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Population dynamics and CPUE of *Alosa* genus with emphasis on *Alosa braschnikovi* (Borodin, 1904) on the coasts of Golestan Province, Iran

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Abstract. *Bibak Z, Paighambari SY, Pouladi M, Ghorbani R, Hosseini SA, Yahyaei M. 2018. Population dynamics and CPUE of* Alosa *genus with emphasis on* Alosa braschnikovi *(Borodin, 1904) on the coasts of Golestan Province, Iran. Biodiversitas 19: 59-66.* The aim of this study was to compare relative abundance and catch per unit effort of members of the *Alosa* genus (family: Clupeidae) in the fishing grounds of Gomishan and Miankale in Golestan coasts. Sampling operations were done by beach seine during 2011 to 2012. A total of 240 fish were collected. Identified species in Gomishan were: *Alosa braschnikovi* (Borodin, 1904) and *A. saposchnikovi* (Grimm, 1887). The most abundant species in this region were individuals of *A. braschnikov*i. The highest length and weight in the region were 35.6±1.85 mm and 447.8±57.43 gr for *Alosa braschnikovi* in Gomishan. Besides the two mentioned species, *A. kessleri* (Grimm, 1887) was caught in Miankale coasts. The most abundant species again was *Alosa braschnikovi* in this region. The highest length and weight were 33.12±3.18 cm and 362.5±99.57 gr for *Alosa braschnikovi* in Miankale region. The results showed that mean of CPUE in Miankale was higher than in the Gomishan region. The comparison of sex ratio for shads showed that males were dominant against females. Also, the comparison between species showed that the highest values for length, and weight of fish species compared belonged to *Alosa braschnikovi*. Among the *Alosa braschnikovi* fishes caught, individuals were in the range of 2 to 5 age groups within the two compared regions and most abundant were observed in 4 age groups.

Keywords: *Alosa*, Beach seine, CPUE, Gomishan, Miankaleh

INTRODUCTION

Due to the geographical location, the breadth, the existence of biotic (plant, animal, biological) and non-biotic reserves (oil and gas resources, sand, sand and salt), the existence of habitats of birds, wetlands, gulfs, ravines, deltas, trade, maritime transit Fisheries, supplying protein, migrating birds, sturgeon and caviar production, Caspian Sea is one of the most important closed seas in the world. The Caspian Sea is the only unique sea that has no connective path with the ocean. The shallow areas of the Caspian Sea are highly productive in terms of ecological conditions. So it's the perfect place for fish larvae and mature fish. These areas are constantly affected by environmental factors such as sea level fluctuations, waves, rivers, and many other factors due to natural and human activities such as pollution (Vahedi 2011).

This sea is shared between the five countries of Iran, Azerbaijan, Russia, Republic of Kazakhstan and Republic of Turkmenistan. Sturgeon fishes which live in the Caspian Sea are one of the most valuable species in the world. In terms of fish, 110 species and subspecies including Caspian white fish, Mullet, Caspian brown trout, Pike perch, Bream, and Kilka live in this sea. Fishing and exploitation of these fish stocks have been carried out in different ways from the distant past until today. At present, the exploitation of bony fish stocks in Caspian region of Iran is merely carried out by beach Seine nets. Also, exploitation process of these fish stocks is carried out every year from early October to mid-March by 134 beach seine nets and 12,000 fishermen in the coastal provinces of the sea. In addition to the number of authorized harbors, another part of the bony fish catches is exploited by unauthorized and unofficial fishermen using fixed gill nets (Abdolmaleki 2005).

Due to excessive withdrawal of bony fish stocks, river pollution and destruction of suitable spawning grounds, uncontrolled water withdrawal from rivers and coastal wetlands, excessive harvesting of sand from grasslands, degradation of natural pasture and reduction in the surface of the Caspian Sea, the bony fish stocks extremely have fallen.

During the past decade, the amount of harvested bony fish by authorized and unauthorized fishermen, based on research on stock assessments and harvest rates, have been between 15-25 thousand tons. Unfortunately, a significant portion of the catch of fish with sub-standard weight and length is related to fishing with the beach seines.

