Original Article

Gillnets Selection of *Alburnus chalcoides* (Güldenstädt, 1772) in Almus Dam Lake (Tokat, Turkey)

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Abstract: In this study gill-net selectivity for *Alburnus chalcoides* inhabiting the Almus Dam Lake was estimated. Experimental gill-net fishing was conducted using gill-net with 15 mm and 20 mm mesh-size, during October 2002 and September 2003. A total of 254 and 198 specimens of *A. chalcoides* were caught by gill-net with 15 mm and 198 with the 20 mm mesh-size, respectively. The total length of the fish ranged from 10.5 cm to 21.5 cm for 15 mm mesh-size and 13.6 cm to 25.6 cm for 20 mm mesh-size. Mean total lengths were calculated as 14.34 ± 1.52 cm and 17.85 ± 1.97 cm for 15 mm and 20 mm mesh-size, respectively. Selectivity analysis indicated an optimum length (100% probability of retention) of 14.77 cm for the 15 mm mesh size and 19.69 cm for the 20 mm mesh size gill-nets. Selectivity Factor was calculated as 0.9846. The vast majority (81%) of fish caught by 15 mm mesh size and 20 mm mesh size were mature. Therefore, both the 15 mm and 20 mm mesh size were suitable for the sustainable fisheries of *A. chalcoides* in the Almus Dam Lake.

Introduction

The Caspian shemaya (Danube bleak), *Alburnus chalcoides* inhabit lower reaches of rives, coastal lakes, estuaries, and brackish areas of sea. This species is widely distributed in the Black, Caspian and Aral Seas and the rivers connected them and reported from the western and southern parts of Anatolia and probably has been spread toward further west Turkey by translocations (Bogustkaya, 1997; Innal and Erk'akan, 2006).

Alburnus chalcoides is a pelagic species occurring close to surface and adults predominantly prey on planktonic crustaceans, terrestrial insects and small fish while its larvae and young juveniles feed on zooplankton, algae and insect larvae (Kottelat and Freyhof, 2007). This species spawns in small rivers or streams with heavy current water on the gravel bottom. Furthermore, the land-locked populations of *A. chalcoides* spawn in reservoir's tributaries by

depositing their sticky eggs on pebbles or stones of river beds (Kottelat and Freyhof, 2007). Spawning period of *A. chalcoides* in Anatolia has been reported May till June (Ünver and Yıldırım, 2011; Balık and Sarı, 1994). The Caspian shemaya is considered as an endangered species and threatened by habitat loss, eutrophication/pollution and construction of dams (Fricke et al., 2007). In addition, this species is locally caught and utilized as a food resource in Turkey, but does not consider as a commercial fish (Geldiay and Balik, 2007). Therefore, there is no catch statistics available about this species (Anonymous, 2014).

The Almus Dam Lake was constructed on Yeşilırmak River in 1966 (Almus, Tokat). The total area of the lake is 3130 km^2 with depth of 43 m. The mean water surface temperatures were reported as 17.4 ± 6.47°C (with range of 3.00-25.53°C) (Kayım, 2002) and 14.8 ± 6.7°C (with range of 5.6-22.8°C)

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(Buhan et al., 2010). Commercial fishing in the lake is conducted by Almus fisheries cooperative mostly using gill-nets. Water quality of the lake appropriate for rainbow trout cage culture (Kayım, 2002; Buhan et al., 2010) that have been started in 1999 (Zengin and Buhan, 2007).

Several studies have been conducted on the Almus Dam Lake, e.g. water quality (Pabucçu, 2000; Kayım, 2002; Buhan et al., 2010), fish fauna (Akyurt and Karataş, 1994; Zengin and Buhan, 2007), biology of inhabiting fish (Cengizler, 1991; Karataş, 1995; Karataş and Akyurt, 1997; Yılmaz and Suiçmez, 2010; Yılmaz et al., 2011; Suiçmez et al., 2011), parasitic fauna of fish (Cengizler, 1993) and hydrographical characteristics (Pabucçu, 2000). However, there is no information available regarding the gill-net selectivity of fish species inhabiting the Almus Dam Lake. Therefore, this study was aimed to identify the gill-net selectivity parameters of *A. chalcoides* inhabiting the Almus Dam Lake.

