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[Research]

Length- length, length -weight relationship and relative condition factor of pike, *Esox lucius* Linnaeus, 1758, in Anzali Wetland (Southwest of the Caspian Sea)

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ABSTRACT

The length- length (LLRs), length-weight (LWR) relationships and relative condition factor (Kn) of 505 specimens of pike, (*Esox lucius* Linnaeus, 1798) from Anzali Wetland, southwest of the Caspian Sea, were studied from April 2012 through March 2013. The length-length relationships among total length (TL), fork length (FL) and standard length (SL) for pike were found to be highly significant ($r^2 > 0.986$, $P < 0.001$). The values of b in length-weight relationship in males (3.1495), females (3.1843) and for all specimens (3.2137) indicated isometric growth. Mean relative condition factor for male, female and all specimens were 1.003, 1.004 and 1.008 respectively. The result of LWR could be used for fishery managers to approve appropriate regulations for sustainable fishery management. Few studies have been conducted on these parameters of pike and this is the first report on LLRs, LWR and Kn of pike from Iranian waters.

Keywords: Length-weight relationship, Condition factor, *Esox lucius*, Anzali Lagoon, the Caspian Sea

INTRODUCTION

Knowledge on quantitative aspects such as length-weight relationship (LWR), length-length relationships (LLRs), condition factor (K), and growth are important tools for the adequate management of any fish species (king, 2007). LWR and LLRs of fish species are useful parameters for fishery scientists in sampling programs and in managing fishery resources. Estimation of the population size of a fish stock for the purpose of its rational exploitation often requires knowledge of these relationships (Le Cren, 1951; Froese, 2006). LWR also can be used to estimate several components of fish population dynamics (Kohler *et al.*, 1995). Examples include the conversion of growth-in-length equations to growth-in-weight in fish stock assessment models (Khaironizam & Norma-Rashid, 2002;

Gurkan & Taşkavak, 2007; Cherif *et al.*, 2008); the estimation of fish biomass from length frequency distributions (Anderson & Gutreuter, 1983; Petrakis & Stergiou, 1995; Soomro *et al.*, 2007); determining the relative condition factor of small fish compared to large fish (Petrakis & Stergiou, 1995) and comparison of life history and morphological aspects of fish populations inhabiting different regions (Gonc.alves *et al.*, 1997; Stergiou & Moutopoulos, 2002; Moradinasab *et al.*, 2012). The LWR is particularly important in parameterizing yield equations and in estimations of stock size (Abdurahiman *et al.*, 2004). LLRs is also very important for comparison of growth studies (Stergiou & Moutopoulos, 2002; Soomro *et al.*, 2007).

The well-being state of the fish can be inferred with a condition factor (K) (LeCren, 1951), which is used for comparing the condition, fatness or well-

being of fish (Tesch, 1968), assuming that heavier fish of a given length are in better condition. K is also a useful index for monitoring of nutritional concentration, age, and growth rate in fish (Ndimele *et al.*, 2010). This index is greatly influenced by both biotic and abiotic environmental conditions and can be used as an indicator for assessing aquatic ecosystem condition where fish inhabit (Anene, 2005). K also influences the reproductive cycle in fish (Welcome, 1979). According to the general cube law governing length-weight relationship, the weight of the fish would vary as the cube of length (Ahmad Dar *et al.*, 2012). Le Cren (1951) proposed relative condition factor (K_n) in preference to K as the former considers all the variations like those associated with food and feeding, sexual maturity, etc., while the latter does so only if the exponent value is equal to 3. Thus K measures the variations from an ideal fish, which holds the cube law while K_n measures the individual deviations from the expected weight derived from the LWR.

