African Journal of Biotechnology Vol. 11(38), pp. 9214-9222, 10 May, 2012
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB11.3242
ISSN 1684–5315 © 2012 Academic Journals

Full Length Research Paper

Population dynamics of Caspian spirlin (Actinopterygii: Cyprinidae) in the Kesselian Stream, Iran

Mahvash Seifali[1]*, Aziz Arshad[2], S. M. Nurul Amin[2], Bahram Hasanzadeh Kiabi[3], Hamid Reza Esmaeili[4] and Faezeh Yazdani Moghaddam[5]

[1]Department of Biology, Faculty of Science, University Alzahra, Tehran, Iran.
[2]Department of Agriculture, Faculty of Agriculture, Universiti Putra Malaysia, Selangor, Malaysia.
[3]Department of Marine Biology, Faculty of Biological Science, University Shahid Beheshti, Tehran, Iran.
[4]Department of Biology, Faculty of Science, University Shirz, Shiraz, Iran.
[5]Department of Biology, Faculty of Science, Ferdowsi University of Mashhad, Iran.

Accepted 12 April, 2012

Studies on age, growth, mortality and recruitment of *Alburnoides* sp. were conducted in Kesselian Stream, South Caspian Sea, Iran from July 2008 to June 2009. Length frequency data were analyzed by using FISAT (FAO-ICLARM Stock Assessment Tools) software for estimating population parameters. Asymptotic length (L∞) and growth coefficient (K) were estimated at 104.48 mm and 1.19/year. Growth performance index (Ø') was calculated as 4.113. Total mortality (Z) was estimated at 3.40/year, whereas fishing mortality (F) and natural mortality (M) were found to be 2.43/year and 0.97/year, respectively. Annual mean temperature and salinity was 12.46°C and 0.32 ppt in the investigated area. The present exploitation rate (E = 0.71) indicated that the fish stock of *Alburnoides* sp. is over exploited in the Kesselian Stream.

Key words: Iran, *Alburnoides* sp., growth, mortality, stock.

INTRODUCTION

Iran is an important geographic area and zoogeography in the Middle East. Iran has been divided into nineteen major drainage basins (Coad, 1995). The Caspian and Tigris basins have the most species diversity. These large basins have connection to the river or marine ecosystems. The South Caspian Basin (north of Iran) is one of the most divers' fresh water environment in Iran (Coad, 1995; Gusssev et al., 1993). The genus *Alburnoides* belongs to the family Cyprinidae and was discovered by Jeitteles (1861). In Iran *Alburnoides* is widely distributed and was found in the basins of the Caspian Sea, Lake Orumiyeh, Tedzhen River, Kavir, Namak Lake, Esfahan (Zayandeh and Shur rivers), Tigris River, Persian Gulf drainage and Kor River (Coad, 2009).

Spirlin is widely distributed in most south Caspian basin (north of Iran) from the Aras River in the west to Atrak River in the east. Spirlin, *Alburnoides bipunctatus* (Bloch, 1782) is used as a common name for many populations but new investigations have found that it is a complex group showing great diversity with at least 6 species in Iran (Bogutskaya and Coad, 2009; Coad and Bogutskaya, 2009; Esmaeili et al., 2010). The populations of *A. bipunctatus* complex group in Iran have been considered as one species. Recently, Bogutskaya and Coad (2009) described six new species from Iran viz, *Alburnoides petrubanarescui, Alburnoides namaki, Alburnoides nicolausi, Alburnoides idignensis*, *Alburnoides eichwaldii* and *Alburnoides qanati*, have more isolated populations particularly from south and east Caspian sea basin which are still unconfirmed and referred to as *Alburnoides* sp. in this study.

Caspian spirlin is locally known as Khayyateh, lapak, parak, sima, kuli, shebeh zury (Coad, 2009a). Spirlins are small cyprinid that is generally found in shallow habitats with gravely bottom and well-oxygenated clear water. Spirlin is sensitive to changes in the structure of river habitat. As a result, this species has been considered as

*Corresponding author. E-mail: masaifali@yahoo.com or masaifali@gmai.com. Tel: 021 88694907. H/P: 09123875663.

