Density and Biomass of Fish Populations in Kirmir Stream of Sakarya River, Turkey

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ABSTRACT

In this study, Zippin's triple-catch removal method was used to estimate density and biomass of fish species in Kirmir Stream of Sakarya River, Central Anatolia Turkey. A total area of 1.5256 ha was sampled and 4167 fishes were caught using electrofishing between February 2007 and November 2007. A total of 9 fish species representing 2 families Cyprinidae and Cobitidae were recorded. Fish species identified are as follows: Chub (*Leuciscus cephalus* Linnaeus, 1758), barbel (*Barbus plebelejus escherichi* Heckel, 1843), *Capoeta tinca* Heckel, 1843, spirlin (*Alburnoides bipunctatus* Bloch, 1782), *Capoeta capoeta sieboldi* Steindachner, 1864, tirgis-nase (*Chondrostoma regium* Heckel, 1843), bleak (*Alburnus orontis* Sauvage, 1882), spined-loach (*Cobitis taenia* Linnaeus, 1758) and angora-loach (*Noemacheilus angorae* Steindachner, 1897). *A. orontis* was the most dominant species, constituting 1199 fish and 28.77% of the total fishes, followed by *C. tinca* (1173 fish and 28.15%), *B. p. escherichi* (584 fish and 14.01%), *L. cephalus* (454 fish and 10.90%), *A. bipunctatus* (322 fish and 7.73%), *C. regium* (245 fish and 5.88 %), *N. angorae* (107 fish and 2.57%) *C. c. sieboldi* (65 fish and 1.56%) and *C. taenia* (18 fish and 0.43%). The density and biomass values were estimated as 11456 fish ha^{-1} and 346.78 kg ha^{-1} in February 2007, 8982 fish ha^{-1} and 279.82 kg ha^{-1} in May 2007, 6320 fish ha^{-1} and 251.52 kg ha^{-1} in August 2007 and 2887 fish ha^{-1} and 168.87 kg ha^{-1} in November 2007, respectively. The lowest density and biomass values were observed in November 2007.

Keywords: Density; Biomass; Electrofishing; Kirmir stream; Ankara; Turkey

Sakarya Nehri'nin Kirmir Çayı'ndaki Balık Populasyonlarının Yoğunluğu ve Biyoması

ÖZET

Bu çalışmada, İç Anadolu Bölgesi'ndeki Sakarya Nehri'nin Kirmir Çayı'nda balık türlerinin yoğunluk ve biyomas değerlerini tahmin etmek için üç avlı ayrılmaya dayalı metot kullanılmıştır. 1.5256 ha'lık alanda örnekleme yapılmış ve

Şubat 2007-Kasım 2007 tarihleri arasında 4167 adet balık elektroşok metoduyla avlanmıştır. Elde edilen örneklemelerde 2 familyaya (Cyprinidae ve Cobitidae) ait 9 balık türü (tatlısu kefali (*Leuciscus cephalus* Linnaeus, 1758), bıyıklı balık (*Barbus plebejus escherichi* Heckel, 1843), siraz balığı (*Capoeta tinca* Heckel, 1843), inci balığı (*Alburnoides bipunctatus* Bloch, 1782), saçaklı siraz (*Capoeta capoeta sieboldi* Steindachner, 1864), karaburun (*Chondrostoma regium* Heckel, 1843), anadolu inci balığı (*Alburnus orontis* Sauvage, 1882), taş ısıran balığı (*Cobitis taenia* Linnaeus, 1758) ve çöpcü balığı (*Nemachelius angorae* Steindachner, 1897) avlanmıştır. *A. orontis* toplam populasyon içerisinde 1199 birey ve % 28.77 ile en yoğun türdür ve bu türü sırasıyla *C. tinca* (1173 birey ve % 28.15), *B. p. escherichi* (584 birey ve % 14.01), *L. cephalus* (454 birey ve % 10.90), *A. bipunctatus* (322 birey ve % 7.73), *C. regium* (245 birey ve % 5.88), *N. angorae* (107 birey ve % 2.57) *C. c. sieboldi* (65 birey ve % 1.56) and *C. taenia* (18 birey ve % 0.43) takip etmiştir. Yoğunluk ve biyomas değerleri sırasıyla Şubat 2007'de; 11456 adet ha^{-1} ve 346.78 kg ha^{-1}, Mayıs 2007'de; 8982 adet ha^{-1} ve 279.82 kg ha^{-1}, Ağustos 2007'de; 6320 adet ha^{-1} ve 251.52 kg ha^{-1} ve Kasım 2007'de; 2887 adet ha^{-1} ve 168.87 kg ha^{-1} olarak tahmin edilmiştir. En düşük yoğunluk ve biyomas değerleri Kasım 2007'de gözlenmiştir.

Anahtar Kelimeler: Yoğunluk; Biyomas; Elektrikle avcılık; Kirmir çayı; Ankara; Türkiye

1. Introduction

A fish population is shaped by the geologic, chemical, physical, and biological factors within and surrounding the environment in which it lives. The relative quality of that environment affects the organisms living there, exerting positive or negative pressure on the population (Platts & McHenry 1988). The fluctuation of the fish population is really important for stock assessment and management. In this way, a major decline and rise in the population size or the population biomass can be detected, and appropriate management strategies can be adopted (Chen et al 2004). A relatively simple and inexpensive method of evaluating the health of lentic systems is to monitor the density and biomass of the fish population (Platts & McHenry 1988; Bohlin et al 1989).

Density and biomass estimates of targeted species by electrofishing capture data are most often generated using depletion (or sometimes referred to as removal) (Moran 1951; Zippin 1958; White et al 1982) or the mark-recapture method (Ricker 1975; Zubik & Fraley 1988). Because these methods are labour intensive, they have been recommended only when researchers require detailed knowledge of the target population. Typically, removal methods have been used in stream environments where fish capture is by electrofishing during two to four intensive sampling periods over a short time period (often within a day) (Kelso 1989).

