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Length-weight relationship, condition factor and relative condition factor of *Alosa braschnikowi* and *A. caspia* in the southeast of the Caspian Sea (Goharbaran)

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ABSTRACT

The main objectives of the present study were to determine the species composition of Caspian shad, genus *Alosa* and to estimate the LWR, CF, and Kn of *A. braschnikowi* and *A. caspia* during different months in the southeastern coast of the Caspian Sea. Two fishing methods, small mesh size beach seine and gillnet were used from December 2013 through July 2014. *A. braschnikowi* and *A. caspia*, were distinguished in the southeastern part of the Caspian Sea (Goharbaran), consisting of 57.1% and 42.9% of the Alosa catch, respectively. The slopes (b values) of the length-weight regression were 3.241 and 2.844 which were significantly different from 3 ($P<0.05$), indicating positive and negative allometric growth, respectively. The average CF of *A. braschnikowi* and *A. caspia* were calculated as 0.72 ± 0.12 and 0.83 ± 0.13, respectively. The average CF for both species were significantly different among months ($P<0.001$). There was a significantly negative correlation between size classes and CF of *A. caspia*. The Kn was greater than 1 for *A. braschnikowi* and lower than 1 for *A. caspia* indicating good well-being of *A. braschnikowi* as opposed to *A. caspia* in the southeastern Caspian Sea.

Keywords: Shad, Length, Condition factor, Relative condition factor, Caspian Sea.

INTRODUCTION

Over the past three decades various factors, such as sea-level fluctuations, pollution (Salmanov 1999; Ivanov 2000; Nasrollahzadeh 2010) and the introduction of exotic species have changed significantly the environment of the largest inland water body in the world, the "Caspian Sea". The new invasive species (Ctenophora, *Mnemiopsis leidyi*) which was first observed in November 1999 (Ivanov *et al*. 2000) has subsequently affected the distribution and abundance of plankton species (Ganjian *et al*. 2010; Roohi *et al*. 2010), kilka stocks (Karimzadeh 2010; Fazli *et al*. 2007, 2009) and communities, habitats and ecosystem functioning of the Caspian Sea (Pourang *et al*. 2016). The Clupeidae is one of the world's most commercially-important families of fish. *Alosa* species belong to family Clupeidae and comprise seven genera and 31 species (Whitehead 1985). These species are widely distributed in the Caspian, Black and Mediterranean seas, and also the Atlantic Ocean. Five species of genus *Alosa* (Caspian herrings) have been reported in Iranian waters of the Caspian Sea, including Caspian marine shad *A. braschnikowi* (Borodin 1904), Caspian shad *A. caspia* (Eichwald, 1838), Caspian anadromous shad *A. kessleri* (Grimm 1887), shad *A. saposchnikowii* (Grimm 1887) and Agrakhan shad *A. sphaerocephala* (Berg 1913) (Abdoli & Naderi 2008; Abbasi 2017; Esmaeili *et al*. 2018). During the last century, genus *Alosa* has been a major item of the Caspian and herring fisheries in almost the entire coast of the Caspian Sea. In the years 1885-1963, the maximum catch of herrings was higher than 300000 metric tons and averaged 104000 metric tons (Malkin & Andrianova 2008), but during the last two decades, their annual catch declined sharply to less than 6000 metric tons in the Caspian Sea.

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For example, in the years 1993–2012, the catch ranged from 144 to 932 (averaged 530) metric tons in Iran and ranged from 72 to 4710 (averaged 1220) metric tons in other neighboring countries of the Caspian Sea (data source: Fishstat Plus, FAO Fisheries Department, Fishery Information, Data and Statistic Unit; FISHSTAT Plus: Universal software for fishery statistical time series). Knowledge of length-weight relationship, condition factor, growth, and recruitment are important tools for the adequate management of any fish species (King 2007). The length-weight relationship (LWR) can give information on the stock condition, condition indices and several aspects of fish population dynamics (Bagenal & Tesch 1978; Gonçalves *et al*. 1997). The condition factor (CF) is used to compare the condition, fatness or well-being of the fish (Bagenal & Tesch 1978) and the relative condition factor (K_n) is influenced by many environmental and biological factors (Le Cren 1951).