Pike, *Esox Lucius* Linnaeus, 1758, are widely distributed in Europe, Asia and North America, and are valuable objects of commercial and recreational fishery throughout much of its natural range (Paukert *et al.*, 2001; Arlinghaus & Mehner, 2004). As a top-level of food chain, the pike plays an important role in the regulation of fish communities in river and lake ecosystems (Jepsen *et al.*, 2001; DeBates *et al.*, 2003; Paukert *et al.*, 2003). Anzali

Wetland is one of the international Lagoons in Iran, one of the most important habitats for fishes, bivalves and birds in the south of the Caspian Sea and an important spawning and nursery ground for commercially important fish species. Pike makes up the highest percentage of the catch composition in this wetland. At the same time, it is a favorite fish for sport fishing and human consumption in the region (Imanpour Namin *et al.*, 2011). However the amount of catch has been dropped dramatically in recent years from 180 tons in 2003 to almost 100 tons in 2010 (Iranian Fishery National Committee, 2011).

Several authors have studied LWR and K in pike (Lorenzoni *et al.*, 2002; İlhan *et al.*, 2003; Griffiths *et al.*, 2004; Çubuk *et al.*, 2005; Erdem *et al.*, 2007; Yagci *et al.*, 2009; Benzer *et al.*, 2010). Considering the importance of the parameters mentioned above, the objectives of the present study were to describe the LWR, LLRs, and K_n of pike population in Anzali Wetland which is the first report on pike from Iranian waters.

MATERIALS AND METHODS

The present study was carried out on 505 pikes caught between April 2012 and March 2013 from Anzali Wetland (37° 28' N, 49° 25'E) in the southwest of the Caspian Sea (Fig. 1). The fish were caught by gill nets (length 20, 40, 60 m, width 2.5 - 3 m and mesh size 18, 23, 32, 36, 45, 55 and 60 mm).

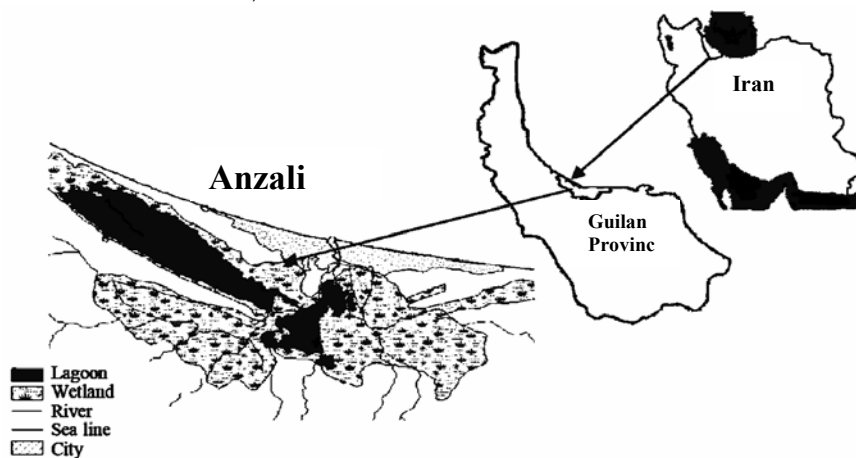


Fig. 1: sampling localities of *E. lucius* in Anzali Wetland (southwest of the Caspian Sea) during 2012-2013.

Total length (TL), fork length (FL) and standard length (SL) for each specimen were measured to the nearest 1 mm; body weight (BW) was measured by digital balance with 0.1 g precision. The sex was assigned by examining gonads and based on macroscopic observation. The length-weight relationship was estimated using the $W = aFL^b$ equation (Ricker, 1975), where W is total weight (g), FL is fork length (cm) and a is the intercept of regression and b is the regression coefficient (slope). If the calculated value for "b" is very close to 3, the species has isometric growth. The following equation was used to confirm this matter:

$$t = \frac{s.d.x}{s.d.y} \times \frac{|b-3|}{\sqrt{1-r^2}} \times \sqrt{n-2}$$

where s.d(x) = Standard deviation of log fork length, s.d. (y) = Standard deviation of log weight, r^2 = Coefficient of determination and n= sample number (Pauly, 1984). Moreover relationships among TL vs FL, FL vs SL, and SL vs TL were calculated by linear regression. Relative condition factor (Kn) as per Le Cren (1951) is expressed as follows: $Kn = \frac{W}{W^3}$. Where W= observed

weight and W^3 = calculated weight derived from length-weight relationship.