It was clear that estimates of population density and biomass would be required if the interrelationships of the various species were to be evaluated (Williams 1965). Many authors in various regions of the world have been studied the density and biomass of fish or fishes per surface unit in rivers (Pires et al 1999; Penaz et al 2003; Dikov & Zivkov 2004; Namin & Spurny 2004; Vlach et al 2005; Kolev 2010). The principal aim of these investigations was to obtain population density and biomass estimates of most, if not all, of the fish species occurring at each site, and it is perhaps pertinent to consider the accuracy of the results obtained.

Little work has been done in Central Anatolia, Turkey on river populations parameters (i.e. density and biomass) of fish (Ölmez 1992; Korkmaz & Atay 1997; Korkmaz et al 1998; Korkmaz 2005). With this respect it is needed to establish the status of fish density and biomass in a number of localities and stream profiles in Central Anatolia, Turkey. As there is no data about density and biomass of fish in Kirmir Stream, the information obtained from Zippin's triple-catch removal method by electrofishing in the stream sections could be important. The objectives of this study were to determine density and biomass estimates, and habitat structure for fish populations in Kirmir Stream and to assess correlations between density and biomass.

2. Material and Methods

2.1. Study area

Kirmir Stream is a branch of the Sakarya River geographically located in the north-western part of the Central Anatolian Region of Turkey at 40-41° N and 32-33° E (Figure 1). The depth of the stream is generally shallow (30-50 cm), but reaches 2-3 m at some points. The bottom structure varies between sandy, stony and muddy (Kucuk & Alpaz 2008).
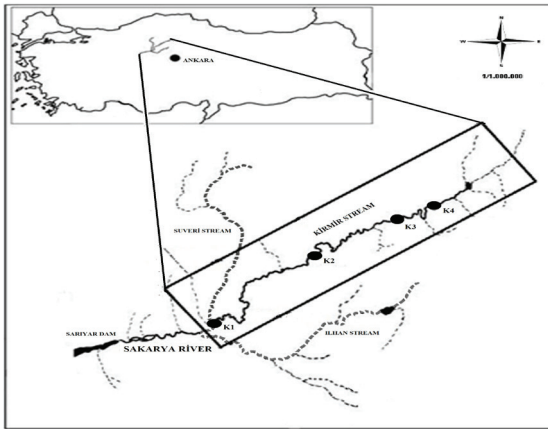

Figure 1- Study area and sampling sites

Şekil 1- Araştırma alanı ve örnekleme yerleri

The bottom of site 1 was covered with small rocky (5-10 cm), and the banks were occasionally wooded; the bottom of site 2 was covered with rocky (20-30 cm), sandy and standing water, and the banks were un-wooded and rocky; the bottom of site 3 was covered with rocky (30-70 cm), and the banks were occasionally wooded and standing water; the bottom of site 4 was covered rocky (30-50 cm) and big rocky, and the its around was reeds.

This study was carried out in Kirmir Stream of Sakarya River. Four sampling sites were assigned on Kirmir Stream (130 km long) for taking fish samples, water samples and measuring water characteristics. These sampling sites in Kirmir Stream were selected according to habitat structure, depth, water velocity, size and structure of substratum (Hankin 1984). At each sampling site, we took the measurement per 10-20 m to determine the mean stream width (m) over a 200 m standard reach length. Some physical and chemical characteristics of sampling sites were shown in Table 1. Width and depth of the stream varies 3.16-6.12 m and 0.12-0.89 m, respectively.

2.2. Sampling methods

Fish populations in Kirmir Stream were sampled approximately every 3 months between February 2007 and November 2007 using electrofishing (500-

Table 1- Some physical and chemical charecteristics of sampling sites

Çizelge 1- Örnekleme yerlerinin bazı fiziksel ve kimyasal özellikleri

Sampling times and sites		pH	Water Temperature (°C)	Dissolved Oxygen (mg L⁻¹)	Water velocity (m sec⁻¹)	Conductivity (µmhos cm⁻¹)	Depth (m)	Width (m)	Area (ha)
February 2007	1	7.84±0.01	10.5±0.00	9.6±0.24	0.24±0.02	1540±1.70	0.63±0.08	5.16±0.05	0.1032
	2	7.81±0.02	10.5±0.00	10.2±0.08	0.45±0.01	1580±1.82	0.17±0.04	5.80±0.06	0.1160
	3	8.11±0.02	8.5±0.03	9.8±0.13	0.59±0.02	1696±1.73	0.51±0.04	3.33±0.06	0.0666
	4	7.89±0.01	9.0±0.00	11.5±0.17	0.42±0.02	1674±1.29	0.41±0.07	5.66±0.05	0.1132
May 2007	1	7.50±0.02	21.5±0.00	6.0±0.17	0.25±0.01	1486±1.71	0.53±0.05	5.08±0.05	0.1016
	2	7.51±0.02	23.5±0.03	8.8±0.17	0.45±0.02	1510±1.71	0.12±0.02	5.70±0.08	0.1140
	3	7.69±0.03	24.5±0.00	8.7±0.13	0.71±0.03	1688±1.29	0.38±0.05	3.16±0.04	0.0632
	4	8.07±0.02	25.0±0.00	7.7±0.15	0.50±0.01	1642±1.83	0.33±0.04	5.60±0.06	0.1120
August 2007	1	8.12±0.02	24.0±0.00	8.6±0.24	0.28±0.02	1897±1.29	0.29±0.05	3.27±0.07	0.0654
	2	8.17±0.02	22.0±0.03	7.3±0.01	0.40±0.01	1584±1.29	0.46±0.08	4.25±0.07	0.0850
	3	8.16±0.03	23.0±0.00	8.9±0.13	0.67±0.03	1966±1.83	0.37±0.06	3.28±0.07	0.0656
	4	8.24±0.01	24.5±0.03	7.9±0.13	0.43±0.02	1786±2.16	0.30±0.06	5.45±0.06	0.1090
November 2007	1	7.62±0.02	7.5±0.00	9.8±0.01	0.27±0.02	1300±3.59	0.82±0.08	6.12±0.04	0.1224
	2	7.76±0.02	5.0±0.00	10.1±0.18	0.50±0.02	1243±2.22	0.50±0.06	5.06±0.05	0.1012
	3	7.56±0.02	6.5±0.00	10.5±0.18	0.67±0.03	1278±1.29	0.89±0.07	4.05±0.08	0.0810
	4	7.83±0.01	7.2±0.03	9.7±0.18	0.53±0.02	1200±1.83	0.21±0.06	5.31±0.04	0.1062
Total sampling area (ha)									1.5256