The steady reductions have been observed in the harvesting rate of caught fish under standard lengths and weights in the study area which is due to increase in fishing capacity and the number of cooperative firms in the coastal zone, the creation of unconditional competition for more exploitation of coastal migratory fish stocks by increasing the fishing effort, increase in the length and width of the nets, increase in the length of the tensile rope and especially reduction in the size of the meshes in all sections of the nets especially in the bag section to 30 mm, and a

tangible change in the portion of small fish relative to immature fish (Abdolmaleki 2005). So far, many studies have been conducted on members of the Clupeidae family, especially Alosa species in the Caspian Sea, including the study of the biological and ecological characteristics of the *Alosa caspia* in the Gorganroud River estuary (Javaheri Baboli and Tabei 1998), a systematic study and identification of *Alosa* species on the coasts of Guilan in the southwestern coasts of the Caspian Sea (Hosseini 2000), estimation of fish stocks in the coastal waters of Caspian Sea (Abdolmaleki et al. 2001), study on abundance and species diversity of Clupeidae species in coastal waters of Mazandaran and Golestan Provinces (Afraei et al. 2004), Identification and introduction of species and sub-species of caught Clupeidae species by beach seines in three coastal provinces (Gilan, Mazandaran, and Golestan) (Ghaninejad et al. 2005), and investigation of the growth parameters of *Alosa* caspia (Eichwald, 1838) on the southern shores of Caspian Sea in connection with regional variation in the southeast, south and southwest of Caspian Sea (Patimar et al. 2011). The main purpose of this study was determining of catch composition, catch per unit effort and determining of the dynamic parameters of the *Alosa* species in Gomishan and Miankaleh fishing areas, on the coasts of Golestan Province.

MATERIALS AND METHODS

Study area

This research was carried out on the southern shores of Caspian Sea in Golestan Province in the eastern regions of Miankaleh and Gomishan, Golestan Province, Iran. Miankaleh Peninsula is located on the southeast coast of Caspian Sea between the Caspian Sea and Gulf of Gorgan in 36º 37´ 46´´ N and 53º 05´ 54´´ E (Figure 1). This peninsula mainly consists of sandy sediments, lime with some clay.

In the distance of about 35 km from northwest of Gorgan, there is a large water catchment with massive bents which is called Gomishan wetland. The southern side of the Gomishan wetland is limited to Gorganroud River. During 2011-2013, 19 bony fish cooperatives with 1,461 fishermen for 6 months have been busy in Golestan Province. Sampling of this research has been done on a monthly sampling from November 2011 to April 2012 from two regions of Miankaleh and Gomishan in Golestan Province. Sampling stations during the study period were included: Azim Gol, Peyvand, Abu Hanifa, Chapaghli, Tohid, Ghoncheh, Shahid Qarajeh, Nezamabad, Basirabad, Makhtumgholi, Khazar, Tamochlar, Ghareh Sou, Golestan, Shayan Aydin, Shahid Beheshti, Chargoli, Noor Golestan and Nemouneh.

During this period, 240 pieces of Clupeidae were collected from the beach seines, 150 samples from the Miankaleh region and 90 samples from Gomishan area. The length of the caught fish was measured by a biometric ruler with a precision of 0.5 cm and weighed with a spring scale with a precision of 10 g and the data were recorded in the checklist. The specimens were transferred to the laboratory and the ages were determined by counting the annual growth lines on the scales. Then they were numbered and placed in containers with 10% formalin and kept for species identification and species detection.

Figure 1. Study area and locations of beach seine cooperatives of bony fish in the southeast of the Caspian Sea, viz. Miankaleh and Gomishan regions, Golestan Province, Iran

Morphometric and meristic characteristics of *Alosa* fish were measured that were included: Total length, fork length, standard length, head length, head width, head height, head height in the eye area, body height, body width, the distance between the two nostrils, eye distance, eye distance to gill closure, the distance of the snout to the end of the upper lip, mouth width, snout length, eye diameter, caudal fin stem length, caudal fin height, dorsal fin base length, dorsal fin height, base fin length, anal fin height, the base of the pectoral fin, pectoral fin height, the length of the pelvic fin base, pelvic fin height, the beginning of the pectoral fin, first dorsal fin to the tip of the snout, the beginning of the dorsal fin to the end of the body, the beginning of the anal fin to the tip of the snout, the end of the anal fin to the body, the beginning of the dorsal fin to the beginning of the anal fin, the end of the first dorsal fin to anal fin, the number of hard and soft rays of pectoral fin, the number of hard and soft rays of ventral fins, the number of hard and soft rays of dorsal fin, the number of hard and soft rays of anal fin, the number of rays of caudal fin, the number of gill spines. After biometrics, their genders were determined.