Material and Methods

This study was carried out between October 2002 and September 2003 in the Almus Dam Lake (40°24'28"N; 36°54'13"E). The specimens were monthly caught using gill-nets. The gill-nets with 15, 20, 25 and 30 mm mesh sizes were used for fishing, but most of *A. chalcoides* specimens were caught by gill-nets with 15 and 20 mm mesh sizes. The used monofilament gill-nets had a length of 100 m and its hanging ratio was 0.5 m. Fishing operations were perform at night and it duration was 12 hrs. Fish samples were transferred to the laboratory immediately, and their total length (TL), fork length (FL) and standard length (SL) were measured to the nearest 1 mm.

In order to compare the results of this study with previous works (Ünver and Erk'akan, 2009; Ünver and Yıldırım, 2011), the relationships between TL-FL, TL-SL, and FL-SL were estimated using linear regression method by Microsoft Excel 2010.

The selectivity parameters were estimated using Holt's model (Sparre and Venema, 1998) by the following formula:

$$S_L = \exp\left[-\frac{(L - Lm)^2}{2 * s^2}\right]$$

Where, Lm is optimum length for being caught, S_L, fraction (ranged 0 to 1) and s, the common standard deviation. Input data for this model were the numbers of caught fish by length group for each gear, i.e. Ca and Cb, and the two used mesh sizes, including ma and mb. The calculation of selectivity parameters was performed as following:

Step 1: Calculation of log ratios for each length group using y = ln(Cb/Ca). Only the lengths where the frequencies overlap, were used. In this formula, Ca is length group caught using the smaller meshed net (15 mm) and Cb is length group caught using the larger meshed net (20 mm).

Step 2: Performing a regression analysis of the calculated log ratios [y = ln(Cb/Ca)] versus the interval midpoint for fish length (x = L), to determine α and b coefficients as following:

$$y = \ln(Cb/Ca) = \alpha + b*L$$

Step 3: The obtained values of α and b along with ma and mb were used to estimate the selection factor (SF) in following formula:

$$SF = \frac{-2 * a}{b * (ma + mb)}$$

The optimum fish lengths for the small and large mesh size were calculated as following:

$$Lma = SF * ma \text{ and } Lmb = SF * mb$$

Where, Lma id optimum length for the smaller meshed net and Lmb is optimum length for the larger meshed net. The common standard deviation (s) is determined as following:

$$s^2 = \frac{-2 * a * (mb - ma)}{b^2 * (ma + mb)} = SF * \frac{mb - ma}{b}$$

Step 4: Points on the selection curves are found by inserting values of L:

$$Sa(L) = \exp\left[-\frac{(L - Lma)^2}{2 * s^2}\right]$$

$$Sb(L) = \exp\left[-\frac{(L - Lmb)^2}{2 * s^2}\right]$$

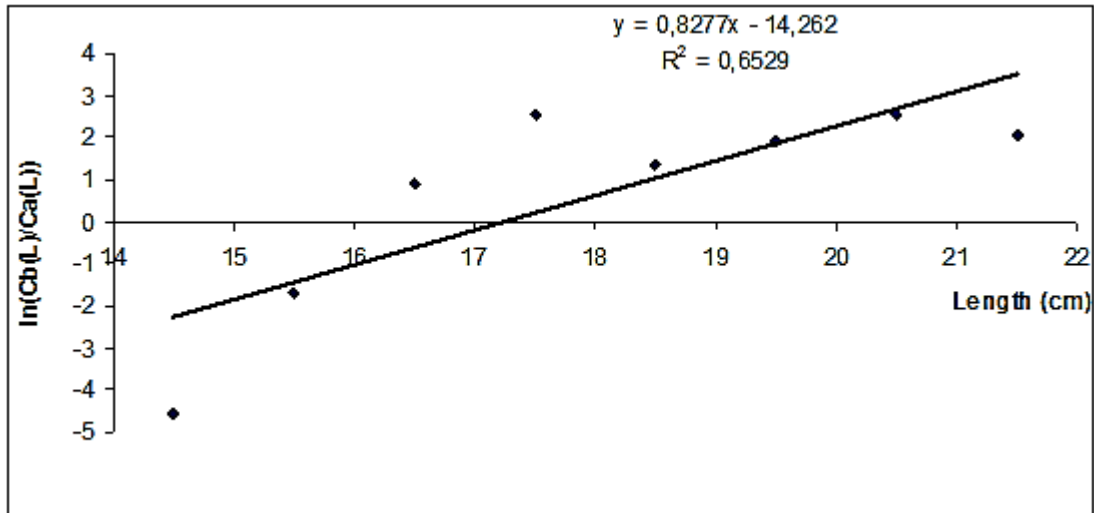Where, $S\alpha$ is selection curve for gill-net with 15 mm