700 V, 2 A, D.C). The electrofishing team consisted of three experienced crew members with one using the anode and the other two using dip nets to capture the fish. Each sampling site under study was closed at both ends with 8-10 mm mesh size nets (Lacroix 1989). Each fishing pass (with 1.5 hour) was carried out in an upstream direction. The time interval between passes was at least 30-60 minutes. Each sampling site was sampled three times with effort standardized among sampling. The depth and width of the sampling sites were measured per 10-20 m (Neves & Pardue 1983). Fish caught in each sample were anesthetized with MS 222 and mortality was not observed. Then, fishes were identified as to species and weighted (±0.01 g). Fish caught were returned to the water as alive in accordance with permission. In each sampling, the numbers and biomass of fish were determined. Then, in order to determine fish density (population size) according to species, it was used Zippin's triple-catch removal method (Zippin 1956; Seber & Whale 1970). Zippin's triple-catch removal method is described as in Equation 1.

$$\hat{N} = \frac{T}{(1 - \hat{q}^k)} = \frac{C_1 + C_2 + C_3}{(1 - \hat{q}^k)} \quad (1)$$

Where; $\hat{p}$ is the catch efficiency ($\hat{p} = 1 - \hat{q}$); T is total catch ($C_1 + C_2 + C_3$); k is the numbers of removals; C_1, C_2, C_3 are the catch in each consecutive removal; $\hat{N}$ is population density. The sampling variance and standard error of $\hat{N}$ were estimated from the Equation 2 and 3, respectively.

$$S_{\hat{N}}^2 = \frac{\hat{N} \cdot (1 - \hat{q}^k) \hat{q}^k}{(1 - \hat{q}^k)^2 \cdot (p.k)^2 \cdot \hat{q}^{k-1}} \text{ and } S_{\hat{N}} = \sqrt{S_{\hat{N}}^2} \quad (2)$$

An approximate 95 per cent confidence interval for $\hat{N}$ is $\hat{N} \pm t.S_{\hat{N}}$. An estimator of $\hat{q}$ is $\hat{q} = (T - C_1) / (T - C_k)$ (k=3). The validity of the Zippin method was tested by calculating R and T_1, $R = (C_2 + 2.C_3) / (C_1 + C_2 + C_3)$, (If $R = 0$ or $R \rangle 1$ then the Zippin method is not applicable) and the goodness of fit statistic ($T_1 < \chi^2 = 3.841$ with k-2 degrees of freedom) for a multinomial distribution where the population size is not known (Seber 1973). The computation used for T_1 was:

$$T_1 = \sum_{i=1}^{k} [C_i - E_i)^2 / E_i] \text{ and } (E_1 = \hat{N}.\hat{p}; E_2 = \hat{N}.\hat{p}.\hat{q}; E_3 = \hat{N}.\hat{p}.\hat{q}^2) \quad (3)$$

The biomass or standing crop ($\hat{B}$) was estimated by $\hat{B} = B. (\hat{N} / N)$. Where; B is the total weight of fish caught and N is the total number of fish caught. Values of density and biomass of fish per unit area where catches were estimated by $\hat{N}A$ and $\hat{B}A$, respectively. Where A is area of sampling sites (in ha) (Bohlin et al 1989).

3. Results and Discussion

A total area of 1.5256 ha was sampled and 4167 fishes were caught from the Kirmir Stream between February 2007 and November 2007. A total of 9 fish species representing 2 families Cyprinidae and Cobitidae were recorded. Fish species identified are as follows: Chub (*Leuciscus cephalus*), barbel (*Barbus plebelejus escherichi*), *Capoeta tinca*, spirlin (*Alburnoides bipunctatus*), *Capoeta capoeta sieboldi*, tirgis-nase (*Chondrostoma regium*), bleak (*Alburnus orontis*), spined-loach (*Cobitis taenia*), angora-loach (*Noemacheilus angorae*).

Number of fish species of Kirmir Steam is fewer than the most studies such as Guadina Basin (Portugal, 16 species) (Pires et al 1999), Veleka River (Bulgaria, 16 species) (Dikov & Zıkov 2004), Bečva River (Czech Republic, 23 species) (Namin & Spurny 2004), Úpoř Brook (Czech Republic, 13 species) (Vlach et al 2005); more than Sakarya Basin (Turkey, 4 species) (Ölmez 1992), Sugul Brook (Turkey, 4 species) (Korkmaz & Atay 1997), Hatilla Brook (Turkey, 2 species) (Korkmaz et al 1998) and Kadıncık Brook (Turkey, 2 species) (Korkmaz 2005). In freshwater, comparisons of the difference between the numbers of species are difficult. Because the habitat structure of sampling sites and abiotic-biotic factors may vary. Small streams may be characterized by great changes in environmental conditions along the gradient of stream size and discharge (Vlach et al 2005).

