1.262 ± 0.126 | 1.295 ± 0.163 |
| Oct. | 1.298 ± 0.115 | 1.294 ± 0.072 |
| Nov. | 1.332 ± 0.099 | 1.306 ± 0.080 |
| Dec. | 1.429 ± 0.247 | 1.370 ± 0.370 |
| Jan. | 1.451 ± 0.419 | 1.430 ± 0.203 |
| Feb. | 1.107 ± 0.547 | 1.156 ± 0.125 |
| Mar. | 1.126 ± 0.291 | 1.193 ± 0.196 |
| Apr. | 1.157 ± 0.352 | 1.198 ± 0.247 |
| May | 1.197 ± 0.151 | 1.222 ± 0.178 |
| Jun. | 1.217 ± 0.093 | 1.261 ± 0.132 |
| Jul. | 1.232 ± 0.282 | 1.264 ± 0.131 |

**Table 3. Seasonal variation in condition factor (K) of male and female*S. Trutta fario* L**

| Season | Male | Female |
|---|---|---|
| Winter | 1.473 ± 0.694 | 1.357 ± 0.210 |
| Spring | 1.269 ± 0.274 | 1.237 ± 0.157 |
| Summer | 1.188 ± 0.282 | 1.263 ± 0.129 |
| Monsoon | 1.213 ± 0.223 | 1.208 ± 0.202 |

This factor varies according to influences of physiologic factors, fluctuating according to different stages of the development. During the present investigation the maximum condition factor values for male and female *S. trutta fario* L. were observed as 1.451 and 1.430, and minimum values observed were 1.107 for male and 1.156 for female respectively. The condition factor when calculated seasonally, showed highest values during winter (spawning season). The high value of condition factor during winter in both the sexes was ascertained due to great increase in the gonadal weight during this period. Isaac-Nanum and Vazzoler (1983) also reported the condition factor as indicator of the period of spawning.

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