Despite the commercial importance of Caspian shads, knowledge on the life history parameters of these fishes is limited to the spatiotemporal habitat preferences of *Alosa* (Haghi Vayghan *et al.* 2016), length-weight relationships (Ghotbi-Jokandan *et al*. 2015), length, weight, age and sexuality (Taghavi *et al*. 2016), feeding habits (Abbasi & Sabkara 2004; Abdollahpour *et al*. 2007; Afraei Bandpei *et al*. 2012; Jalili *et al*. 2013; Azizov *et al*. 2015) as well as biology and stocks (Malkin & Andrianova 2008). Therefore, the main objectives of the present study were to determine the species composition of genus *Alosa* and to estimate the LWR, CF, and K_n of *A. braschnikowi* and *A. caspia* in the southeastern coast of the Caspian Sea.

MATERIALS AND METHODS

The sampling area, Goharbaran is located beside the Amirabad port and Neka Power Plant in the southeastern part of the Caspian Sea. Two fishing methods, small mesh size beach seine (SBS) in depths ≤ 2 m and multi-mesh gill net (MGN) (30 m length and 4 m height, with 22, 26, 33, 40, 45 and 56 mm mesh sizes, knot to knot) in three depths 5, 7 and 10 m were used during December 2013 to July 2014. The total length (TL) was measured to the nearest 1 mm and total weight to the nearest 1 g. The length-weight relationship was derived by applying an exponential regression as the following equation:

$$W = aTL^b$$

where W is the total weight (g), TL, the total length (cm), and a and b are parameters to be estimated (Ricker 1975). Parameters estimation was conducted by least-squares linear regression on log-log transformed data:

ln (W) = ln (a) + b × ln (TL).

T-test for departure from isometry (b = 3) was carried out using the following formula (Pauly 1984):

$$t = \frac{s.d.\ln(TL)}{s.d.\ln(W)} \times \frac{|b-3|}{\sqrt{1-r^2}} \times \sqrt{n-2}$$

where s.d.ln (TL) and s.d.ln (W) are standard deviations' natural logarithm of the total length (cm) and weight, respectively; a and b are regression parameters and R^2 is correlation coefficient between length and weight and n is sample size.

The condition factor (CF) was calculated as the following equation (Froese 2006):

$$CF = \frac{W}{TL^3} \times 100$$

where W (g) is weight and TL (cm) is the total length.

The relative condition factor (K_n) compensates for changes in form or condition with an increase in length and was calculated using the following equation (Froese 2006):

$$K_n = \frac{W}{aTL^b}$$

where W is weight (g), TL is the total length (cm), and a and b are the exponential form of the intercept and slope, respectively, of the logarithmic length-weight equation. The Pearson correlation coefficient was calculated to investigate the relationship of K_n and CF length. The comparison between the average values for months was carried out through analysis of variance (ANOVA). The Tukey pairwise test for multiple comparisons was used to assess differences between the months (Zar 2010). Statistical analyses were performed using SPSS 18 and Excel 2013 software packages.

RESULTS

A total of 308 caught specimens belonged to two species of *A. braschnikowi* and *A. caspia*, consisting of 176 (57.1%) and 132 (42.9%) of the catch, respectively. The specimens of *A. braschnikowi* were caught during December 2013 and January-April 2014, while those of *A. caspia* in December 2013, May and July 2014 (Fig. 1).

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The length frequency of the two species shows that the smallest specimen was caught by SBS (Figs. 2 - 3).

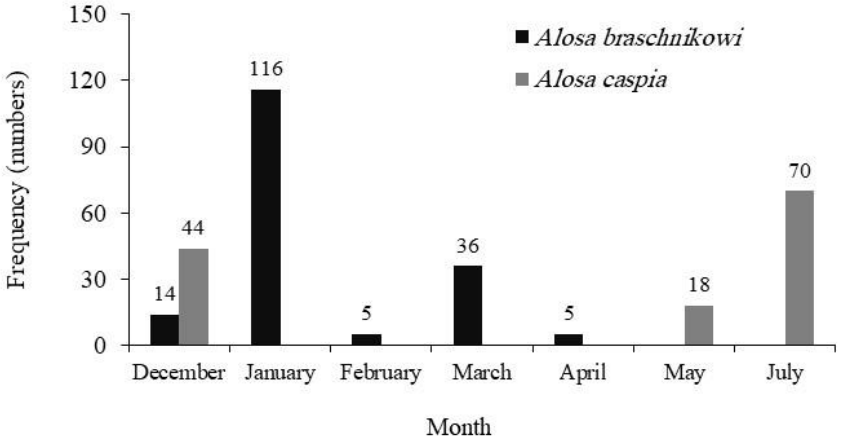

Fig. 1. Monthly species composition of *Alosa* in catches in the southeastern Caspian Sea.