A. orontis was the most dominant species, constituting 1199 fish and 28.77% whilst *C. taenia* was the least species 18 fish and 0.43% (Table 2). Number of fish identified (4167 fish) in Kirmir Stream is fewer than 5548 fish Bečva River by Namin & Spurny (2004); more than 1303 fish Veleka

River by Dikov & Zikov (2004), 1166 fish Sakarya Basin by Ölmez (1992), 2943 fish Sugul Brook by Korkmaz & Atay (1997), 748 fish Hatila Brook by Korkmaz et al (1998) and 79 fish Kadıncık Brook by Korkmaz (2005). These differences can be explained by both species diversity and the higher amount of fish in large rivers where it could be find alternative habitats according to small stream.

Table 2- Population size, density and biomass % of each species in Kirmir Stream

Çizelge 2- Kirmir Çayı'nda türlerin sayısı, yoğunluğu, biyoması ve % değerleri

Species	N (fish)	N%	$\hat{N}$ (fish ha^{-1})	$\hat{N}$%	$\hat{B}$ (kg ha^{-1})	$\hat{B}$%
L. cephalus	454	10.90	6100	12.94	268.88	9.79
B. p. escherichi	584	14.01	6880	14.59	215.92	7.86
Capoeta tinca	1173	28.15	13036	27.65	656.76	23.91
A. bipunctatus	322	7.73	3856	8.18	59.56	2.17
C. c. sieboldi	65	1.56	856	1.82	82.64	3.01
C. regium	245	5.88	2892	6.14	53.12	1.94
A. orontis	1199	28.77	12304	26.10	1404.28	51.13
C. taenia	18	0.43	161	0.34	1.34	0.05
N. angorae	107	2.57	1056	2.24	3.84	0.14
Total	4167	100.00	47141	100.00	2746.34	100.00

Total fish density in Kirmir Stream varied between 161 fish ha^{-1} and 3036 fish ha^{-1}. *C. tinca* dominated with 27.65% (13036 fish ha^{-1}) of the total density. *A. orontis* was also very abundant (26.10%, 12304 fish ha^{-1}). *B.p.plebejus*, *L.cephalus*, *A.bipunctatus* and *C.regium* accounted for 14.59% (6880 fish ha^{-1}), 12.94 % (6100 fish ha^{-1}), 8.18% (3856 fish ha^{-1}) and 6.14% (2892 fish ha^{-1}), respectively. The density of other species reached the total value of 2073 fish ha^{-1} (<10%). The biomass of the fish assemblage estimated the value of 2746.34 kg ha^{-1}. The dominant species were *A. orontis* (1404.28 kg ha^{-1}) and *C. tinca* (656.76 kg ha^{-1}) which accounted for 51.13% and 23.91% of the total biomass. Other species are as follows: *L. cephalus* created 9.79 % (268.88 kg ha^{-1}), *B. p. plebejus* 7.86% (215.92 kg ha^{-1}), and the remaining species < 5% (2.976.98 kg ha^{-1}) (Table 2). If these results are referred to the components of the ichthyofauna, it can be stated that the highest density of fish and biomass states were estimated from locations in which the *A. orontis* and *C. tinca* were present.

The comparative analyses of fish density and biomass in streams studied by Ölmez (1992), Korkmaz & Atay (1997), Dikov & Zikov (2004), Namin & Spurny (2004), Vlach et al (2005), Korkmaz (2005) have shown that the fish density and biomass in the Kirmir Stream is >5338 fish ha^{-1} and 126.1 kg ha^{-1} for 16 species in Veleka River, 35452.2 fish ha^{-1} and 1728.9 fish ha^{-1} in Bečva River, 1166 fish ha^{-1} and 319 kg ha^{-1} for 4 species obtained using mark-recapture in Sakarya Basin, 1009 fish ha^{-1} and 48.47 4.1 kg ha^{-1} for 4 species in Sugul Brook and 32 fish ha^{-1} and 4.1 kg ha^{-1} in Kadıncık Brook. However, values of the fish density and biomass 74074 fish ha^{-1} and 395 kg ha^{-1} for 13 species in Úpoř Brook were higher than our results. These differences can be said to be caused by the fact that selective fishing or catch efficiency. The variable catch efficiency is not only dependent on the characteristics and habits of fish populations but also on factors related to the design and implementation of the sampling and on the physical, chemical and environmental characteristics of the habitat (Bravo et al 1999).

The results of successive electrofishing together with estimates of density and biomass at the four stations and sampling periods are presented in Tables 3-6.

Table 3- Stock density and biomass obtained from sampling sites in the Kirmir River, February 2007. C_1–C_3 are the catch from successive electrofishing; N and B are total numbers and weights, respectively; *, absolute estimate; **, fish number; *, fish weight**

*Çizelge 3- Kirmir Çayı'ndaki örnekleme yerlerinden elde edilen balıkların yoğunluk ve biyomas tahminleri (Şubat 2007). C_1–C_3 ardışık elektrikle avcılıktan elde edilen av; N ve B sırasıyla toplam balık sayısı ve ağırlığı; *, mutlak tahmin; **, balık sayısı; ***, balık ağırlığı*