Catch per unit effort (CPUE)

The Gulland equation formula was used to assess CPUE index for each species:

$$\text{CPUE} = \frac{\text{Cw}}{\text{N1} \times \text{N2}}$$

Where Cw is the total weight of caught fish in each towing, N2 is the number of net roll at any towing stage, and N2 is towing time (Gulland 1983).

Length-weight relationship

The relationship between length and weight from exponential length-weight relationship. In fish, the relationship between length (cm) and weight (g) is usually shown as follows:

$$W = aL^b$$

Also to test the growth pattern, Pauly-Monero test and for the test of allometric and isometric significant growth and for determining of the b significant value Pauly test was used (Biswas 1993).

$$t = \sqrt{n-2} \times \frac{|b-3|}{\sqrt{1-r^2}} \times \frac{SdLnX}{SdLnY}$$

The calculated t with table t with n-2 degrees of freedom is compared. If calculated t was smaller than table t, it is isometric growth and if calculated t was greater than table t, so the growth will be an allometric growth.

Statistical analysis

One-way ANOVA was used to compare each of the traits between *A. braschnikovi*, *A. saposchnikovi* and *A. kessler*i, and the Duncan test was used at the 5% confidence level to compare the means. DFA multivariate test was used to isolate the species. PCA test was used to determine the separation traits of two populations of Gomishan and Miankaleh. Independent t-test was used to compare the mean of catch per unit of effort of each species between Gomishan and Miankaleh regions and t-test was used for comparison between two years in each region. SPSS V.19 and Excel V.2013 software were used to analyze the data.

RESULTS AND DISCUSSION

In general, according to studies which were carried out in the Caspian Sea, except for Clupeidae family, other bony fish are lacking in species diversity in this aquatic environment. In comparison to the diversity and abundance, *Alosa* species on the coast of Golestan Province are less than Guilan and Mazandaran provinces. Among the known *Alosa* species on the coast of Golestan, the highest catch ratio and dominance belonged to *A. Braschnikovi*. The catch and density of this species depend upon the ecological and environmental conditions on the coast of this province and unfortunately, there is a decreasing trend in the number of this species each year.

During this research in the Miankaleh region, three species (*A. braschnikovi*, *A. saposchnikovi*, *A. kessler*i) and in the Gomishan area two species (*A. braschnikovi*, *A. saposchnikovi*) belonging to the *Alosa* genus that were identified and which were distinguished from each other based on some apparent traits and available scientific resources on the Golestan coast which corresponded with the study of Afraei et al (2004). According to Hosseini et al. (2000), morphometric and meristic characteristics of *A. braschnikovi* were included a large size (approximately 31.5 cm); thick, tight and shorter gill filaments, number of gills spines (29.5±2.83), dark color in the tip and behind the head of fish with a green luminance which are corresponded with the results of present study.

The measured meristic traits in three species are as follows (Table 1). There was no significant difference between the three species in the comparison of meristic traits ($P \geq 0.05$). The number of thoracic and abdominal keels and the number of radius in pelvic and dorsal fins in *A. braschnikovi* were higher than other two species. The number of gill spines and the number of radius in dorsal fins in *A. saposchnikovi* were higher than other two species, but these differences were not significant ($P \geq 0.05$) (Table 1).

The measured morphometric traits in three species are as follows (Table 2; Table 3). In comparison of relative traits (to reduce the effect of allometric growth of traits, the ratio of morphometric traits to total length was used), it was observed that there is a significant difference in the length of the dorsal fin and the distance between the

beginning of pelvic fin to the snout in migrant species relative to the other species (P≤0.05), While the other two species did not have a significant difference and there were no significant differences in the other traits (P≥0.05).

Table 1. Analysis results (Mean + SE) of the meristic characteristics for 3 species of *Alosa*

Meristic characteristics	*A. braschnikovi*	*A. saposchnikovi*	*A. kessleri*
Number of pectoral Keel	18.19±1.8 [a]	17.06±2.6 [a]	18.16±2.2 [a]
Number of pelvic Keel	13.5±1.2 [a]	12.8±1.4 [a]	13±1.2 [a]
Number of gill spine	42.5±11 [a]	47.4±14.9 [a]	35.66±8.6 [a]
Number of radius in pectoral fin	16.6±1.1 [a]	16±1.03 [a]	16±0.8 [a]
Number of radius in dorsal fin	16.7±2 [a]	16.86±1.45 [a]	15.66±0.8 [a]
Number of radius in anal fin	16.75±1.87 [a]	16.33±1.75 [a]	15.83±1.16 [a]

Note: Same letters indicate statistical non- significant difference between different species (P≥0.05).