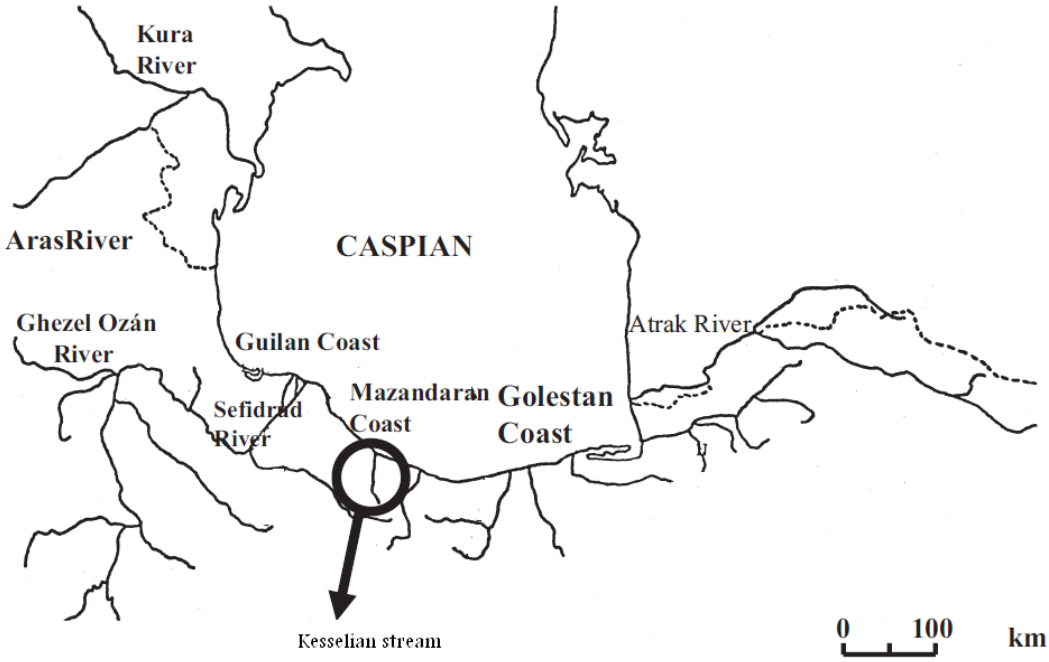

Figure 1. Study areas showing the Kesselian Stream from South Caspian basin of Iran.

threatened species in some countries. Dam construction can critically endanger this fish (Siryova, 2004). It inhabits both running and stagnant waters and feeds mainly on small planktonic and benthic organisms as well as insects. Spirlin is associated with sport fishing, aqua-culture and zoogeography and gathering of information on the species for effective resource management and conservation is vital. Previous studies were focused on developmental growth of the species but information on the population dynamics is still unavailable.

Growth parameters have been known to influence the outcome of particular stock assessments and fisheries management as a whole. There have been few papers that dealt with the growth of spirlin (Bastl et al., 1975; Johal, 1979; Papadopol and Cristofor, 1980; Soric and Ilic, 1985; Breitenstein and Kirchhofer, 2000). The present study presents an investigation of the population parameters and exploitation level of *Alburnoides* sp. to assess the stock position of the species from Kesselian stream in the Mazandaran Province of Iran.

MATERIALS AND METHODS

Study area and sampling

This study was conducted at Kesselian, Amirkola (52° 59′, 36° 13′) in the Mazandaran Province of Iran. The Kesselian Stream is one of the major tributaries of the Talar River in Mazandaran Province and an important Caspian Sea subarea (Figure 1). Caspian Sea basin is located in the European area of the Eurasia and is one of the most diverse freshwater ecosystems in Iran (Coad, 1995). Specimens were collected monthly with the aid of an electro shocker between July 2008 and June 2009. Specimens were preserved in 10% formalin solution and transported to the laboratory for further analysis. The physical and chemical parameters of the Kesselian Stream were measured. The mean water temperature, ambient temperature and waters pH were 12.46°C, 17.5°C and 6.5, respectively.

Laboratory measurement

In total, 1019 specimens were measured and weighed. An electronic digital caliper was used to measure the fork length (FL) to the nearest 0.01 mm. Total body weights were recorded by an electronic analytical balance (± 0.01 g). Monthly length data were grouped into length classes at 4 mm intervals (Table 1). The length-frequency data were analyzed using the FISAT (FAO-ICLARM Stock Assessment Tools) software as explained in detail by Gayanilo et al. (1996).

Length-weight relationship

The relationships between fork length and total weight were determined by fitting the data to an equation $W = aL^b$, where W is the weight in g, L the fork length in mm, constant ‘a’ and ‘b’ are relative growth coefficient. To make the relationship linear, a logarithmic transformation was used (Bagenal and Tesch, 1978):

$\text{Log } W = \text{Log } a + b \text{ Log } L.$

Size frequency distribution

The Bhattacharya method in the FISAT statistical package was used to identify the modes in the polymodal length-frequency distributions of *Alburnoides* sp. All identified size/age groups were derived from at least three consecutive points and selection of the best results was based on the following criteria; (a) values of the

Table 1. Monthly pooled fork length frequency of *Alburnoides* sp. from the Kesselian Stream, Mazandaran Province, Iran.