Sites	Fish species	C_1	C_2	C_3	N	B (g)	$\hat{N}\pm t\times S_{\hat{N}}$	$\hat{B}$ (g)	$\hat{p}$	$(1-\hat{q}^3)$	R	T_1	$\hat{N}$ (fish ha⁻¹)	$\hat{B}$ (kg ha⁻¹)
K1	L.cephalus	27** (1365.08)***	11 (615.37)	1 (389.17)	39	2369.62	40±4	2430.38	0.69	0.97	0.33	1.74	388	23.55
	B.p.escherichi	33 (910.25)	11 (327.04)	9 (263.81)	53	1501.10	58±8	1642.71	0.55	0.91	0.55	1.82	562	15.92
	C. tinca	3 (137.73)	2 (92.61)	0 (0)	5	230.34	5±2	230.34	0.61	0.94	0.40	1.02	48	2.23
	A.bipunctatus	7 (57.34)	4 (31.58)	1 (8.14)	12	97.06	13±4	105.15	0.55	0.91	0.50	0.33	126	1.02
	C.c.sieboldi	3 (176.93)	0 (0)	1 (31.17)	4	208.10	4*	208.10	0.67	0.96	0.50	2.64	39	2.02
	C.regium	6 (96.28)	2 (29.17)	1 (17.12)	9	142.57	10±2	158.41	0.63	0.95	0.44	0.08	97	1.53
	A.orontis	42 (515.80)	22 (267.03)	9 (101.65)	73	884.48	82±12	993.53	0.52	0.89	0.55	0.19	795	9.63
	N. angorae	1 (4.7)	0 (0)	0 (0)	1	4.7	1*	4.70	1.00	1.00	0.00	0.00	10	0.05
K2	L.cephalus	33 (1295.26)	14 (642.03)	9 (378.13)	56	2315.42	63±10	2604.85	0.51	0.88	0.57	0.43	543	22.46
	B.p.escherichi	15 (469.42)	7 (241.84)	3 (67.56)	25	778.82	28±6	872.28	0.55	0.91	0.52	0.02	241	7.52
	C.tinca	123 (5856.27)	42 (1786.29)	13 (503.46)	178	8146.02	185±8	8466.37	0.66	0.96	0.38	0.10	1595	72.99
	A.bipunctatus	5 (40.96)	3 (25.17)	1 (8.11)	9	74.24	10±4	82.49	0.51	0.88	0.56	0.14	86	0.71
	C.c.sieboldi	3 (246.03)	1 (71.23)	1 (22.30)	5	339.56	6±4	407.47	0.51	0.88	0.60	0.26	52	3.51
	C.regium	8 (134.95)	5 (88.32)	1 (23.17)	14	246.44	16±4	281.65	0.54	0.90	0.50	0.69	138	2.43
	A.orontis	30 (341.59)	11 (134.64)	9 (84.12)	50	560.35	57±10	638.80	0.51	0.88	0.58	1.35	491	5.51
	N. angorae	18 (74.14)	6 (20.17)	3 (12.22)	27	106.53	29±2	114.42	0.63	0.95	0.44	0.19	250	0.99
K3	L.cephalus	10 (697.54)	2 (79.19)	1 (26.14)	13	802.87	13±4	802.87	0.73	0.98	0.31	0.29	195	12.06
	B.p.escherichi	17 (482.35)	9 (275.92)	5 (142.03)	31	900.30	37±12	1074.55	0.46	0.84	0.61	0.00	556	16.13
	C.tinca	39 (1654.70)	14 (608.61)	1 (39.88)	54	2303.19	55±2	2345.84	0.73	0.98	0.30	2.22	826	35.22
	A.bipunctatus	14 (104.25)	7 (60.97)	4 (27.92)	25	193.14	29±10	224.04	0.48	0.86	0.60	0.02	435	3.36
	C.c.sieboldi	1 (478.16)	0 (0)	0 (0)	1	478.16	1*	478.16	1.00	1.00	0.00	0.00	15	7.18
	C.regium	12 (203.15)	5 (92.11)	3 (51.89)	20	347.15	22±6	381.87	0.54	0.90	0.55	0.13	330	5.73
	A.orontis	1 (14.56)	1 (10.38)	0 (0)	2	24.94	2*	24.94	0.51	0.88	0.50	0.75	30	0.37
	N. angorae	1 (3.74)	1 (2.11)	0 (0)	2	5.85	2*	5.85	0.51	0.88	0.50	0.75	30	0.09
K4	L.cephalus	10 (741.12)	5 (263.27)	2 (114.95)	17	1119.34	19±6	1251.03	0.54	0.90	0.53	0.04	168	11.05
	B.p.escherichi	9 (281.44)	3 (83.49)	2 (52.13)	14	417.06	15±4	446.85	0.59	0.93	0.50	0.29	133	3.95
	C. tinca	81 (3507.71)	33 (1582.03)	12 (534.57)	126	5624.31	134±10	5981.41	0.61	0.94	0.45	0.06	1184	52.84
	A.bipunctatus	12 (90.4)	7 (59.47)	2 (15.1)	21	164.97	23±6	180.68	0.52	0.89	0.52	0.48	203	1.60
	C.c.sieboldi	3 (212.76)	1 (94.60)	0 (0)	4	307.36	4*	307.36	0.73	0.98	0.25	0.27	35	2.72
	C.regium	21 (341.28)	8 (125.44)	3 (44.10)	32	510.82	34±4	542.75	0.63	0.95	0.44	0.01	300	4.79
	A.orontis	106 (1245.87)	35 (364.87)	22 (236.91)	163	1847.65	175±12	1983.67	0.59	0.93	0.48	2.59	1546	17.52
	C. taenia	1 (11.07)	0 (0)	0 (0)	1	11.07	1*	11.07	1.00	1.00	0.00	0.00	9	0.10
Total		695 (21792.83)	272 (8074.95)	119 (3195.75)	1086	33063.53		35284.59					11456	346.78

Table 4- Stock density and biomass obtained from sampling sites in the Kirmir River, May 2007, symbol explanation presented in Table 3

Çizelge 4- Kirmir Çayı'ndaki örnekleme yerlerinden elde edilen balıkların yoğunluk ve biyomas tahminleri (Mayıs2007), simgelerin açıklaması Çizelge 3'de verilmiştir