Table 2. Analysis results (Mean + SE) of the morphometric characteristics for 3 species of *Alosa*

Morphometric characteristics (relative to total length)	*A. braschnikovi*	*A. saposchnikovi*	*A. kessleri*
Total length	32.16±3.2 [a]	30±3.3 [a]	30.25±2.04 [a]
Fork length	30.4±2.8 [a]	30.25±3.35 [a]	26.5±2.8 [a]
Standard length	18.16±2.8 [a]	15.8±2.6 [a]	17.18±1.7 [a]
Head length	5.07±0.9 [a]	5.2±0.9 [a]	5.3±0.6 [a]
Head width	1.8±0.42 [a]	2.03±0.38 [a]	2.03±0.23 [a]
Head height	4.3±0.6 [a]	3.9±3.9 [a]	4±0.3 [a]
Head height in eye area	3.5±0.5 [a]	3.3±0.6 [a]	3.3±0.29 [a]
Body height	6.35±0.97 [a]	6.03±0.78 [a]	6.03±1.03 [a]
Body width	2.73±0.83 [a]	2.43±0.73 [a]	2.41±0.33 [a]
Nasals distance	0.4±0.18 [a]	0.48±0.15 [a]	0.4±0.1 [a]
Eyes distance	1.23±0.49 [a]	1.1±0.27 [a]	0.94±0.14 [a]
Eye distance to the end of the gill	3.01±0.77 [a]	3.05±0.57 [a]	3.06±0.36 [a]
The beginning of the snout to the lips	0.76±0.19 [a]	0.62±0.14 [a]	0.68±0.11 [a]
Mouth width	0.82±0.26 [a]	0.66±0.19 [a]	0.5±0.16 [a]
Snout length	1.13±0.26 [a]	1.02±0.23 [a]	0.91±0.21 [a]
Eye diameter	1.03±0.14 [a]	1.32±0.23 [a]	1.3±0.16 [a]
Caudal fin length	2.24±0.71 [a]	2.14±0.43 [a]	1.63±0.29 [a]
Caudal fin height	2±0.41 [a]	1.95±0.44 [a]	2.2±0.46 [a]
Dorsal fin length	3.86±0.62 [a]	3.61±0.5 [a]	1.58±0.37 [a]
Dorsal fin height	1.91±0.72 [a]	1.88±0.61 [a]	1.58±0.17 [a]
Anal fin length	4.5±0.8 [a]	4.1±0.5 [a]	4.5±0.58 [a]
Anal fin height	1.1±0.6 [a]	0.9±0.28 [a]	0.9±0.25 [a]
Pectoral fin length	1.65±0.91 [a]	1.75±0.93 [a]	2.03±0.98 [a]
Pectoral fin height	1.86±0.62 [a]	1.55±0.48 [a]	1.45±0.05 [a]
Pelvic fin length	1.1±0.47 [a]	1.05±0.57 [a]	1.04±0.51 [a]
Pelvic fin height	0.92±0.41 [a]	0.8±0.37 [a]	0.56±0.21 [a]
The beginning of the pectoral fin to the snout	6.45±0.85 [a]	6.3±1.33 [a]	6.75±1.21 [a]
The beginning of the pelvic fin to the snout	12.7±1.5 [a]	12.02±3.3 [a]	12.15±1.26 [a]
End of the dorsal fin to the end of the body	12.72±1.51 [a]	12.02±1.53	12.15±1.26 [a]
The beginning of anal fin to snout	19.3±3 [a]	18.19±1.85 [a]	18.2±1.4 [a]
The beginning of anal fin to end of the body	7.48±1.44 [a]	7.48±1.47 [a]	7.26±2.11 [a]
The beginning of dorsal fin to the beginning of anal fin	6.43±0.96 [a]	6.09±1.01 [a]	6.03±0.52 [a]
The end of dorsal fin to the end of anal fin	2.28±0.66 [a]	2.18±0.63 [a]	1.96±0.45 [a]

Note: Same letters indicate statistical non- significant difference between different species (P≥0.05).

