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Length–weight relationship and condition factor for five fish species in Anzali Wetland and Talar River of the Caspian Sea Basin of Iran

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Abstract
This study includes the Length-weight Relationship and Fulton's Condition Factor of five species from the Caspian Sea basin. A total of 161 specimens were collected from the Anzali wetland and Talar River of the Caspian Sea basin in autumn, 2015 using electrofishing device. The specimens were ranged 4.55-23.04 cm in total length and 0.50-39.87 g in total weight. Based on the results, the values of 'b' ranged between 2.68 (*C. auratus*) and 3.14 (*S. cephalus*) with a average of 2.91 and the r^2 values greater than 0.93 showing a highly significant relationship. The results revealed that the growth type of *S. cephalus* and *H. leucisculus* were positive allometry (b>3), and those of *B. cyri*, *C. gracilis* and *C. auratus* negative allometry (b<3). In the present study, the condition factor was found to be between 0.078±0.042 (Mean ± SD) to 1.041±0.112 (Mean ± SD). It was highest in *H. leucisculus* in and lowest for *C. gracilis* (0.078). This study provided some basic information of five studied species for fishery biologists in Iran.

Keywords: Freshwater fishes, Fulton's Condition, Caspian Sea Basin, Fish species

1. Introduction
Length-weight relationship (LWR) is of great importance in fishery assessments. LWRs are used for estimating the weight corresponding to a given length [1], to assess the well-being of individuals and determine possible differences between separate unit stocks of the same species [2]. In addition, LWRs can give information on the life span, mortality, growth and production [3, 4, 5].
Condition factor (K) is used as an index of growth and feeding intensity [6], to compare the condition, fatness, or well-being of fishes, based on the assumption that heavier fish of a given length are in better condition [7]. In addition, this factor reflects information on the physiological state of the fishes in relation to its welfare, the accumulation of fat and gonadal development from a nutritional point of view [8]. Condition factor decreases with increasing in length and also influences the reproductive cycle in fishes [4, 6, 9].
Therefore, this study examines the length-weight relationship and condition factor of *Barbus cyri*, *Hemiculter leucisculus*, *Squalius orienatlis*, *Capoeta gracilis* and *Carassius auratus* from the Caspian Sea basin of Iran. The results of this study can be applied for successful management of these species in the future.

2. Materials and Methods
A total of 161 specimens of above mentioned fish species were collected from the Anzali wetland and Talar River from the Caspian Sea basin by electrofishing device during autum 2015 (Table 1). The collected specimens were anesthetized in 1% clove oil solution at the field and their Body Weight (BW) were obtained using a digital balance to the nearest 0.01g after drying by a clean towel and photographed by a digital camera (Canon, 510 IS, 12 MP). A scale was put beside the photographed fishes for extracting morphometric measurements using ImageJ software (version: 1.47). Then, the samples were transported to the laboratory for identification based on Coad [10] and Jouladeh-Roudbar *et al* [11]. The total length of labeled specimens was obtained using ImageJ software.
The relationships between all body length parameters were calculated by the method of least squares to fit a linear regression as: $Y = \alpha + bX$. Where, Y is various body lengths, α is proportionality constant, X is total length and b is regression coefficient [8]. The weight-length relationship was calculated using the expression: $W = aL^b$, where the W is the body weight (g),

L the total length (cm), "*a*" the intercept of the regression and b is the regression coefficient or slope [12, 13]. Also, Fulton's condition factors (K) were calculated for each individual fish according to the equation (Le cren, 1951) [8]: $K = w/aL^b$. Where W is the whole body weight (g), L is the total length (cm), and *a* and *b* are the parameters of length-weight relationship.

3. Results and Discussion

In this study, *a* total of 161 individuals of the five species were used to estimate LWRs. The number of specimens, length ranges (minimum and maximum), weight ranges (minimum and maximum), parameters of length-weight relationships (*a* and *b*), the coefficient of determination (r^2) and condition factor (K) are given in Table 1.

Table 1: Descriptive statistics and estimated parameters of the length–weight relations and condition factor for five fish species in the Caspian Sea basin, Iran.

			Total length (cm)		Body weight (g)		LWR parameters			Condition factor (K)
Species	**River**	**N**	**Min**	**Max**	**Min**	**Max**	***a***	***b***	r^2	**(Mean ± SD)**
B. cyri	Talar River	30	4.56	6.20	1.00	2.76	0.0112	2.89	0.93	1.038 ± 0.082
H. leucisculus	Anzali wetland	32	10.22	16.23	14.80	31.67	0.0092	3.12	0.95	1.041 ± 0.112
S. cephalus	Tajan River	33	10.56	22.50	13.80	39.87	0.0112	3.14	0.98	1.021 ± 0.105
C. gracilis	Talar River	30	4.55	7.01	0.50	5.11	0.0502	2.74	0.99	0.078 ± 0.042
C. auratus	Anzali wetland	36	9.03	23.04	6.02	34.03	0.0112	2.68	0.96	1.020 ± 0.139

The specimens were ranged from 4.55 to 23.04 cm in total length and 0.50 to 39.87 g in total weight. The finding of this study can provide an updated information regarding the parameters of length-weight relationships (*a* and *b*) of studied species in ongoing anthropologically effected water bodies of the Caspian Sea basin.

The normal distribution of exponent *b* in fishes has been reported to be 2.5-3.5 [12, 14]; similar to the results of the present study in which ranged between 2.68 (*C. auratus*) and 3.14 (*S. cephalus*) with an average of 2.91. In this study, the growth types of *S. cephalus* and *H. leucisculus* were determined as positive allometry ($b>3$), whereas those of *B. cyri*, *C. gracilis* and *C. auratus* showed negative allometry ($b<3$). Difference in '*b*' values can be attributed to the seasonal effect, habitat, sex, gonadal maturity, diet, stomach fullness, health, sample size, preservation

Techniques and locality [7, 15, 16] that were not studied in this study. Based on the results, the most of the r^2 values were greater than 0.93 showing highly significant LWRs and ranged from 0.93 to 0.99 (Table 1)

In the present study, the condition factor were found to be between 0.078±0.042 (Mean ± SD) to 1.041 ± 0.112 (Mean ± SD). It was highest for *H. leucisculus* in the Caspian Sea basin. The factor of condition (K) reflects, through its variations, information on the physiological state of the fish in relation to its welfare [8]. The 'K" value of all studied species but *C. gracilis* from Talar River were above the ideal value and indicated that the species were in good conditions in their natural habitats. This study provided some basic information that will be useful for their fishery management.

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