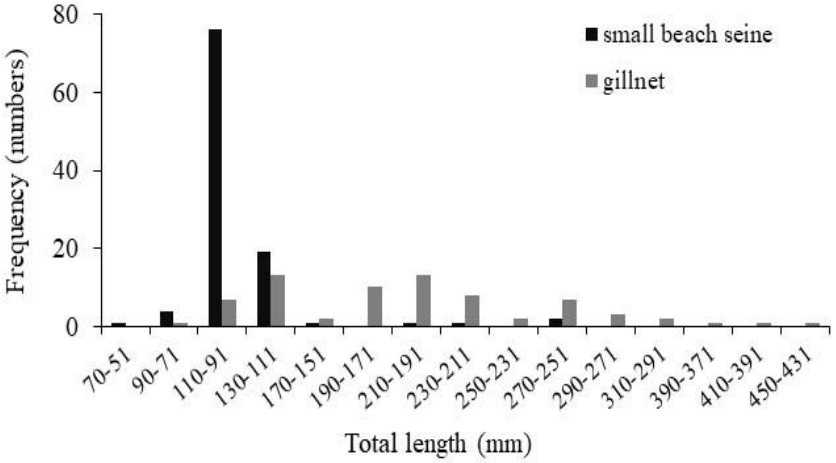

Fig. 2. Length frequency of *Alosa braschnikowi* in two fishing methods (small mesh size beach seine and gill net) in the Southeast Caspian Sea.

Given the whole samples, the total length and weight of *A. braschnikowi* ranged from 51 to 440 mm and 1.0 to 736.0 g by averaged (± SD) 144.0 (± 65.9) mm and 44.5 (± 90.0) g, while in the case of *A. caspia*, it ranged from 31 to 220 mm and 0.3 to 87.7 g by averaged (± SD) 110.8 (± 38.0) mm and 14.8 (± 14.7) g, respectively. Length-length relationships and the coefficient of determination (R^2) for *A. braschnikowi* was calculated as $W = 0.0038 \times FL^{3.241}$ ($R^2 = 0.989$, n = 176) while for *A. caspia* it was $W = 0.0119 \times FL^{2.844}$ ($R^2 = 0.98$, n = 132). The estimations of "b" were 3.241 and 2.844 which were significantly different from 3.0 (t-test; t = 6.9, p < 0.001 and t = 4.4, p < 0.001), indicating positive and negative allometric growth for the two species, respectively (Fig. 4). The average CF of *A. braschnikowi* was 0.72 ± 0.12. Monthly variations of CF was significantly different (F = 19.1, P < 0.001; Table 1). The K_n was 1.10 ± 0.141 and a significant difference was found among months (F = 4.0, P < 0.004; Table 1). The highest values of CF and K_n were 0.85 and 1.21 in February, respectively. The correlation between TL and CF was not statistically significant ($R^2 = 0.36$, P > 0.05; Fig. 5). A perusal of the data on the K_n values showed that the parameter was higher than 1 in all size classes except the size class of 371-410 mm. In the size class of 291-330 mm, K_n was the highest (1.39). The average CF and K_n of *A. caspia* were 0.83 ± 0.13 and 0.87 ± 0.12, respectively. There were statistically significant differences in both parameters among the months (F = 10.4; P < 0.001 and F = 8.7, P < 0.001, respectively; Table 2). The highest values of CF and K_n were 0.88 and 0.91 in July, respectively. The correlation between TL and CF was statistically significant ($R^2 = 0.42$, P < 0.05; Fig. 6). The K_n values showed that the parameter was lower than 1 in all size classes. In the size class of 211-230 mm, K_n was the highest (0.95).

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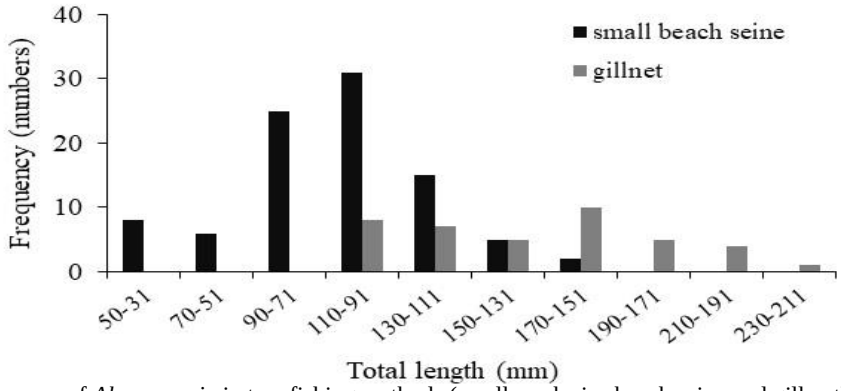

Fig. 3. Length frequency of *Alosa caspia* in two fishing methods (small mesh size beach seine and gill net) in the Southeast Caspian Sea.