Mid FL	July/2008	August	September	October	November	December	January/2009	February	May	April	March	June
31.5	-	1	-	-	-	-	-	-	-	-	-	-
35.5	-	3	-	-	-	1	-	-	-	1	-	-
39.5	-	4	-	-	1	9	-	-	2	5	-	-
43.5	-	2	-	-	-	17	2	1	6	4	3	-
47.5	1	8	4	1	4	25	5	10	15	11	9	-
51.5	14	2	5	-	11	24	16	12	19	10	9	1
55.5	19	6	-	3	15	19	11	15	13	15	5	2
59.5	11	17	1	8	17	32	22	15	12	9	9	2
63.5	7	15	7	6	19	16	13	18	13	8	13	3
67.5	2	6	5	7	20	13	19	14	9	9	16	-
71.5	1	6	6	7	10	5	9	10	3	2	16	-
75.5	3	5	3	3	4	11	11	9	2	1	5	-
79.5	-	1	2	2	3	2	6	2	-	-	5	1
83.5	2		-	1	-	4	1	1	1	-	1	3
87.5	-	1	1	-	1	1	1	-	-	-	-	8
91.5	-	-	1	-	-	1	-	1	-	-	-	8
95.5	-	-	1	-	-	-	-	-	-	-	-	4
99.5	-	-	-	1	-	-	-	-	-	-	-	3
Total	60	77	36	39	105	182	116	108	95	75	91	35

separation index (SI) for the different age groups; (b) number of identified age groups and (c) standard deviation (SD) (Gayanilo et al., 1989).

Growth parameters

Asymptotic length (L∞) and growth co-efficient (K) of the von Bertalanffy equation for growth in length were estimated by means of ELEFAN-I (Pauly and David, 1981). The von Bertalanffy growth equation is defined as follows (Sparre and Venema, 1998): $L_t = L\infty [(1-\exp (-K (t-t_0))]$, with L∞ being the predicted asymptotic length, L_t is the size at age t, K is the instantaneous growth coefficient and t_o the point at which the von Bertalanffy curve intersects the age axis, t_0 is the hypothetical age at which the length is zero (Newman, 2002). The growth performance index (Ø') (Pauly and Munro, 1984) was calculated by estimation of K and L∞ using the equation:

$$Ø' = 2\log_{10}L\infty + \log_{10}K$$

Mortality parameters

Estimations of the mean mortality rate (Z) were obtained from using length converted catch curve analysis. Natural mortality (M) was calculated using the equation of Pauly (1980):

$$\text{Log}_{10}M = 0.0066 - 0.279\ \text{Log}_{10}\ L\infty + 0.6543\ \text{Log}_{10}K + 0.4634\ \text{Log}_{10}\ T$$

Where, M is the natural mortality; L∞ is the asymptotic length; K is the growth co-efficient of the von Bertalanffy growth function (VBGF) and T is the mean annual habitat water temperature (°C). The annual mean water temperature for the study area was 12.46°C.

The instantaneous fishing mortality (F) was taken as the difference between total and natural mortality: F = Z - M, where Z is the total mortality and M represents natural mortality. The exploitation level (E) was obtained from the relationship:

$$E = F/Z = F/(F + M).$$

Recruitment pattern

The recruitment pattern was obtained by projecting the length-frequency data backwards on the time axis using growth parameters (Moreau and Cuende, 1991). By NORMSEP analysis of FISAT statistical package, normal

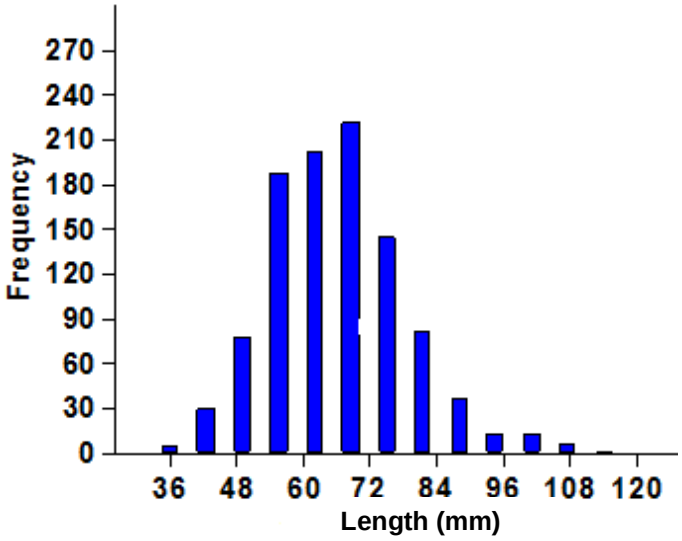

Figure 2. Annual size frequency distribution of *Alburnoides sp* from the Kesselian stream, Iran.