Figure 1. The regression of ln(Cb/$C\alpha$) on fish length for *Alburnus chalcoides* for gill nets of 15 mm and 20 mm mesh size from Almus Dam Lake.
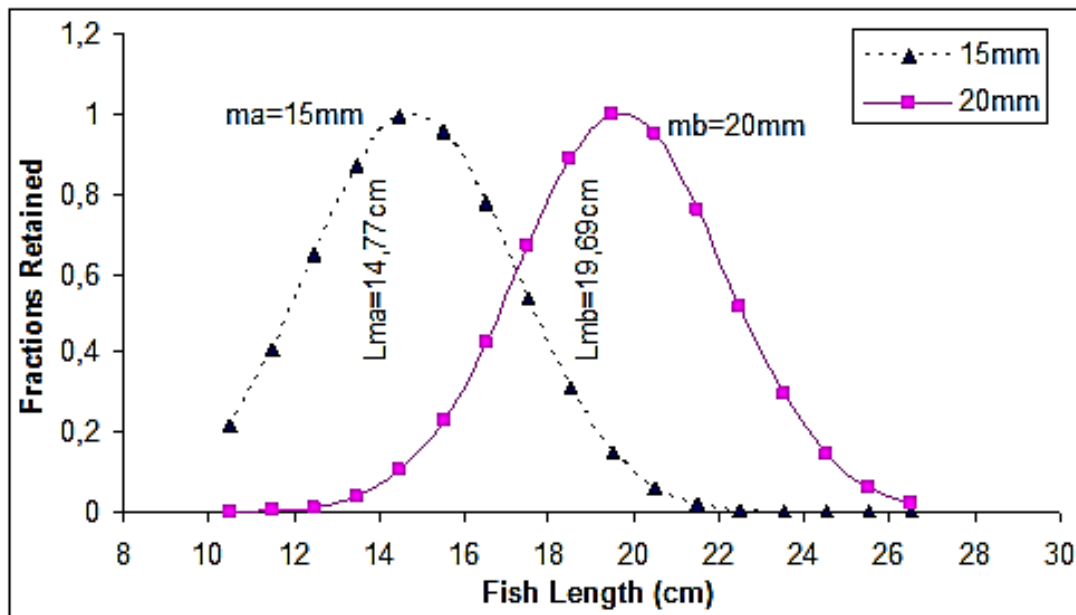

Figure 2. Selection curves for *Alburnus chalcoides* for gill nets of 15 mm and 20 mm mesh size from Almus Dam Lake.

mesh size and *Sb,* selection curve for gill-net with 20 mm mesh size.

Step 5: From obtained data of step 4 and the catches $Ca(L)$ and $Cb(L)$, an index of the number in the population is estimated for each mesh size as following:

$$Na(L) = Ca(L) / Sa(L)$$
$$Nb(L) = Cb(L) / Sb(L)$$

Results

A total of 254 and 198 specimens of *A. chalcoides* were caught with 15 mm and 20 mm mesh-size gill-net, respectively. Total length of the fish ranged from 10.5 to 21.5 cm for 15 mm mesh-size and 13.6 to 25.6 cm for 20 mm mesh-size. Mean total lengths were calculated as 14.34 ± 1.52 cm and 17.85 ± 1.97 cm for 15 mm and 20 mm mesh-sizes, respectively. The distribution at the points designated by ln(CaL/CbL) for successive pairs of gill-nets are presented in Figure 1. The regression constants α and b were estimated as -14.262 and 0.8277, respectively (Fig. 1).

For the calculation of selectivity parameters using Holt's method, the data and value of the selectivity parameters are presented in Table 1. The values of the Selectivity Factor (*SF*) and Standard Deviation

Table 1. Estimation of net selectivity curves for *Alburnus chalcoides* from Almus Dam Lake.