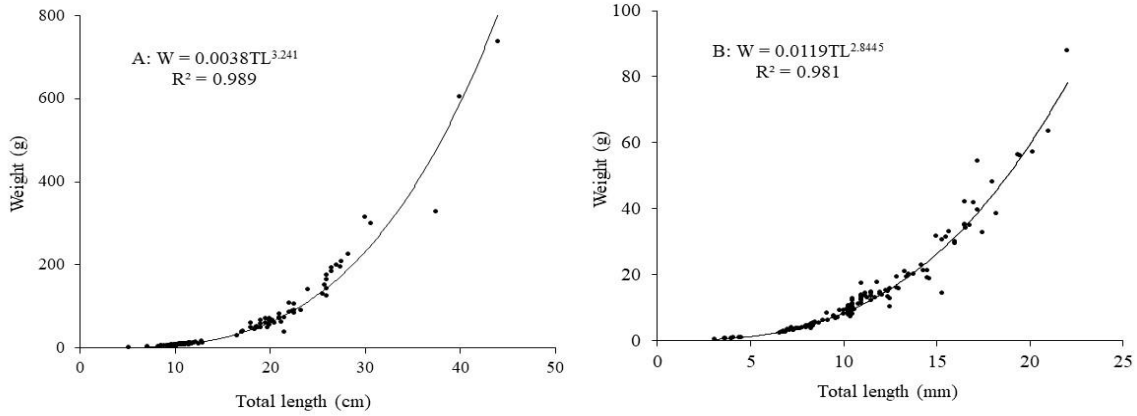

Fig. 4. Length-weight relationship of *Alosa braschnikowi* (A) and *Alosa caspia* (B) in the Southeast Caspian Sea.

Table 1. Monthly average condition factor (CF) and relative condition factor (Kn) of *Alosa braschnikowi* in the Southeast Caspian Sea.

Parameter	Month (year)	n	Mean	S.D.	Min-Max
CF	December (2013)	14	0.82[b]	0.148	0.54-1.02
	January (2014)	115	0.67[a]	0.061	0.52-0.87
	February (2014)	5	0.85[b]	0.169	0.70-1.03
	March (2014)	36	0.81[b]	0.149	0.57-1.17
	April (2014)	5	0.76[ab]	0.120	0.64-0.93
	Total	**175**	**0.72**	**0.117**	**0.52-1.17**
K_n	December (2013)	14	1.15	0.153	0.84-1.37
	January (2014)	115	1.07	0.109	0.51-1.38
	February (2014)	5	1.21	0.211	0.94-1.47
	March (2014)	36	1.15	0.187	0.93-1.90
	April (2014)	5	1.04	0.157	0.88-1.26
	Total	**175**	**1.10**	**0.141**	**0.51-1.90**

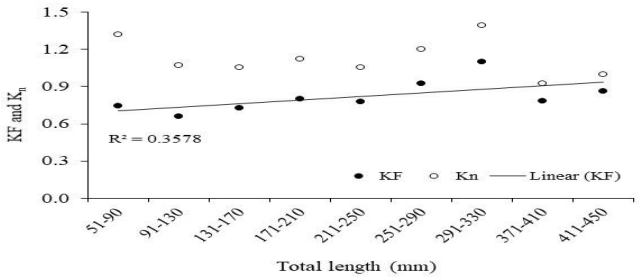

Fig. 5. Variation of mean condition factor (CF) and relative condition factor (Kn) of *Alosa braschnikowi* in size classes in the southeastern Caspian Sea.

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Table 2. Monthly average condition factor (CF) and relative condition factor (Kn) of *Alosa caspia* in the Caspian Sea.