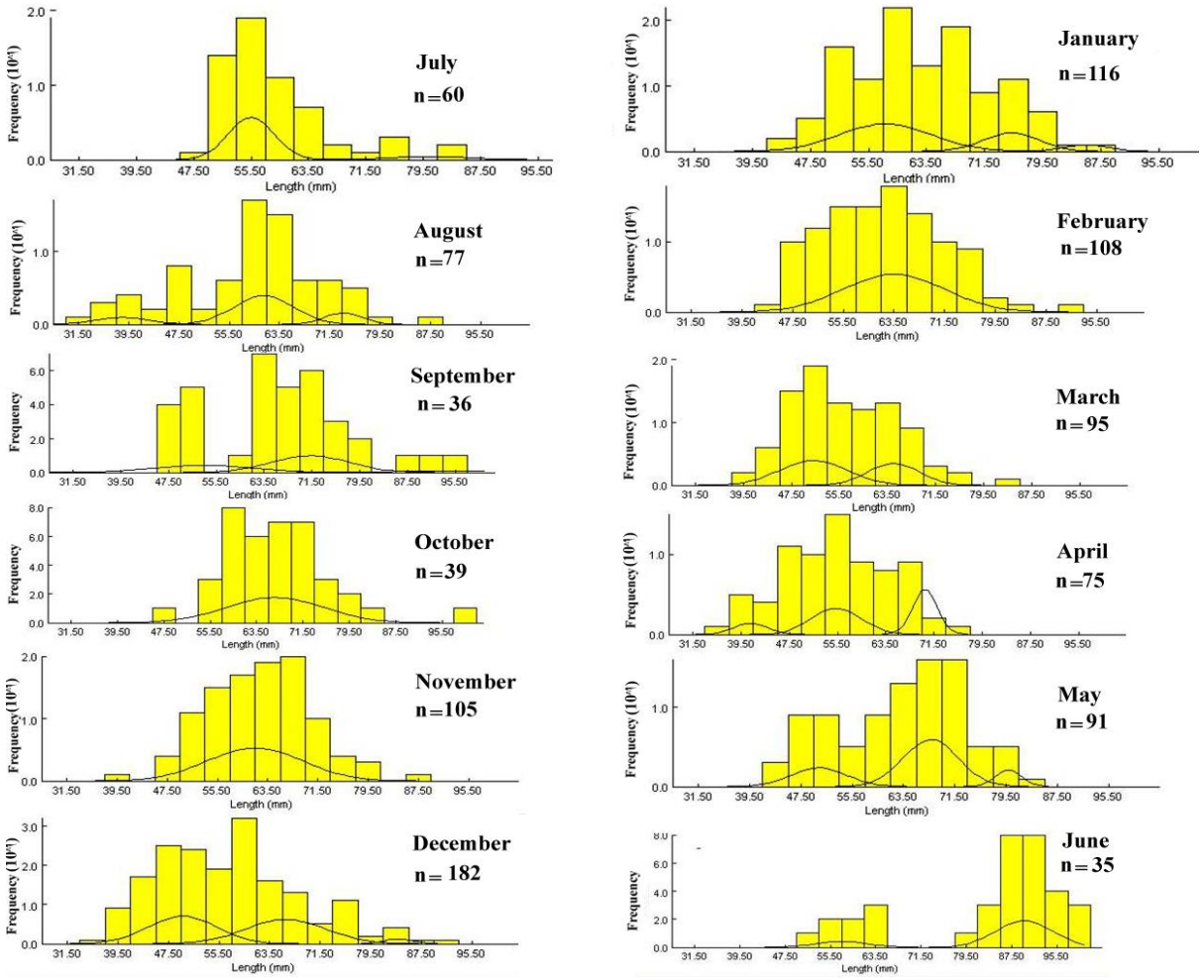

Figure 3. Monthly size frequency of *Alburnoides* sp.

Table 2. Identified age groups from fork length-frequency analysis of *Alburnoides* sp. using Bhattacharya's method.