RESULTS

A total of 505 individuals of pike were obtained during the study period; 156 were male, 263 female and 86 unsexed. Fork length (min-max, mean±SE) of males, females and all specimens were 205-566, 342.7±0.52; 183-661, 361.1±0.49 and 183-725, 385.2±0.41 mm, respectively. Male body weight varied in the range of 56.3-1852.3 g, with average of 352.1±19.21, females in the range of 52.9- 2050.3 g, with average of 461.08±21.65, and all specimens between 52.9- 3442.5 g, with average of 544.69±21.39 g. The descriptive data of TL, FL, SL, and BW of males, females and total specimens are shown in Table 1.

Table 1: Statistical description obtained for 505 *E. lucius* sampled from Anzali Wetland, southwest of the Caspian Sea: (TL: total length, FL: fork length, SL: standard length (mm) and BW: body weight (g) (range , mean± standard error (SE).

Parameter	Sex			
	Males 156	Females 263	total specimens 505	
TL	range	215-596	194-662	194.-763
	Mean±SE	351.6±0.55	380.8±0.51	405.8±0.43
FL	range	205-566	183-661	183-725
	Mean±SE	342.7±0.52	361.1±0.49	385.2±0.41
SL	range	192-527	173-591	173-669
	Mean±SE	318.9±0.49	336.4±0.46	359.0±0.39
BW	range	56.3-1852.3	52.9-2050.3	52.9-3442.5
	Mean±SE	352.1±19.21	461.1±21.65	544.7±21.39

The results of comparing mean fork length ($t = -2.200$, $df = 417$, $P < 0.05$) and body weight ($t = -2.138$, $df = 417$, $P < 0.05$) indicated significantly differences between males and females.

The parameters of length-weight relationship (a, b, r^2 , d_f and t_{cal}) for males,

females and total specimens are presented in Fig. 2. The obtained regression coefficient (r^2) values for males, females and total specimens were 0.980, 0.974 and 0.983, respectively. The obtained b values for LWR were close to 3, i.e., 3.1495 for males, 3.1843 for females, and 3.2137 for total

specimens, which showed isometric growth in males, females and total specimens. The t values were obtained

using the equation mentioned above and were compared with t-table and showed isometric growth pattern in this species.

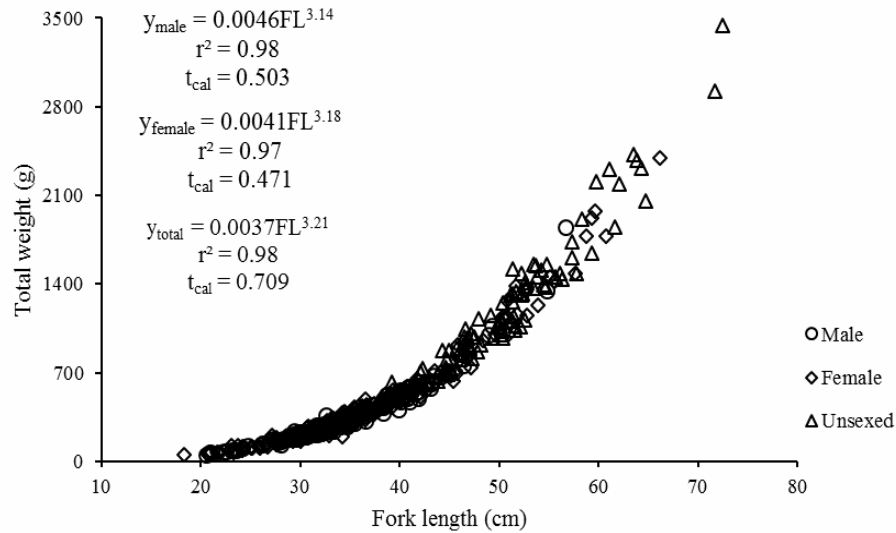


Fig. 2: Relationship between fork length (cm) and body weight (g) for males, females and total specimens of *E. lucius* L. from Anzali Wetland, southwest of the Caspian Sea