Parameter	Month (year)	n	Mean	S.D.	Min-Max
K	December (2013)	44	0.78[a]	0.111	0.40-1.07
	May (2014)	18	0.80[a]	0.049	0.71-0.88
	July (2014)	70	0.88[b]	0.132	0.60-1.30
	Total	**132**	**0.83**	**0.129**	**0.40-1.30**
K_n	December (2013)	44	0.81[a]	0.127	0.44-1.19
	May (2014)	18	0.80[a]	0.048	0.72-0.88
	July (2014)	70	0.90[b]	0.124	0.65-1.35
	Total	**132**	**0.87**	**0.124**	**0.44-1.35**

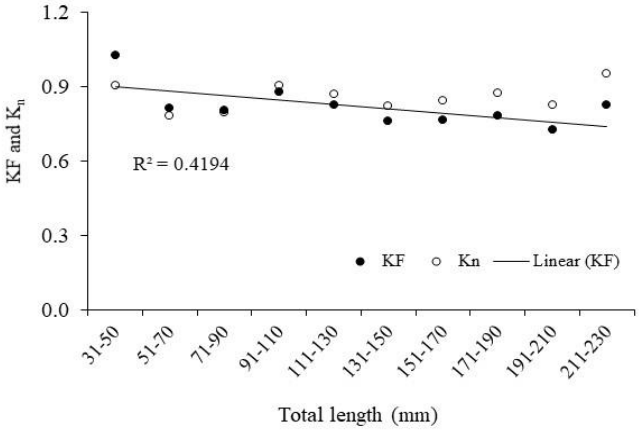

Fig. 6. Variation of mean condition factor (CF) and relative condition factor (Kn) of *Alosa caspia* in size classes in the Caspian Sea.

DISCUSSION

In the last century, genus *Alosa* has been a major item of the Caspian and herring fisheries in almost the entire coast of the Caspian Sea. Five species of genus *Alosa* have been reported in the Iranian waters of the Caspian Sea including A. *braschnikowi*, *A. caspia*, *A. kessleri*, *A. saposchnikowii* and *A. sphaerocephala* (Abdoli & Naderi 2008; Abbasi 2017; Esmaeili *et al*. 2018) . However, in the present study, only two species *A. braschnikowi* and *A. caspia* were found in the south-eastern part of the Caspian Sea (Goharbaran) and the slope (b) of the length-weight relationships for the two species were within the expected range of 2.5–3.5 (Froese 2006), i.e., 2.844 and 3.241 for *A. caspia* and *A. braschnikowi*, respectively. In contrast, Taghavi Jelodar *et al*. (2016) and Ghotbi-Jokandan *et al*. (2015) reported lower b values for *A. braschnikowi* (2.93 and 3.10 in the southern Caspian Sea, respectively). In other study, Taghavi Jelodar *et al*. (2016) and Patimar *et al*. (2011) reported lower values (2.385, 2.626 and 2.796, in the southern, south middle and south-western Caspian, respectively), while in the case of *A. caspia*, higher values (2.98 and 3.272, in the southern and southeastern Caspian Sea) were reported (Patimar *et al*. 2011; Ghotbi-Jokandan *et al*. 2015) (Table 3). According to Bagenal and Tesh (1978) and Froese (2006), the sampling gear, geographic location and the associated environmental conditions such as water temperature, which is the determining factor of feeding capacity, season, stomach fullness, disease and parasite loads can affect the value of b, hence the changes in this parameter. In the present study, the highest mean values of CF were 0.85 and 0.88 in February and July, respectively. According to Kumolu & Ndimele (2010), the condition factor reflects information on the physiological status of fish in relation to welfare, and higher values indicate favorable environmental conditions (Blackwell *et al*. 2000). Also, there was a significantly negative correlation between size classes and CF in *A. caspia* (Fig. 6). CF can be influenced by season, sex, type of food, age of fish, reserved fat and environmental conditions (Bagenal and Tesch 1978; Abowei 2009). The K_n indicates the suitability of the environment for fish growth and the general well-being of the fish. A K_n>1, indicates good well-being of the fish, while a value <1 reflects poor condition. In the present study, the K_n was greater than 1 for *A. braschnikowi* indicated that the well-being of the fish was good, while lower than 1 for *A. caspia* exhibited its low well-being in the Southeast Caspian Sea. Also, a seasonal/monthly variation of K_n can be influenced by maturity, gonad development, feeding activity and several other factors (Le Cren 1951; Bagenal & Tesch 1978; Simon *et al*. 2012). *A. braschnikowi* feed mainly on small clupeids, gobies, and atherinids (Vetchanin 1984; Whitehead 1985; Afraei

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Bandpei *et al*. 2012). Vetchanin (1984) reported that the diet of *A. braschnikowi* in the Southeast Caspian Sea was composed of 85% anchovy (*Clupeonella engrauliformis*) as well as some gobies (genus *Neogobius*) and shrimps. However, in the years 2003-2004 the diet significantly shifted to atherinid fish (*Atherina caspia*) (Afraei Bandpei *et al*. 2012). In contrast, *A. caspia* in the southern Caspian Sea feed mainly on zooplankton (95.0%) and phytoplankton (*Rhizosolenia* and *Sprirogyra*) (4.5%) (Abbasi & Sabkara 2004; Abdollahpour *et al*. 2007).