Month	Mean FL (mm) of age groups	SD (mm)	N	SI
July	55.51	3.17	45	-
	80.17	5.40	6	5.75
August	38.53	4.23	10	-
	61.04	4.69	46	5.05
	73.65	3.12	12	3.23
September	53.50	8.47	9	-
	71.27	6.48	16	2.38
	96.60	11.17	3	2.87
October	66.69	8.46	37	-
November	61.50	7.55	100	-
December	49.75	5.37	95	-
January	66.06	6.34	98	2.79
	83.81	2.24	7	4.14
	57.89	6.32	67	-
February	75.21	3.79	27	3.43
	85.38	3,08	8	2.69
	63.50	7.94	107	-
March	51.16	5.59	55	-
	64.50	4.27	37	2.71
April	41.01	2.95	10	-
	55.27	4.18	34	4
	70.03	2.04	29	4.75
May	50.31	4.36	26	-
June	67.79	4.28	64	4.05
	79.94	2.03	11	3.85
	57.50	4.80	5	-
	89.68	5.02	24	6.55

FL, Fork length; SD, standard deviation; SI, separation index; N, no. of individuals.

distribution of the recruitment pattern was defined (Pauly and Caddy, 1985).

RESULTS

Size frequency distribution

In total, 1019 individuals of Caspian spirlin were measured to study the size frequency distribution. The annualsize frequency distribution obtained from monthly samples showed exploited sizes to be from 31.50 to 99.50 mm, with the bulk between 43.5 and 79.5 mm (Table 1 and Figure 2). Monthly size frequency distribution showed the modal lengths with cohorts in different months (Figure 3). The modal length of Caspian spirlin was between 38.53 mm in August and 96.60 mm in September, with satisfactory separation index (Table 2). The length frequency distribution in 12 months suggested that the population consisted of a maximum of

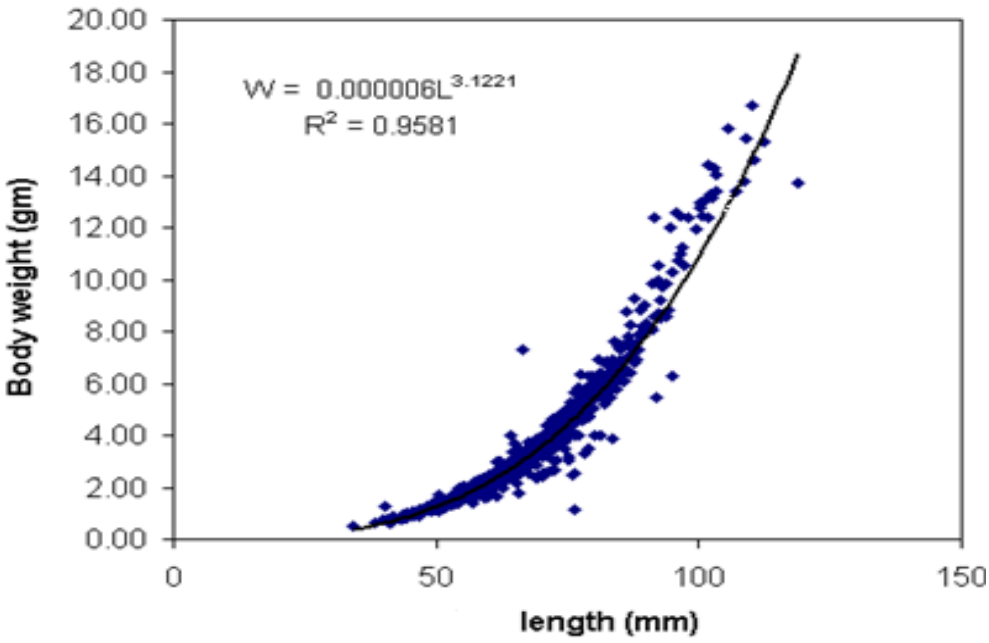

Figure 4. Length weight relationship of *Alburnoides* sp.

Table 3. Estimated population parameters of *Alburnoides* sp.

Population parameter	*Alburnoides* sp.
Asymptotic length (L∝) mm	104.48
Growth co-efficient (K/year)	1.19
Natural mortality (M/year)	0.97
Fishing mortality (F/year)	2.43
Total mortality (Z/year)	3.40
Exploitation level (E)	0.71
Length range (mm)	34-112
Sample number (N)	1019

two age groups (Table 2).

Length weight relationship

The length of individuals ranged from 34 to 112 mm and the weight from 0.51 to 16.72 mg. Length-weight relationship of *Alburnoides sp* in arithmetic scale is given in Figure 4. The length-weight relationship equation of Caspian spirlin was established as: Log W = -5.2081 + 3.1221Log L and in exponential form the equation was $W = 0.000006\ L^{3.1221}$ ($r^2 = 0.958$). The regression between total length and total weight showed positive relationship and highly significant ($p < 0.001$).