Table 3. Analysis results (Mean + SE) of the morphometric traits to total length for 3 species of *Alosa*

Morphometric characteristics (relative to total length)	*A. braschnikovi*	*A. saposchnikovi*	*A. kessleri*
Dorsal fin length	0.12±0.015 [b]	0.121±0.015 [b]	0.135±0.008 [a]
Dorsal fin height	0.059±0.02 [a]	0.064±0.022 [a]	0.052±0.004 [a]
Anal fin length	0.051±0.027 [a]	0.059±0.031 [a]	0.067±0.032 [a]
Anal fin height	0.035±0.022 [a]	0.029±0.007 [a]	0.029±0.006 [a]
Pectoral fin length	0.032±0.016 [a]	0.035±0.019 [a]	0.036±0.015 [a]
Pectoral fin height	0.057±0.017 [a]	0.051±0.014 [a]	0.048±0.003 [a]
Pelvic fin length	0.032±0.016 [a]	0.035±0.019 [a]	0.036±0.015 [a]
Pelvic fin height	0.028±0.011 [a]	0.027±0.014 [a]	0.018±0.007 [a]
The beginning of the pectoral fin to the snout	0.2±0.017 [a]	0.2±0.034 [a]	0.022±0.036 [b]
The beginning of the dorsal fin to the snout	0.395±0.019 [a]	0.4±0.014 [a]	0.4±0.031 [a]
End of the dorsal fin to the end of the body	0.464±0.029 [a]	0.466±0.023 [a]	0.472±0.021 [a]
The beginning of the anal fin to the snout	0.6±0.024 [a]	0.6±0.018 [a]	0.6±0.018 [a]
The beginning of anal fin to the end of the body	0.225±0.062 [a]	0.249±0.042 [a]	0.245±0.013 [a]
The beginning of dorsal fin to the beginning of anal fin	0.199±0.02 [a]	0.203±0.024 [a]	0.199±0.018 [a]
The end of dorsal fin to the end of anal fin	0.07±0.017 [a]	0.072±0.019 [a]	0.064±0.013 [a]

Same letters indicate statistical non- significant difference between different species (P≥0.05)

Sex ratio

In the study of sex ratio of 35 fish belong to *A. braschnikovi*, 22 male and 13 female were observed which was not significant ($\aleph^2$=2.31, DF= 1, P=0.13). Also among the 15 fish belonging to *A. saposchnikovi*, 11 male and 4 female were determined which this ratio was not significant ($\aleph^2$=2.27, DF= 1, P=0.07). Only 6 fish belong to *A. kessler*i were found in Miankaleh region which was included 4 male and 2 female fish. In general, male fish were dominant in all three species. According to Ghaninejad et al. (2003), *A. braschnikovi* had the highest percentage of existed species and it was predominant in number. It was estimated that about 77.35% of the caught Clupeidae by the beach seines, 42.04% of the catches which were taken by unauthorized operations and 60.73% of the catches of fish in the northern coast of Iran belonged to *A. braschnikovi*. Also, the sex ratio was not significantly different in this species and it was in balance condition (1 male: 1 female) which is compatible with this study.

Length-weight and length-age relationship

In the study of the relationship between length and weight in *A. braschnikovi*, this relationship followed the isometric pattern. In the other words, length and weight growth were homogeneous (Figure 2). Also, the length-age relationship in *A. braschnikovi* follows a logarithmic pattern (Figure 3). According to the present results, the maximum length and weight of the *A. braschnikovi* in both fishing areas were 35.6±1.85 cm and 447.8±57.43 g for 5 years fish in Gomishan region, and were 33.12±3.18 cm and 362.5±99.57 g for 4 years old samples in Miankaleh region, respectively (Table 4). Ghaninejad et al .(2003) reported that the highest percentages of length and weight composition belonged to species with a weight range of about 400 grams. In the survey by Afraee et al. (2004), the highest abundance of *A.braschnikovi* was in the age groups of 2 years and the lowest abundances were in the age groups of 1 and 6 years. Also, in the similar study by Patimar et al. (1996), the age groups of 2, 3, 4, and 5 years were observed on the southern shores of the Caspian Sea which are not similar with the results of this study.