Table 3. The length-weight relationships in *Alosa braschnikowi* and *A. caspia* from different locations.

Alosa braschnikowi						
Study area	**N**	**TL (cm) Min-Max**	**W (g) Min-Max**	**b**	**r^2**	**Author (s)**
Southern Caspian Sea, Iran	147	17.4-47.0	37-1085	3.10	0.977	Ghotbi-Jokandan *et al*. 2015
Southern Caspian Sea, Iran	54	21.0-42.5	91.3-700.8	2.93	0.98	Taghavi Jelodar *et al*. 2016
Southeastern Caspian, Iran	176	5.1-44.0	1.0 – 736.0	3.241	0.989	Present study
Alosa caspia						
Southern Caspian Sea, Iran	113	11.6-27.6	11-164	2.98	0.97	Ghotbi-Jokandan, 2015
Southern Caspian Sea, Iran	60	23.0-31.0	94.9-238.7	2.385	0.946	Taghavi Jelodar et al. 2016
Southeastern Caspian, Iran	159	?? – 28.3	?? – 171.8	3.272	0.872	Patimar *et al*. 2011
South middle Caspian, Iran	97	?? – 27.7	?? – 145.7	2.626	0.777	Patimar *et al*. 2011
Southwestern Caspian, Iran	145	?? – 26.9	?? – 138.3	2.796	0.933	Patimar *et al*. 2011
Southeastern Caspian, Iran	132	3.1-22.0	0.3-87.7	2.844	0.980	Present study

Over the past three decades, the new invasive species (Ctenophora, *Mnemiopsis leidyi*) has affected the whole ecosystem of the Caspian Sea (Roohi *et al*. 2010; Pourang *et al*. 2016). It feeds aggressively on zooplankton (Mutlu 1999) which has significantly reduced the abundance and distribution of zooplankton species and their predators, especially two main pelagic fish stocks of kilka, *C. engrauliformis* and *C. grimmi* (Fazli *et al*. 2007, 2009; Roohi *et al*. 2010; Pourang *et al*. 2016). Afraei Bandpei *et al*. (2012) concluded that *A. braschnikowi* displays an opportunistic feeding behavior and feeds on a variety of prey items as well as a wider range of food items and is adapted to the conditions, resulting in its good well-being. Due to the food competition of *A. caspia* with two species of kilka and especially *M. leidyi*, the well-being of the fish was not good in the southeastern Caspian Sea.

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REFERENCES

Abbasi, K & Sabkara, J 2004, Studying *Alosa caspia caspia* (Caspian shad) diet in southeastern Caspian Sea (Mazandaran and Golestan provinces). *Iranian Journal of Biology*, 17: 272-290, [In Persian].

Abbasi, K 2017, Fishes of Guilan. The Encyclopedia of Guilan Culture and Civilazation 66: 206 p.

Abdoli, A & Naderi, M 2008, Biodiversity of fishes in southern region of the Caspian Sea. Abzeeyan Publication, Tehran. Iran. 242 p.

Abdollahpour Biria, H, Abbasi, K, Keyvan, A & Sabkara, J 2007, Study of feeding habit of Caspian Shad (*Alosa caspia caspia*) in Guilan Province Coasts. *Iranian Scientific Fisheries Journal*, 16: 115-128, [In Persian].

Afraei Bandpei, MA, Mohammed, El-Sayed, AF, Pourgholam, R, Nasrolahzadeh, H & Valinassab, T 2012, Food and feeding habits of the Caspian marine shad, *Alosa braschnikowi* (Clupeidae) in the southern Caspian Sea. *Cybium*, 36: 411-416.

Azizov, A, Suleymanov, S & Salavatian, M 2015, The features of the feeding of Caspian marine shad, *Alosa braschnikowii* (Borodin, 1904) in the western part of the Caspian Sea. *Caspian Journal of Environmental Sciences*, 13: 77-83.

Abowei, JFN 2009, The condition factor, length-weight relationship and abundance (Regan, 1909) from Nkoro River, Nigeria, *Advance Journal Food Science and Technology*, 2: 16-21.

Bagenal, TB & Tesch, FW 1978, Age and growth. In: Methods for assessment of fish production in fresh waters. 3rd edn. T. Bagenal (Ed.). IBP Handbook No. 3. Blackwell Scientific Publications, Oxford, UK, pp. 101–136.