Sites	Fish species	C_1	C_2	C_3	N	B (g)	$\hat{N}\pm t\times s_{\hat{N}}$	$\hat{B}$ (g)	$\hat{p}$	$(1-\hat{q}^3)$	R	T_1	$\hat{N}$ (fish ha^{-1})	$\hat{B}$ (kg ha^{-1})
K1	L.cephalus	12 (701.26)	5 (244.65)	3 (142.03)	20	1087.94	22±6	1196.73	0.54	0.90	0.55	0.13	217	11.78
	B.p.escherichi	18 (513.67)	7 (200.55)	3 (83.91)	28	798.13	30±4	855.14	0.61	0.94	0.46	0.02	295	8.42
	C. tinca	9 (451.23)	2 (85.61)	1 (37.21)	12	574.05	12±2	574.05	0.73	0.98	0.33	0.27	118	5.65
	A.bipunctatus	5 (47.31)	0 (0)	2 (20.46)	7	67.77	7±2	67.77	0.61	0.94	0.57	4.60	69	0.67
	C.regium	4 (104.12)	2 (47.98)	0 (0)	6	152.10	6±2	152.10	0.66	0.96	0.33	0.78	59	1.50
	A.orontis	41 (410.86)	14 (168.45)	9 (112.04)	64	691.35	69±8	745.36	0.59	0.93	0.50	1.12	679	7.34
	C. taenia	1 (10.84)	0 (0)	0 (0)	1	10.84	1*	10.84	1.00	1.00	0.00	0.00	10	0.11
	N.angorae	2 (6.8)	0 (0)	0 (0)	2	6.8	2*	6.80	1.00	1.00	0.00	0.00	20	0.07
K2	L.cephalus	22 (1243.02)	11 (627.84)	5 (236.91)	38	2107.77	43±8	2385.11	0.52	0.89	0.55	0.02	377	20.92
	B.p.escherichi	21 (602.62)	8 (324.91)	7 (191.33)	36	1118.86	42±10	1305.34	0.48	0.86	0.61	1.06	368	11.45
	C. tinca	40 (2012.58)	17 (1421.63)	8 (387.16)	65	3821.37	71±8	4174.11	0.57	0.92	0.51	0.05	623	36.62
	A.bipunctatus	2 (16.14)	1 (9.25)	0 (0)	3	25.39	3*	25.39	0.66	0.96	0.33	0.39	26	0.22
	C. c. sieboldi	6 (675.81)	3 (215.92)	1 (240.36)	10	1132.09	11±4	1245.30	0.55	0.91	0.50	0.07	96	10.92
	C.regium	8 (148.70)	2 (41.52)	1 (18.97)	11	209.19	11±2	209.19	0.69	0.97	0.36	0.18	96	1.84
	A.orontis	29 (345.06)	12 (142.89)	7 (91.53)	48	579.48	53±8	639.84	0.54	0.90	0.54	0.26	465	5.61
	C. taenia	10 (87.97)	4 (16.99)	2 (17.27)	16	122.23	17±2	129.87	0.57	0.92	0.50	0.04	140	1.14
	N.angorae	22 (91.27)	11 (35.12)	3 (4.68)	36	131.07	39±2	141.99	0.57	0.92	0.47	0.52	342	1.25
K3	B.p.escherichi	18 (486.28)	7 (199.37)	4 (99.56)	29	785.21	32±6	866.44	0.55	0.91	0.52	0.17	506	13.71
	C. tinca	67 (2467.08)	21 (1478.56)	12 (578.93)	100	4524.57	106±8	4796.04	0.63	0.95	0.45	1.45	1677	75.89
	A.bipunctatus	15 (150.22)	6 (50.01)	4 (37.47)	25	237.70	28±6	266.22	0.53	0.90	0.56	0.30	443	4.21
	C. c. sieboldi	2 (335.55)	0 (0)	0 (0)	2	335.55	2*	335.55	1.00	1.00	0.00	0.00	32	5.31
	C.regium	3 (61.39)	0 (0)	0 (0)	3	61.39	3*	61.39	1.00	1.00	0.00	0.00	47	0.97
	A.orontis	15 (175.61)	5 (67.12)	4 (50.12)	24	292.85	26±6	317.25	0.55	0.91	0.54	0.78	411	5.02
K4	L.cephalus	17 (1021.22)	9 (472.36)	4 (232.59)	30	1726.17	34±8	1956.33	0.51	0.88	0.57	0.04	304	17.47
	B.p.escherichi	13 (335.71)	6 (161.94)	2 (66.13)	21	563.78	23±4	617.47	0.59	0.93	0.48	0.09	205	5.51
	C. tinca	17 (872.50)	6 (312.54)	4 (224.79)	27	1409.83	29±6	1514.26	0.57	0.92	0.52	0.48	259	13.52
	A.bipunctatus	5 (41.59)	3 (25.28)	1 (10.24)	9	77.11	10±4	85.68	0.51	0.88	0.56	0.14	89	0.76
	C.regium	4 (73.14)	1 (18.72)	1 (13.41)	6	105.27	6±2	105.27	0.61	0.94	0.50	0.51	54	0.94
	A.orontis	68 (785.62)	23 (264.22)	10 (121.56)	101	1171.40	106±6	1229.39	0.63	0.95	0.43	0.22	946	10.98
	N.angorae	1 (2.55)	0 (0)	0 (0)	1	2.55	1*	2.55	1.00	1.00	0.00	0.00	9	0.02
Total		497 (14277.72)	186 (6633.43)	98 (3018.66)	781	23929.81		26018.77					8982	279.82

Table 5- Stock density and biomass obtained from sampling sites in the Kirmir River, August 2007, symbol explanation presented in Table 3

Çizelge 5- Kirmir Çayı'ndaki örnekleme yerlerinden elde edilen balıkların yoğunluk ve biyomas tahminleri (Ağustos2007), simgelerin açıklaması Çizelge 3'de verilmiştir