Growth parameters

The length-frequency data were fitted to FISAT and the extreme value theory was applied to find out the maximum length (L∞) from extreme values. The observed extreme length was 99.50 mm and the computer predicted extreme length was 102.82 mm. Extreme length range was 96.55 to 109.09 mm at 95% confidence interval level. Asymptotic length (L_∞) was 104.48 mm and growth co-efficient was (K) = 1.19/year (Table 3). Restructured length frequency data and growth curves are presented in Figure 5. The calculated growth performance index (Ø′) was 4.113 (Table 3).

Mortality and exploitation

By using length converted catch curve, total mortality was estimated at 3.44/year. Natural mortality (M) and fishing mortality (F) was found to be 0.97/year and 2.43/year, respectively (Table 3). From these information, the

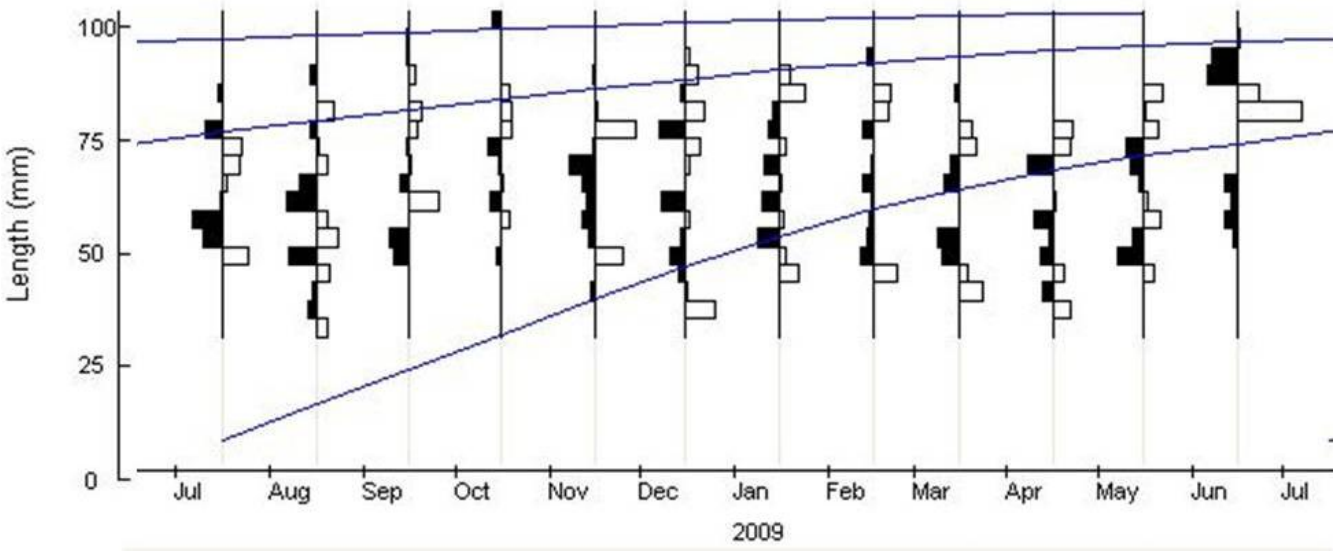

Figure 5. Von Bertalanffy growth curves of *Alburnoides* sp. superimposed on the restructured length-frequency histograms (L∞ = 104.48 mm and K = 1.19/yr)

.