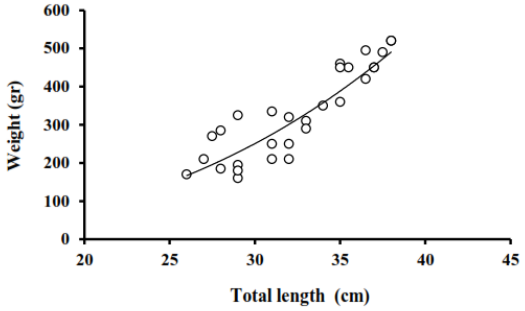

Figure 2. Length-weight relationship in *A.braschnikovi*

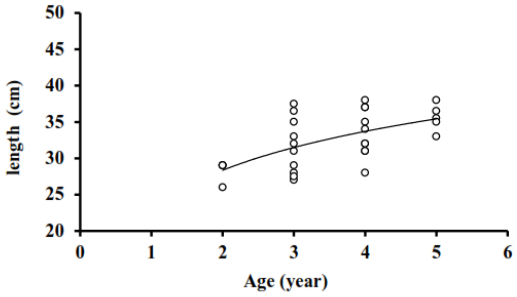

Figure 3. Length-age relationship in *A.braschnikovi*

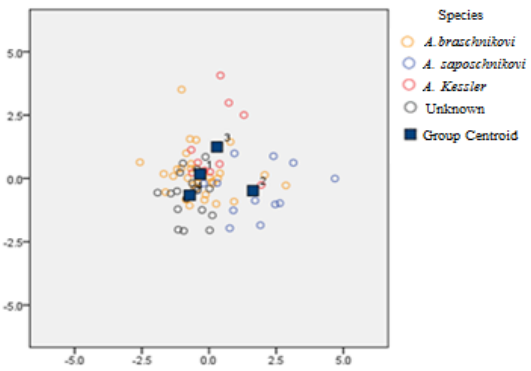

Figure 4. Distribution of Clupeidae family on the coasts of Miankaleh and Gomishan regions, Golestan Province, Iran

Table 4. Biometric characteristics of 3 species belong to *Alosa* species

Fishing zone	Species	Number	Age (year)	Length (cm)	Weight (gr)
Gomishan	*A. braschnikovi*	12	3	35±4.53	211.25±107.26
			4	33±4.58	336.66±102.63
			5	35.6±1.85	447.8±57.43
	A. saposchnikovi	6	3	34±1.52	230±43.58
			4	34±1	300±10
Miankaleh	*A. braschnikovi*	23	2	28±1.73	141.66±40.72
			3	30±2.36	214.16±39.54
			4	33.12±3.18	362.5±99.57
	A. saposchnikovi	9	4	31.5±3.88	270±100.74
			3	31±1.41	205±21.21
	A. kessleri	6	4	29.75±0.35	225±35.35
			5	31±1.41	280±84.85

Samandani et al (2007) investigated the distribution of economical bony fish populations at depths less than 10 meters on the coast of Mazandaran using gill nets with different meshes. They found that catch per unit effort for Clupeidae was 0.52 per each fishing effort. Also, averages of length and weight were 23.1±4.4 cm and 125.9±12.3 g respectively, while the average of age for these fish was between 2 and 4 years old. Compared to the present study, differences in means of length and weight were observed. These differences can be due to differences in season, sampling area or fishing gear.

Based on the DFA multivariate test for species isolation, three species were separate (Figure 4). In this study, an unidentified group of fish found and it was determined that unspecified fish was belonged to *A. braschnikovi*. Also, *A. braschnikovi* and *A. kessler*i are similar in terms of characteristics compared to *A. saposchnikovi*. In the study of factor analysis (data reduction of morphometric traits) in detecting of *A. braschnikovi* in Gomishan and Miankaleh regions, 8 factors with a specific value greater than 1 and with a dispersion percentage of 69.55% were detected (Table 5).

In the study of the diagnostic characteristics of *A. braschnikovi* in two regions based on the upper values than 0.7, the distance between the two nostrils, caudal fin length, end of the anal fin to the end of the body, the beginning of dorsal fin to the beginning of anal fin, pelvic and pectoral fins length, caudal fin height, dorsal fin height, anal fin length, head height, head height in the eye area, end of the dorsal fin to the end of the body, body width, distance between eyes, the beginning of the dorsal fin to the snout and the beginning of the anal fin to the snout were more valuable than other traits (Table 6).

In the survey of catch per unit effort in two regions, it was observed that the average of catch per unit effort in Miankaleh fishing area is higher than Gomishan region. The highest amount of catch per unit effort was in Nemoooneh beach seine cooperative which was located in Miankaleh region, while lowest amount of catch per unit effort belonged to Azim Gol beach seine cooperative in Gomishan area. Also in the survey of catch per unit effort during two years, it was observed that the average of catch per unit effort in the Gomishan and Miankaleh fishing areas in 2011 were higher amounts compared to 2012 (Table 7).