Table 2: Length-length relationships among total length (TL), fork length (FL) and standard length (SL) for males, females and total specimens of *E. lucius* from Anzali Wetland, southwest of the Caspian Sea.

Sex	Parameters of the LLRs				
	N	Equation	a	b	r ²
Males	157	TL = a + bFL	0.304	1.046	0.995
		FL = a + bSL	0.315	1.065	0.988
		TL = a + bSL	0.584	1.115	0.986
Females	267	TL = a + bFL	0.540	1.040	0.997
		FL = a + bSL	0.147	1.069	0.997
		TL = a + bSL	0.662	1.116	0.997
Total specimens	537	TL = a + bFL	0.415	1.043	0.998
		FL = a + bSL	0.325	1.064	0.997
		TL = a + bSL	0.729	1.110	0.996

The parameters of LLRs (equation, a, b, r^2 and n) are given in Table 2. Results for LLRs revealed high correlation ($p < 0.001$), with all coefficient almost equal to 0.986. The monthly relative condition factor (Kn) ranged from 0.949- 1.106. These values

were 1.003, 1.004, 1.029, 1.00 for males, females, unsexed, and total specimens respectively. The lowest and highest Kn values were found in April and January (Fig. 3).

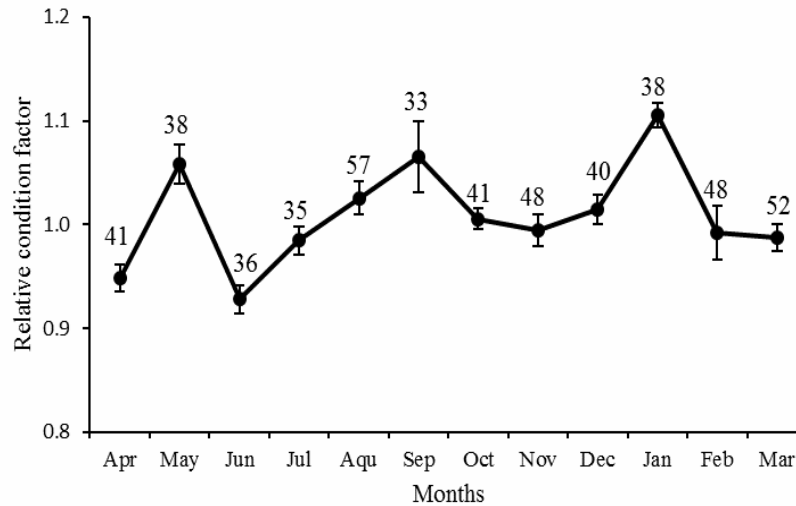


Fig. 3: Relative condition factor (Kn) (mean \pm SE) of *E. lucius* sampled from Anzali Wetland (southwest of the Caspian Sea) from April 2012 through March 2013.