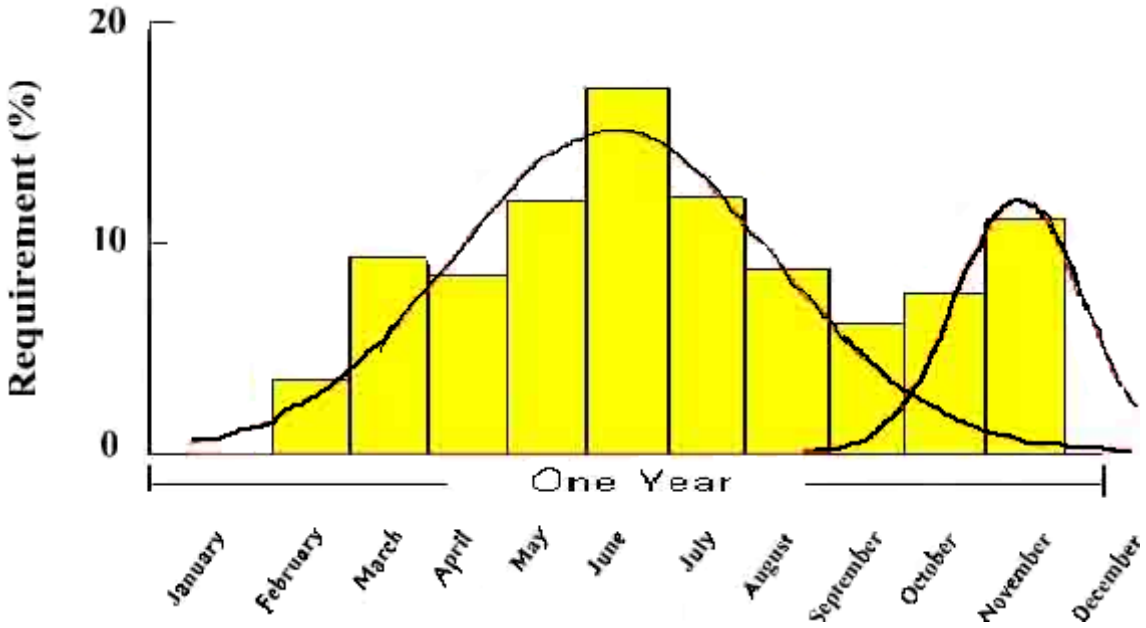

Figure 6. Recruitment pattern of *Alburnoides* sp.

present exploitation rate (E) was calculated as 0.71 for *Alburnoides* sp. in the investigated area and regarded to be over exploited stock.

Recruitment pattern

Recruitment pattern of Caspian spirlin in the study area was continuous throughout the year (Figure 6). There are two major peaks in recruitment. The first peak was recorded in June-July and the second peak was observed in November to December (Figure 6).

DISCUSSION

The 'b' parameter value in the weight-length model was estimated at 3.122, indicating isometric growth and not significantly higher than isometric value at 5% level. The growth coefficient 'b' generally lies between 2.5 and 3.5

Table 4. Comparison of growth parameters of *Alburnoides* sp. with previous study.

Location	Species	L∞ (cm)	K/year	Ø′	Source
Caspian Sea Iran	*Alburnoides* sp.	10.45	1.19	4.11	Present study
Turiec Slovenian	*A. bipunctatus*	15.6	0.28	4.22	Bastl et al. (1975)
Radimna Slovenian	*A. bipunctatus*	14.4	0.30	4.13	Papadopol and Cristofor (1980)
Croatian- Slovenian	*A. bipunctatus*	15.2	0.28	4.24	Treer et al. (2000)
Sava Crotia	*A. bipunctatus*	12.0	0.59	4.44	Treer et al. (2006)

and the relation is said to be isometric when it is equal to 3 (Carlander, 1977). Treer et al. (2000) examined weight expressed positive allometric growth in four out of the five locations and negative in one location in Croatia. The reasons for the variation of 'b' in the different regions are said to be due to seasonal fluctuations in environmental parameters, physiological conditions of the fish at the time of collection, sex, gonad development and nutritive conditions in the environment of fish (Biswas, 1993).

The comparison on growth parameters for this species with other studies showed that the present *L*∞ value (104.48 mm) and *K* value (1.19/year) is not similar with them. Table 4 shows the values of L∞ and K variation ranging from10.44 (present study) to 20.1 cm for L∞ and 0.15 to 1.19/year (present study) for K. Table 4 summarizes previous published values of the phi-prime of spirlin from other countries. The value of Ø' shows variation, ranging from 4.10 to 4.44. In general, the correlated parametric values adjust themselves to provide a similar growth pattern represented by *Ø′* (Sparre and Venema, 1998). The Ø' was calculated at 4.113 for Iranian population of Caspian spirlin in Kesselian. The phi-prime of Croatian spirlin, *Alburnoides sp* is *Ø′* = 4.11. This is very similar to those from the rivers Radimna (Papadopol and Cristofor, 1980) and (Skora, 1972). These data confirm the reliability of spirlin growth curves, as the overall growth performance *Ø′* which has minimum variance within the same species (Moreau et al., 1986). These values are not different from the phi-primes for the related genus *Alburnus* species.

Natural mortality (0.97/year) was observed to be lower than fishing mortality (2.43/year). The higher value of E (E = 0.71) indicates the 'over-fishing' condition of Caspian spirlin in the study area. According to Gulland (1965), the yield is optimized when F = M; therefore, when E is more than 0.5, the stock is over-fished. The recruitment pattern suggests that annual recruitment consists of two seasonal peaks (Figure 6), two cohorts were produced per year and the first peak occurred in June-July and the second peak observed in November to December. So far, no reports have been published about the recruitment of Caspian spirlin from Iran. Recruitment pattern of the fish revealed that its recruits into the stock occur almost round the year and major spawning is achieved in June to July. Fishing pressure is high and need to be reduced for sustainable production. Some fishing restriction should be imposed to get higher fish yield from that basin.