Received: May 3. 2020 Accepted: Oct. 17. 2020
DOI:
Article type: Research

Blackwell, BG, Brown, ML & Willis, DW 2000, Relative weight (W_r) status and current use in fisheries assessment and management. *Review Fisheries Science*, 8: 1-44.

Esmaeili, HR, Sayyadzadeh, G, Eagderi, S & Abbasi, K 2018, Checklist of freshwater fishes of Iran. *Fish Taxa*, 3:1–95.

Fazli, H, Zhang, CI, Hay, DE, Lee, CW, Janbaz, AA & Borani, MS 2007, Population ecological parameters and biomass of anchovy kilka (*Clupeonella engrauliformis*) in the Caspian Sea. *Fisheries Science*, 73: 285–294.

Fazli, H, Zhang, CI, Hay, DE, Lee, CW 2009, Stock assessment and management implications of anchovy kilka (*Clupeonella engrauliformis*) in Iranian waters of the Caspian Sea. *Fisheries Research*, 100: 103-108.

Froese, R 2006, Cube law, condition factor and weight-length relationships: history,meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22: 241-253.

Ganjian, A, Wan Maznah, WO, Yahya, K, Fazli, H, Vahedi, M, Roohi, A & Farabi, SMV 2010, Seasonal and regional distribution of phytoplankton in the southern part of the Caspian Sea. *Iranian Journal of Fisheries Sciences*, 9: 382-401.

Ghotbi-Jokandan, SR, Alavi-Yeganeh, MS & Jamshidi, S 2015, Length-weight and length-length relationships of four Alosa species along the southern Caspian Sea coast. *Journal of Applied Ichthyology*, 31: 814–815.

Gonçalves, JMS, Bentes, L, Lino, PG, Ribeiro, J, Canario, AVM & Erzini, K 1997, Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. *Fisheries Research*, 30: 253-256.

Haghi Vayghan, A, Fazli, H, Ghorbani, R, Lee, MA & Nasrollazadeh Saravi, H 2016, Temporal habitat suitability modeling of Caspian shad (*Alosa* spp.) in the southern Caspian Sea. *Journal of Limnology*, 75: 210-223.

Ivanov, PI 2000, Biological resources of the Caspian Sea. KaspNIRKH, Astrakhan.

Ivanov, PI, Kamakim, AM, Ushivtzev, VB, Shiganova, TA, Zhukova, O, Aladin, N, Wilson, S, Harbinson, GR & Dumont, HJ 2000, Invasion of Caspian Sea by the come jellyfish *Mnemiopsis leidyi* (Ctenophora). *Biological Invasions*, 2: 255–258.

Jalili, S, Ansari Fard, F & Romiani, L 2013, Evaluation of Nutritional Quality of Caspian Shad Muscle, *Alosa caspia caspia* (Eichwald, 1838) in Southern Caspian Coast. *World Journal of Fish and Marine Sciences*, 5: 176-181.

Karimzadeh, G, Gabrielyan, B & Fazli, H 2010, Population dynamics and biological characteristics of kilka species (Pisces: Clupeidae) in the southeastern coast of the Caspian Sea. *Iranian Journal of Fisheries Sciences*. 9: 422-433.

King, M 2007, Fisheries biology, assessment and management. Wiley-Blackwell 400 p.

Kumolu, CA & Ndimele, PE 2010, Length- weight relationships and condition factors of twenty-one fish species in Ologe Lagoon, Lagos, Nigeria. *Asian Journal of Agricultural Science*s, 2: 174-179.

Le Cren, ED 1951, The length-weight relationship and seasonal cycle in the gonad weight and condition in the perch (*Perca fluviatilis*). *Journal of Animal Ecology*, 20: 201-219.

Malkin, EM & Andrianova, SB 2008, Biology and Traits of the Formation of Stock of Big–Eyed Shad *Alosa saposchnikowii*. *Journal of Ichthyology*, 48: 443–451.

Mutlu, E 1999, Distribution and abundance of ctenophores, and their zooplankton food in the Black Sea. II. *Mnemiopsis leidyi*. *Marine Biology*, 135: 603–613.

Nasrollahzadeh, A, 2010. Caspian Sea and its Ecological Challenges. *Caspian Journal of Environmental Sciences*, 8: 97-104.

Patimar, R, Habibi S & Jafari F 2011, A study on the growth parameters of *Alosa caspia caspia* Eichwald, 1838 in the southern Caspian coast, *Journal of Fisheries, Iranian Journal of Natural Resources*, 64: 15-27.

Pauly, D 1984, Fish population dynamics in tropical waters: A manual for use with programmable calculators. ICLARM, Manila.