DISCUSSION

The mean fork lengths and body weights of females were higher than those of males ($P < 0.05$). This is in agreement with findings for pike population of Karamik Lake in Turkey (Çubuk *et al.*, 2005). Values of b (3.1495, 3.1843 and 3.2137 for males, females and total specimens, respectively) of length-weight relationships confirmed that the growth pattern was isometric in these specimens. Griffiths *et al.*, (2004), Lorenzoni *et al.*, (2002), and Roche *et al.*, (1999) reported isometric growth for males and females in a northern Ontario River, in Trasimeno Lake and in an Irish reservoir, respectively. However, lower values were reported by Çubuk *et al.*, (2005) in Karamik Lake and Altındağ *et al.*, (1999) in Kesikköprü Dam Lake (Turkey). These variations in b exponents for the same species could be attributed to differences in sampling, sample size or length ranges (Yeamin Hossain, 2010). In addition, growth increment, differences in age and stage of maturity, food, as well as environmental conditions such as

temperature, salinity and seasonality can also affect b value for the same species (Weatherley & Gill, 1987). According to Tesch (1968), the b value in each fish population may differ according to species, sex, age, season and feeding.

The mean relative condition factor of males, females and total specimens were 1.003, 1.012 and 1.007, respectively. In studies on population dynamics, high values of condition factor indicates favorable environmental conditions and low values indicate less favorable environmental conditions (Blackwell *et al.*, 2000). No information is available on the Kn of Pike, therefore we have referred to condition factor (K) values of Pike in various studies. Cubuk *et al.*, (2005) reported 0.812 as average value for K in pike population of Karamik Lake which was higher than that in pike population of Uluabat Lake (Cubuk *et al.*, 2001) and lower than those of Işikli Lake (İlhan *et al.*, 2003), Mogan Lake (Şahin, 1998) and Kesikköprü Dam Lake (Altındağ *et al.*,

1999). According to Le Cren (1951) and Ricker (1975), the condition factor exhibits changes depending on gonad development, age, seasonal changes in growth and net mesh size. Oni *et al.*, (1983) noted that the condition factor for a species or population is not constant over time and may be influenced by biological and non-biological factors such as feeding areas and gonadal development (Saliu, 2001).

In the present study, the values of *a*, *b* and *r*² of 505 pike were 0.415, 1.043 and 0.998 for TL vs FL, 0.325, 1.064 and 0.997 for FL vs SL and 0.729, 1.110 and 0.996 for TL vs SL. To the date we were not able to find any references dealing with LLRs for the studied species therefore it was not possible to compare the present results with previous studies.

In conclusion, this study has provided basic information on the LLRs, LWR and Kn of Pike in Iranian waters which would be useful for fishery biologists, sustainable fishery management and fish conservation in the region.

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روابط طول-طول، طول-وزن و فاکتور وضعیت نسبی اردک ماهی (*Esox lucius*)
در تالاب انزلی (جنوب غربی دریای خزر) (Linnaeus, 1785)

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چکیده

روابط طول-طول (LLR_s)، طول-وزن (LWR) و فاکتور وضعیت نسبی (Kn) اردک ماهی (*Esox lucius* Linnaeus, 1785) در تالاب انزلی، واقع در جنوب غربی دریای خزر، توسط 505 نمونه از شهریور 1391 تا تیر 1392 مورد مطالعه قرار گرفت. روابط طول-طول بین طول کل (TL)، طول چنگالی (FL) و طول استاندارد (SL) اردک ماهی به طور قابل توجهی معنی دار بود ($r^2 > 0.986$, $P < 0.001$). مقادیر b در رابطه طول-وزن در جنس نر (3/14)، جنس ماده (3/18) و مجموع نمونه‌ها (3/21) نشان‌دهنده رشد ایزومتریک این گونه می‌باشد. میانگین فاکتور وضعیت نسبی در جنس نر، ماده و مجموع نمونه‌ها به ترتیب برابر با 1/003، 1/004 و 1/008 بود. نتایج رابطه طول-وزن می‌تواند توسط مدیران شیلاتی جهت بهبود مدیریت شیلاتی پایدار مورد استفاده قرار گیرد. مطالعات اندکی روی این پارامترها در اردک ماهی متمرکز شده‌اند و این به عنوان اولین گزارش LLR_s ، LWR و Kn اردک ماهی از آبهای ایران می‌باشد.

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