REFERENCES

Bagenal TB, Tesch FW (1978). Age and growth in-methods of assessment of fish production in fresh waters, Ed. Bagenal T. Oxford Blackwell Scientific Publication. pp. 101-136.

Bastl I, Holèik J, Kirka A (1975). Ichthyologic investigation of the protected habitat of the Danubian salmon (*Hucho hucho* L.) on the River Turiec (Czechoslovakia) and suggestions for its management, Ac. Rer. Nature Mus. Nat. Slov., Bratislava, (In Slovakian with English summary). 21: 191-224

Biswas SP (1993). Manual of methods in fish biol.*South* Asia publishers. Pvt. Ltd, New Delhi, p.195.

Bogutskaya NG, Coad BW (2009). A review of vertebral and fin-ray counts in the genus *Alburnoides* (Teleostei: Cyprinidae) with a description of six new species. *Zoosystematica Rossica,* 18(1): 126-173.

Carlander K (1977). Handbook of freshwater fishery boil. vol. 1. The Iowa State University Press, Ames IA, p. 431.

Coad BW (1995). Freshwater fishes of Iran. Acta Sci. Nat. Brno. 29:1-64.

Coad, B.W., and Bogutskaya, N.G., (2009). *Alburnoides qanati*, a new species of cyprinid fish from southern Iran (Actinopterygii, Cyprinidae) *ZooKeys.* 13:67-77.

Coad, B.W., (2009a). *Alburnus zagrosensis* n.sp., a new species of fish from the Zagros Mountains of Iran (Actinopterygii: Cyprinidae). *Zoology in the Middle East* 48: 63-70.

Gayanilo FC, Soriano Jr. M, Pauly D (1989). A draft guide to the complete ELEFAN, *ICLARM Contribution 435*: 70.

Gayanilo FC, Sparre P, Pauly D (1996). The FAO-ICLARM stock assessment tools (FiSAT) users' guide, FAO computerized information series, fisheries. *FAO,* Rome. p.126.

Gussev A, Jalali B, Molnar K (1993). New and known species of Dactylogyrus Diesing, 1850 (Monogenea, Dactylogyridae) from Iranian freshwater cyprinid fishes. Systematic Parasitol. 25(3):221-228.

Moreau J, Cuende FX (1991). On improving the resolution of the recruitment patterns of fishes. *ICLARM Fishbyte,* 9: 45-46.

Moreau J, Bambino C, Pauly D (1986). Indices of overall fish growth performance of 100 tilapia (Cichlidae) populations. In: Maclean J. L., Dizon L. B., Hosillos L. V. (ed): The first Asian fisheries forum. *Asian Fisheries* Society, Manila,pp. 201-206.

Papadopol M, Cristofor S (1980). Recherches sur L.ecologie de deux populations de Spirlin, *Alburnoides bipunctatus* (Bloch), des eaux de la Roumanie (Pisces, Cyprinidae). Trov. Mus. Hist. nat. Grigore Antipa, 22: 483-493.

Pauly D (1980). On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. J. Conservation and Int. Exploration Maritime, 39(3): 175-192.

Pauly D, Caddy JF (1985). A modification of Bhattacharya's method for the analysis of mixtures of normal distributions. FAO, Rome, FAO Fish. Cir, 78(1): 1-16.

Pauly D, David N (1981). ELEFAN-I BASIC program for the objective extraction of growth parameters from Length frequency data. Meeresforsch, 28(4): 205-211.

Siryova S (2004). External morphpology of spirlin *Alburnoides*

bipunctatus. Acta Zool. Univ. Comenianae.46(2): 65-74.
Skora S (1972), The Cyprinid *Alburnus bipunctatus* Bloch from the basins of the rivers Upper San and Dunajec. Acta Hydrobiol. 14: 173-204.
Soric VM, Ilic KR (1985). Systematic and ecological characteristics of *Alburnoides bipunctatus* (Bloch) in some waters of Yugoslavia, Ichtyologia, 17 (1):47-58.
Sparre P, Venema SC (1998). Introduction to tropical fish stock assessment, part 1-Manual, FAO Fisheries Technical Paper 306(1):376.
Treer T, Habekovi D, Aničić I., Safner R., Piria M (2000) Growth of five spirlin (*Alburnoides bipunctatus*) populations from the Croatian rivers. Agric. Conspectus Scientificus, 65(3): 175-180.