According to Table 8, the averages of catch per unit effort of fishing operations in 2011 and 2012 in the Miankale region were higher than Gomishan area. In both regions, the catch per unit effort in 2011 was higher than 2012 and there were significant differences between study regions ($P \leq 0.05$).

During fishing season in 2011 to 2012, a 39% reduction in bony fish harvesting ratio has been reported by cooperative companies which can be due to the excessive increasing in fishing cooperatives, failure to comply the standards of the fishing gears especially in mesh size, and also it can be happened based on illegal fishing activities in the Caspian sea (Yahyaei 2012). Based on available statistics of catches and reports by Daryanabard et al. (2009), there has been a significant decrease in catch rate and amounts of fish stocks over the past few decades, and human activities have been more effective than natural factors in fluctuation and reduction of bony fish stocks. Clupeidae exists in all parts of Caspian Sea and differs only in terms of abundance and distribution in different parts (Afraei et al. 2004).

Table 5. Results of factor analysis (reduction of morphometric traits) in detecting the *A.braschnikovi* species in two regions, viz. Miankaleh and Gomishan regions, Golestan Province, Iran

Components	Special amount	Percentage of variance	Cumulative percentage
1	3.6	12.11	12.11
2	3.4	11.38	23.48
3	3.2	10.63	34.11
4	2.7	9.1	43.20
5	2.4	7.98	51.18
6	2.3	7.81	58.99
7	1.8	5.94	64.93
8	1.4	4.62	69.55

Table 6. Derived morphometric traits from factor analysis in *A. braschnikovi* detection in Miankaleh and Gomishan regions, Golestan Province, Iran

Morphometric characteristics	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
The distance between the two nostrils	0.77							
Caudal fin length		-0.77						
The end of anal fin to the end of body		0.73						
The beginning of dorsal fin to the beginning of anal fin		0.72						
Pelvic fin length	0.79							
Pectoral fin length	0.76							
Caudal fin height			0.7					
Dorsal fin height			0.73					
Anal fin length			-0.74					
Head height				0.85				
Head height in the eye area				0.85				
The end of dorsal fin to the end of body					0.73			
Body width						0.79		
Two eyes distance						0.71		
The beginning of the dorsal fin to the tip of the snout							0.85	
The beginning of the anal fin to the tip of the snout								0.78

Table 7. Catch per unit effort of 3 species of *Alosa* in Miankaleh and Gomishan regions, Golestan Province, Iran in 2011-2012

Fishing area	Beach seine cooperatives	2011			2012		
		Catch amount (kg)	Number of seining	CPUE	Catch amount (kg)	Number of seining	CPUE
Gomishan	Abu Hanifeh	220	69	3.2	136	165	0.8
	Shahid Gharajeh	186	122	1.5	18	14	1.3
	Chapagholi	331	151	2.2	99	173	0.6
	Tohid Gomishan	230	109	2.1	101	135	0.7
	Peyvand	119	67	1.8	123	131	0.9
	Azim Gol	13	33	0.4	0	0	0
	Khazar Gomishan	226	152	1.5	112	160	0.7
	Molla Nafas	171	77	2.2	5	9	0.6
Miankaleh	Shayan Aydin	1375	175	7.9	403	158	2.6
	Golestan	1067	140	7.6	653	155	2.4
	Niyaz Abad	694	106	6.5	315	118	2.7
	Makhtoom Gholi	633	138	4.6	247	110	2.2
	Toomajlar	501	91	5.5	264	99	2.7
	Nemooneh	2227	208	10.7	882	197	4.5
	Chargholi	1331	180	7.4	699	185	3.8
	Shahid Beheshti	906	118	7.7	367	140	2.6
	Basir Abad	445	105	3.2	377	120	3.1
	Ghareh soo	567	125	1.5	347	134	2.6
	Ghoncheh Golestan	570	115	2.2	391	125	3.1
	Noor Golestan	1287	163	2.1	810	167	4.9
	Yashar	790	128	1.8	291	114	2.6

Table 8. Average of catches per unit effort of fishing operation in two regions of Miankaleh and Gomishan regions, Golestan Province, Iran in 2011-2012