Pourang, N, Eslami, F, Nasrollahzadeh Saravi, H & Fazli, H 2016, Strong biopollution in the southern Caspian Sea: the comb jelly *Mnemiopsis leidyi* case study. Biol. Invasions. 18: 2403-2414.

Ricker WE (1975 Computation and interpretation of biological statistics of fish populations. *Bulletin of the Fisheries Research Board of Canada*, 191: 1–382.

Roohi, A; Kideys, AE, Sajjadi, A, Hashemian, A, Pourgholam, R, Fazli, H, Ganjian Khanari, A & Eker-Develi, E 2010, Changes in biodiversity of phytoplankton, zooplankton, fishes and macrobenthos in the Southern Caspian Sea after the invasion of the ctenophore *Mnemiopsis Leidyi*. *Biological Invasions*, 12: 2343–2361.

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Salmanov, MA 1999, Ecology and biological reproduction of the Caspian Sea. Edited by U.I. Sorokin. Baku, 397 p.

Simon, KD, Bakar, Y, Mazlan, AG, Zaidi, CC, Samat, A, Arshad, A, Temple, SE & Brown-Peterson, NJ 2012, Aspects of the reproductive biology of two archer fishes *Toxotes chatareus* (Hamilton 1822) and *Toxotes jaculatrix* (Pallas1767). *Environmental Biology of Fish*es, 93: 491–503.

Taghavi Jelodar, H, H., Abbasi, A & Fazli H 2016, The study of some biological indices of Alosa four species in Caspian Sea coast (Mazandaran province). *Aquatic Physiology and Biotechnology*, 4(2): 1-17 (In Farsi).

Vetchanin, VI 1984, Feeding of the Astrakhan shad, *Alosa brashnikovi* (Clupeidae), in the southeastern Caspian Sea. *Journal of Ichthyology*, 24: 143-147.

Whitehead, PJP 1985, FAO Species Catalogue. Clupeoid Fishes of the World (suborder Clupeiodei). An Annotated and Illustrated Catalogue of the Herrings, Sardines, Pilchards, Sprats, Anchovies, and Wolfherrings. Part 1: Chirocentridae, Clupeidae and Pristigasteridae. FAO Fisheries Synopsis, Rome, 303 pp.

Zar, JH 2010, Biostatistical analysis. 4th edition. Prentice Hall, Upper Saddle River, New Jersey, 946 p.

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روابطه بین طول – وزن، ضریب چاقی و ضریب چاقی نسبی *Alosa braschnikowi* و *A. caspia* در سواحل جنوب شرقی دریای خزر (گهرباران)

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چکیده

هدف اصلی این مطالعه تعیین ترکیب گونه‌ای شگ ماهیان خزر جنس *Alosa* و برآورد رابطه طول- وزن، ضریب چاقی و ضریب چاقی نسبی گونه‌های *A. braschnikowi* و *A. caspia* در ماه‌های مختلف در سواحل جنوب شرقی دریای خزر (گهرباران) بود. برای تهیه نمونه از دو روش صید، پره‌ریز چشمه و دام گوشگیر در ماه‌های آذر سال ۱۳۹۲ الی تیر سال ۱۳۹۳ استفاده شد. دو گونه *A. braschnikowi* و *A. caspia* با فراوانی نسبی به ترتیب ۵۷/۱ ٪ و ۴۲/۹ ٪ از جنس *Alosa* شناسائی شد. مقدار شیب خط (مقدار b) رابطه طول- وزن دو گونه به ترتیب ۳/۲۴۱ و ۲/۸۴۴ بود که با مقدار عدد ۳ اختلاف معنی‌داری داشته ($P < 0.05$) و به ترتیب بیانگر رشد آلومتریک مثب و منفی بود. میانگین ضریب چاقی گونه‌های *A. braschnikowi* و *A. caspia* به ترتیب ۰/۱۲± ۰/۷۲ و ۰/۱۳± ۰/۸۳ محاسبه شد. ضریب چاقی هر دو گونه در ماه‌های مختلف دارای اختلاف معنی‌داری بود ($P < 0.001$). همبستگی منفی معنی‌داری بین کلاسهای طولی و ضریب چاقی گونه *A. caspia* وجود داشت. ضریب چاقی نسبی گونه *A. braschnikowi* بزرگتر از عدد ۱ و گونه *A. caspia* کمتر از ۱ بود که بیانگر به ترتیب وضعیت مطلوب و نامطلوب سلامت دو گونه در سواحل جنوب شرقی دریای خزر می‌باشد.

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