Sites	Fish species	C_1	C_2	C_3	N	B (g)	$\hat{N}\pm t\times S_{\hat{N}}$	$\hat{B}$ (g)	$\hat{p}$	$(1-\hat{q}^3)$	R	T_1	$\hat{N}$ (fish ha^{-1})	$\hat{B}$ (kg ha^{-1})
K1	L.cephalus	14 (754.91)	6 (287.12)	3 (149.63)	23	1191.66	25±6	1295.28	0.55	0.91	0.52	0.03	382	19.81
	B.p.escherichi	18 (766.34)	7 (289.28)	3 (131.89)	28	1187.51	30±4	1272.33	0.61	0.94	0.46	0.02	459	19.45
	Capoeta tinca	9 (471.67)	3 (279.34)	2 (152.09)	14	903.10	15±4	967.61	0.59	0.93	0.50	0.29	229	14.80
	A.bipunctatus	2 (27.43)	1 (9.57)	0 (0)	3	37.00	3*	37.00	0.66	0.96	0.33	0.39	46	0.57
	C.c.sieboldi	4 (273.33)	0 (0)	0 (0)	4	273.33	4*	273.33	1.00	1.00	0.00	0.00	61	4.18
	C.regium	6 (171.34)	1 (38.14)	1 (22.09)	8	231.57	8±2	231.57	0.73	0.98	0.38	0.99	122	3.54
	A.orontis	6 (85.11)	3 (40.63)	1 (13.27)	10	139.01	11±4	152.91	0.55	0.91	0.50	0.07	168	2.34
K2	L.cephalus	23 (1242.65)	9 (415.90)	6 (315.27)	38	1973.82	42±8	2181.59	0.54	0.90	0.55	0.50	494	25.67
	B.p.escherichi	10 (416.3)	4 (171.62)	2 (96.45)	16	684.37	17±4	727.14	0.57	0.92	0.50	0.04	200	8.55
	Capoeta tinca	27 (904.91)	7 (534.62)	7 (351.18)	41	1790.71	44±6	1921.74	0.59	0.93	0.51	2.88	518	22.61
	C.c.sieboldi	1 (596.57)	1 (280.31)	0 (0)	2	876.88	2*	876.88	0.51	0.88	0.50	0.75	24	10.32
	C.regium	1 (41.93)	1 (27.16)	0 (0)	2	69.09	2*	69.09	0.51	0.88	0.50	0.75	24	0.81
	A.orontis	22 (297.26)	10 (135.61)	4 (57.12)	36	489.99	39±6	530.82	0.57	0.92	0.50	0.03	459	6.24
	N.angorae	6 (18.7)	2 (5.79)	2 (4.15)	10	28.64	11±2	31.50	0.51	0.88	0.60	0.55	129	0.37
K3	L.cephalus	2 (109.14)	0 (0)	0 (0)	2	109.14	2*	109.14	1.00	1.00	0.00	0.00	30	1.66
	B.p.escherichi	10 (408.21)	6 (253.91)	2 (85.13)	18	747.25	21±6	871.79	0.51	0.88	0.56	0.28	320	13.29
	Capoeta tinca	28 (1179.34)	13 (742.37)	5 (312.08)	46	2233.79	50±8	2428.03	0.57	0.92	0.50	0.07	762	37.01
	A.bipunctatus	9 (114.92)	4 (58.31)	2 (26.15)	15	199.38	17±4	225.96	0.54	0.90	0.53	0.02	259	3.44
	C.c.sieboldi	3 (195.48)	1 (28.28)	0 (0)	4	223.76	4*	223.76	0.73	0.98	0.25	0.27	61	3.41
	C.regium	3 (89.19)	2 (62.56)	0 (0)	5	151.75	5±2	151.75	0.61	0.94	0.40	1.02	76	2.31
	A.orontis	15 (233.18)	5 (68.75)	4 (52.76)	24	354.69	26±6	384.25	0.55	0.91	0.54	0.78	396	5.86
K4	L.cephalus	7 (327.81)	2 (124.96)	1 (79.36)	10	532.13	10±2	532.13	0.66	0.96	0.40	0.12	92	4.88
	B.p.escherichi	9 (351.17)	3 (113.35)	1 (38.70)	13	503.22	14±2	541.93	0.66	0.96	0.38	0.02	128	4.97
	Capoeta tinca	34 (1563.51)	15 (905.62)	5 (539.47)	54	3008.60	58±6	3231.46	0.59	0.93	0.46	0.17	532	29.65
	A.bipunctatus	3 (49.44)	1 (13.20)	1 (9.79)	5	72.43	6±4	86.92	0.51	0.88	0.60	0.26	55	0.80
	C.regium	5 (111.71)	2 (49.23)	1 (25.73)	8	186.67	9±2	210.00	0.57	0.92	0.50	0.03	83	1.93
	A.orontis	12 (151.91)	8 (135.64)	1 (16.37)	21	303.92	23±6	332.86	0.55	0.91	0.48	1.92	211	3.05
Total		289 (10953.46)	117 (5071.27)	54 (2478.68)	460	18503.41		19898.77					6320	251.52

Table 6- Stock density and biomass obtained from sampling sites in the Kirmir River, November 2007, symbol explanation presented in Table 3

Çizelge 6- Kirmir Çayı'ndaki örnekleme yerlerinden elde edilen balıkların yoğunluk ve biyomas tahminleri (Kasım2007), simgelerin açıklaması Çizelge 3'de verilmiştir