Beach seine cooperatives	2011	2012	P
Gomishan	1.86±0.8 [a]	0.7±0.36 [b]	0.003
Miankaleh	6.51±1.91 a	3.12±0.022 b	0

Different ecological conditions, nutritional needs and food relations, and their adaptations to the environment determine the density and distribution of different species. This issue can also be surveyed on the southern shores of Caspian Sea, and the distribution is most often associated with the ecological conditions of the region. In the studies of Afraei et al. (2005), the study on the condition of *A. braschnikovi* density was detected that the density of this species increases from east to west of the Caspian Sea, so that this amount was 42.8% in Golestan Province and 56.2% in Mazandaran province. Furthermore, the relationship between length and weight of this species has been homogeneous throughout the study area which shows similar results to the present research (Fazli 2011).

According to a recent study, in both fishery areas of Gomishan and Miankaleh, *A.braschnikovi* has the most length and weight compared to other species and *Alosa* species in Gomishan region has more length compared to *Alosa* species in Miankaleh region. In all species, the male was dominant over the female. The average of catch per unit effort for *Alosa* species in Miankaleh region was more than Gomishan region during 2011 to 2012. In both regions, the catch per unit effort in 2011 was higher than in 2012. Also in both regions, the most abundance of age groups belonged to groups of 3 and 4 years old which indicated sexual maturity in most species.

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REFERENCES

Abdolmaleki SH. 2001. The final report of project: Stock assessment of bony fish in the Caspian Sea (Clupeidae part). Work Report. Caspian Bony Fish Research Center, Iran.

Abdolmaleki SH. 2005. The final report of project: Stock assessment of bony fish in Caspian Sea during 2006-2007. Caspian Bony Fish Research Center, Iran.

Afraei MA, Par Afkandeh Haghighi F, Salmani AV, Rostami H. 2003. Systematic review of the species of Alosa genus on the coasts of Mazandaran and Golestan Provinces. Iran J Fisheries Sci 3:13-26.

Afraei MA, Par Afkandeh Haghighi F, Janbaz A. 2005. Abundance and diversity of Clupeidae species on the coasts of Mazandaran and Golestan Provinces. Iran J Fisheries Sci 1:22-23.

Biswas SP. 1993. Manual of methods in fish biology. South Asian Publishers, New Delhi.

Daryanabard GR, Shabani A, Keimaram F, Gorgin S. 2010. Reproduction and sexual maturation of *Liza aurata* in Iranian waters of the Caspian Sea. J Agri Sci Nat Resour 13:1-13.

Fazli H. 2011. The final report of project: Stock assessment of bony fishes on the southern coasts of the Caspian Sea (2007-2010). Iranian Fisheries Research Institute, Caspian Sea Ecology Institute, Iran.

Ghaninejad D, Abdolmaleki SH, Boorani M, Poor Gholami A, Abbasi K, Marakhah S. 2005. The final report of project: Stock assessment of bony fish in the Caspian Sea (Clupeidae part). Caspian Bony Fish Research Center, Iran.

Ghaninejad D, Maleki SH. 2007. Stable exploitation of bony fish in Iranian coasts Caspian Sea: Necessities and Needs, National Inland Water Aquaculture Institute, Sci J Fisheries 18(2):105-106.

Gulland JA. 1983. Fish Stock Assessment. FAO Fish Tech, 30-53 p.

Hosseini S. 2000. Systematic review and identification of Cluepidae fish belong to Alosa genus on the southwest coast in Caspian Sea. Islamic Azad University, Lahijan Branch, Master thesis, 145 p.

Javaheri Baboli M, Tabiei A. 1998. Biological and ecological characteristics Alosa caspia in the estuary of Gorgan rud .[Hon. Thesis].

Patimar R, Habibi SV, Jafar F. 2011. Study of growth parameters in Alosa caspia on the southern shores of the Caspian Sea. Iran Natl Resour J 64 (1): 15-27.

Samadani A, Javanshir Khoi A, Jamili S. 2007. Distribution of economical bony fish populations in less than ten meters depths on the coast of Mazandaran province. J Environ Sci Technol 11 (2): 134-138.

Vahedi F. 2011. The final report of project: Study of physicochemical properties of water in the southern part of the Caspian Sea. Caspian Sea Ecology Institute, Iran.

Yahyaei M. 2012. The final report of project: Catch and exploitation in 2011-2011. Fisheries Department, Golestan Province, Iran.