Length interval midpoint L (x)	Number caught		$\ln(\frac{CbL}{CaL})$ (y)	Selection		Population estimates	
	ma=15 Ca(L)	mb=20 Cb(L)		Sa(L)	Sb(L)	Na(L)	Nb(L)
10.5	1	0		0.2161	0.0008	4.6284	
11.5	3	0		0.4072	0.0035	7.3677	
12.5	13	0		0.6486	0.0129	20.0424	
13.5	55	0		0.8733	0.0398	62.9769	
14.5	96	1	-4.56434	0.9939	0.1037	96.5870	9.6448
15.5	49	9	-1.69459	0.9561	0.2282	51.2492	39.4380
16.5	21	52	0.906721	0.7774	0.4246	27.0130	122.482
17.5	4	51	2.545531	0.5343	0.6676	7.4867	76.3924
18.5	6	23	1.343735	0.3104	0.8873	19.3319	25.9200
19.5	2	14	1.945910	0.1524	0.9969	13.1238	14.0436
20.5	2	25	2.525729	0.0632	0.9466	31.6217	26.4090
21.5	2	16	2.079442	0.0222	0.7598	90.1418	21.0575
22.5	0	5		0.0066	0.5155		9.6995
23.5	0	0		0.0016	0.2956		0
24.5	0	0		0.0003	0.1433		0
25.5	0	1		0.0001	0.0587		17.0353
26.5	0	1		0	0.0203		49.1931

$$\ln(\frac{CbL}{CaL}) = a + b * L \qquad a=-14.262; \ b=0.8277$$

$$SF = \frac{-2*a}{b*(ma+mb)} = \frac{-2*(-14.262)}{0.8277*(15+20)} = 0.9846$$

Lma=SF*ma=14.77

Lma=SF*ma=19.69

$$s^2 = SF * \frac{mb-ma}{b} = 0.9846 \frac{20-15}{0.8277} = 5.95$$

$$s = \sqrt{S^2} = 2.44$$

(SD) were obtained 0.9846 and 5.95, respectively. Selectivity curve is shown in Figure 2. The optimum catch lengths of the monofilament gill-nets with 15 and 20 mm mesh sizes were calculated as 14.77 cm (TL) and 19.69 cm (TL), respectively.
In order to compare the results of this study with previous works, the relationships among TL-FL, TL-SL and FL-SL were described as follows;
FL = 0.886*TL+0.4644 ($r^2 = 0.9171$)
SL = 0.7933*TL+0.7555 ($r^2 = 0.8299$)

SL = 0.9105*FL+0.0948 ($r^2 = 0.8914$)

Discussion

Proper estimation of age and length at first maturity is very crucial for fish stock management. Yılmaz and Suiçmez (2010) reported the ages of *A. chalcoides* ranged I-III year old with mean total lengths of 12.85, 14.70 and 16.50 cm, respectively in Almus Dam Lake. In other works on *A. chalcoides*, the mean total lengths for each age given as I-10.28

cm, II-16.04 cm, III-21.26 cm, IV-24.17 cm and V-28.00 cm for Ömerli Dam Lake (Tarkan et al., 2005); I-11.59 cm, II-15.93 cm, III-18.04 cm and IV-20.23 cm for Bird Lake (Bandırma) (Balık et al., 1996). In the previous studies, the length and age at first maturity of *A. chalcoides* was reported 13.30 cm (Ünver and Yıldırım, 2011) at age of I-III (Ünver and Yıldırım, 2011; Balık and Sarı, 1994). Based above mentioned information, the lengths at first maturity was estimated as 15.93 cm, 16.04 cm and 16.50 cm for *A. chalcoides* of the Almus Dam Lake, Bird Lake and Ömerli Dam Lake, respectively.

The fishery can greatly influence the population structure and reproductive potential of the species. Therefore, adult organism should reproduce at least once in their lifetime before to be exploited for the sustainable fisheries. Fishing gear selectivity studies are important for fisheries management due to regulating the mesh size of gill-net and recognizing the approximate minimum catch sizes of the target species (Spare et al., 1989).

The results showed that, the optimum catch lengths of gill-nets with 15 and 20 mm mesh sizes were estimated as 14.77 cm (TL) and 19.69 cm (TL) of length, respectively. The results given above indicate 15 mm mesh size gill-net for fishing operations should be discouraged for *A. chalcoides* in the Almus Dam Lake. However, the use of gill-net with 20 mm mesh size is appropriate due to enhancing sustainability of the fisheries resources of the Almus Dam Lake. Ünver and Yıldırım (2011) suggested the specimen size allowed for commercial fishing must be over 15.8 cm according to length at first maturity. In conclusion, selectivity parameter of *A. chalcoides* was estimated and allowable gillnet mesh size was determines as 20 mm for sustainable fisheries in the Almus Dam Lake.

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