Sites	Fish species	C_1	C_2	C_3	N	B (g)	$\hat{N}\pm t\times S_{\hat{N}}$	$\hat{B}$ (g)	$\hat{p}$	$(1-\hat{q}^3)$	R	T_1	$\hat{N}$ (fish ha^{-1})	$\hat{B}$ (kg ha^{-1})
K1	L.cephalus	9 (271.36)	3 (112.37)	2 (90.54)	14	474.27	15±4	508.15	0.59	0.93	0.50	0.29	123	4.15
	B.p.escherichi	11 (567.14)	4 (203.61)	2 (101.37)	17	872.12	18±4	923.42	0.61	0.94	0.47	0.08	147	7.54
	Capoeta tinca	3 (101.54)	1 (37.65)	0 (0)	4	139.19	4*	139.19	0.73	0.98	0.25	0.27	33	1.14
	A.bipunctatus	4 (468.84)	2 (251.77)	0 (0)	6	720.61	6±2	720.61	0.66	0.96	0.33	0.78	49	5.89
	C.c.sieboldi	2 (359.44)	1 (60.42)	0 (0)	3	419.86	3*	419.86	0.66	0.96	0.33	0.39	25	4.07
	C.regium	2 (64.53)	1 (33.96)	0 (0)	3	98.49	3*	98.49	0.66	0.96	0.33	0.39	25	0.95
	A.orontis	13 (201.56)	5 (70.69)	2 (34.12)	20	306.37	21±4	321.69	0.61	0.94	0.45	0.00	172	3.12
	N.angorae	2 (6.13)	1 (2.25)	0 (0)	3	8.38	3*	8.38	0.66	0.96	0.33	0.39	29	0.07
K2	L.cephalus	6 (287.31)	2 (79.16)	0 (0)	8	366.47	9±2	412.28	0.73	0.98	0.25	0.56	89	4.07
	B.p.escherichi	5 (239.20)	3 (141.83)	1 (42.12)	9	423.15	10±4	470.17	0.51	0.88	0.56	0.14	99	4.65
	Capoeta tinca	8 (802.96)	4 (324.96)	0 (0)	12	1127.92	12±2	1127.92	0.66	0.96	0.33	1.55	119	11.15
	A.bipunctatus	3 (568.14)	3 (229.47)	0 (0)	6	797.61	7±4	930.55	0.51	0.88	0.50	1.84	69	9.20
	C.c.sieboldi	3 (505.22)	0 (0)	0 (0)	3	505.22	3*	505.22	1.00	1.00	0.00	0.00	30	4.36
	C.regium	2 (75.62)	2 (47.81)	0 (0)	4	123.43	5±4	154.29	0.51	0.88	0.50	1.18	49	1.33
	A.orontis	26 (413.58)	9 (141.06)	5 (62.09)	40	616.73	43±6	662.98	0.61	0.94	0.48	0.41	425	5.72
	N.angorae	2 (7.76)	1 (2.58)	0 (0)	3	10.34	3*	10.34	0.66	0.96	0.33	0.39	25	0.04
K3	L.cephalus	4 (214.06)	1 (322.12)	0 (0)	5	536.18	5*	536.18	0.79	0.99	0.20	0.21	62	6.62
	B.p.escherichi	6 (288.36)	3 (153.45)	1 (44.96)	10	486.72	11±4	535.39	0.55	0.91	0.50	0.07	136	6.61
	Capoeta tinca	14 (1128.71)	6 (751.67)	4 (494.36)	24	2374.74	27±8	2671.58	0.51	0.88	0.58	0.23	333	32.98
	A.bipunctatus	5 (621.69)	2 (191.23)	1 (34.02)	8	846.94	9±2	952.81	0.57	0.92	0.50	0.03	111	11.76
	C.c.sieboldi	2 (437.83)	1 (105.77)	0 (0)	3	543.60	3*	543.60	0.66	0.96	0.33	0.39	37	8.16
	C.regium	3 (84.57)	2 (50.39)	0 (0)	5	134.96	5±2	134.96	0.61	0.94	0.40	1.02	62	2.03
	A.orontis	4 (66.25)	1 (17.63)	1 (13.57)	6	97.45	6±2	97.45	0.61	0.94	0.50	0.51	74	1.46
K4	L.cephalus	1 (429.21)	0 (0)	0 (0)	1	429.21	1*	429.21	1.00	1.00	0.00	0.00	9	4.04
	B.p.escherichi	3 (134.11)	1 (40.60)	1 (36.24)	5	210.95	6±4	253.14	0.51	0.88	0.60	0.26	56	2.38
	Capoeta tinca	13 (925.88)	6 (517.39)	2 (367.51)	21	1810.78	23±4	1983.24	0.59	0.93	0.48	0.09	217	18.67
	A.bipunctatus	1 (124.88)	1 (73.41)	0 (0)	2	198.29	2*	198.29	0.51	0.88	0.50	0.75	19	1.87
	C.regium	4 (128.75)	2 (71.23)	1 (39.18)	7	239.16	8±4	273.33	0.51	0.88	0.57	0.00	75	2.41
	A.orontis	11 (167.12)	5 (52.67)	2 (27.28)	18	247.07	20±4	274.52	0.57	0.92	0.50	0.02	188	2.43
Total		172 (9691.75)	73 (4087.15)	25 (1387.36)	270	15166.21		6297.24					2887	168.87

Since $T_1 < \chi^2 = 3.84$, there were no significant difference (95% certainty) between capture probabilities and equations (1-2) are appropriate. According to sampling period, the lowest density and biomass values were observed during November 2007 with 2887 fish ha^{-1} and 168.87 kg ha^{-1} whilst the highest density and biomass values were observed during February 2007 with 11456 fish ha^{-1} and 346.78 kg ha^{-1}. Water temperature is the most important factor that influences on population parameters ($\hat{N}$ and $\hat{B}$). The reason for the decrease in total fish density and biomass during the sampling period can be explained by seasonal changes occurred in the water temperature.

4. Conclusions

A total of 9 fish species representing 2 families Cyprinidae and Cobitidae were recorded. *A. orontis* was the most dominant species by its density and biomass. The results of this study contribute to knowledge of fish density and biomass in Kirmir Stream. Moreover, this study, being the first quantitative survey on fish communities in the Kirmir Stream, provides a baseline for future evaluation of the changes. Therefore it has been not put forward any recommendation terms of managerial politics in this study. Additionally, long-term sampling is necessary to predict changes in fish communities and to implement successful planning of stream fish monitoring.

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