Journal of Animal and Veterinary Advances 8 (11): 2305-2310, 2009
ISSN: 1680-5593

Fish Community Structure in Suveri Stream, Central Anatolia, Turkey

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Abstract: In this study, the fish community structure in Suveri Stream with respect to diversity, density and biomass values of fish species were assessed. During the investigation into fish community of Suveri Stream carried out between August 25 and 27 in 2005, 9 species belonging to two families were identified. These fish species were chub (*Leuciscus cephalus*), barbel (*Barbus plebelejus escherichi*), *Capoeta tinca*, *Capoeta capoeta sieboldi*, spirlin (*Alburnoides bipunctatus*), tirgis-nase (*Chondrostoma regium*), bleak (*Alburnus orontis*), spiny loach (*Cobitis taenia*), angora-loach (*Noemacheilus angorae*). *C. tinca* was the most dominant species, constituting 77.96% of the total communities, followed by *A. orontis* (14.08%), *L. cephalus* (2.62%) and *C. regium* (2.91%). According to the occurrence frequency, *C. tinca* was considered as constant species. Other fish groups were ranked as common for *A. orontis*, rare or accidental for *L. cephalus*, *C. regium*, *Barbus plebelejus escherichi*, *Capoeta capoeta sieboldi*, *A. bipunctatus*, *C. taenia* and *N. angorae*. Density and biomass of fish in Suveri Stream were found to vary between 4843-6865 inds ha^{-1} and 40.70-60.26 kg ha^{-1}, respectively. The shannon diversity index (H'), evenness index (J') and species dominance varied between 0.55-1.04, 0.27-0.50 and 0.882-0.952, respectively. Diversity index was low due to occurrence of a few abundant species and many rare species. Based on Shannon index, the studied sections of Suveri Stream are categorized as severely impacted.

Key words: Shannon diversity index, evenness index, richness, dominance index, density, biomass, Suveri Stream, Turkey

INTRODUCTION

There is an abiding interest in the number of species in local communities, because species are the fundamental particles of biodiversity. There are approximately, 8,500 freshwater fish species, most of which occur in rivers and connected alluvial floodplains. These communities show a dynamic structure that reflects characteristics and alterations that interact with biotic processes, specially predation and competition (Siqueira-Souza and Freitas, 2004). Analysis of fish community structure is widely considered as an integrative indicator of the ecological state of water bodies (Ziliukas and Ziliukiene, 2009). The aspects of the fish community that contribute to the community structure are species composition, species diversity, abundance, size structure and trophic composition. Fish populations are typically monitored with abundance estimates (Thompson, 2003).

A fish community consists of a great number of species differing from each other in dynamics of their abundance. Each community possesses some particular structure. Species diversity is considered to be the main index of the species structure in a community that can be evaluated by information indices It has been established that the more equal the distribution of species according to their relative abundance in a fish community, the higher is the species diversity in it (Ziliukas, 2005).

In general, species composition in freshwater declines with increasing latitude, depth and altitude. In addition to these factors, diversity can be influenced by the number of predators. Species diversity in tropical areas depends on small periodic disturbances. The populations are normally small and human disturbance, such as deforestation and pollution, can cause many species extinctions (Gomiero and Braga, 2006).

Community structure is the numerical abundance of each species in the community and descriptors may include totals or various subtotals of those abundances as well as estimates of biomass. Diversity indices combine information on the number of species in an assemblage (richness) and their relative abundance (evenness). A diversity index is a parameter describing assemblage structure. The common diversity indice can be apply at the species level for fishes-Shannon's H'. Evenness is a measure of the equitability in relative abundance among species. To report only diversity as an community structural index confounds the effects of species richness and evenness thus, it is appropriate to report richness,

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diversity and evenness when describing fish community structure. Another simple community structural index related to evenness is species dominance, which may be expressed as the relative abundance of a subset of the most numerous (Kwak and Peterson, 2007).

The composition of fish in Europe freshwater has been investigated quite thoroughly (Pilhl and Wenhage, 2002; Barbosa *et al*., 2003; Ziliukas, 2003, 2005; Namin and Spurny, 2004; Matic-Skoko *et al*., 2007; Suarez *et al*., 2007; Ziliukas and Ziliukiene, 2009). In Central Anatolia, there is no study addressed the community patterns of fish living in different stream systems. With this respect, it is needed to establish the species composition and status of fish communties in a number of localities and stream profiles in Central Anatolia, Turkey. As there is no data about fish community structure in Suveri Stream, the information obtained from electrofishing in the stream sections were analyzed.

The aim of this study was to determine the fish species, their distribution and diversity, equitability (evenness), density and biomass of fish communities in Suveri Stream.

MATERIALS AND METHODS

Suveri Stream, which is one of the important two tributaries of the Kirmir River located on the Middle Anatolia Region in Turkey (Fig. 1). Suveri Stream is about long of km and coordinates on the 40-41°N and 32-33°E of the Sakarya Basin (Kucuk and Alpbaz, 2008).

Suveri Stream was sampled at three different sampling sites. The sampling sites in Suveri Stream were selected according to habitat structure, depth, water velocity, size and structure of the substratum (Hankin, 1984). Some physical characteristics and chemical of sampling sites were shown in Table 1.

Fish samples were collected quantitatively on between August 25 and 27 in 2005 by electro-fishing. A pulsed DC current of 2 amperes at 500-750 volts was used in electro-fishing, the current being supplied by a generator. 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 10 mm mesh size nets. Each fishing pass was carried out in an upstream direction. The time interval between the first and second pass was at 60 min. Sampling sites were sampled two times with effort standardized among samples. Each sampling site was fished by repeatedly crossing the stream from one side to the other, moving upstream after each crossing in order to cover the whole sample area. The width of the sample area were then

Table 1: Some physical and chemical parameters of sampling sites in Suveri Stream

Sampling sites	pH	Water temperature (°C)	Dissolved oxygen (mg L^{-1})	Water velocity (m sec^{-1})	Conductivity (μmhos)
1	8.03	20	8.4	0.43	1766
2	7.89	21	7.6	0.20	1698
3	8.16	22.5	8.5	0.46	1975

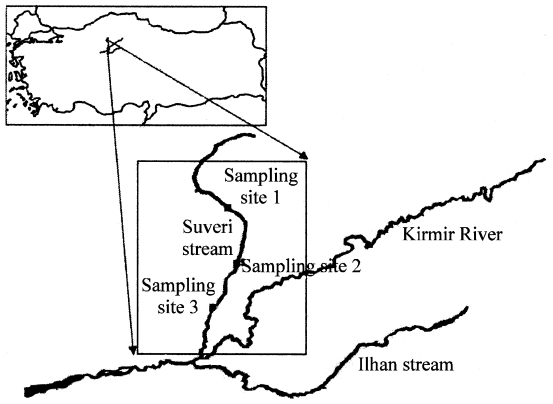

Fig. 1: Study area of Suveri Stream and sampling sites

measured per 10-20 m. Fish caught in each sample were examined for species identification and their wet mass (±0.1 g) and then returned all fishes to the water. In each catch, species composition, density and biomass of fish species were determined. Then, in order to compare the data, it was calculated the density and biomass values for the unit of the area where catches were conducted (Bohlin *et al*., 1989).

The identification of the fish species composition of the fish community was performed according to Geldiay and Balik (2007). The dominance was expressed as the percentage of corresponding species in total number of individuals captured during the whole study period.

The frequency of occurrence for each species (V%) was calculated according to the equation:

$$V = a_i / A \times 100\%$$

Where:

a_i = The number of collected samples when, some particular species was caught

A = The total number of all samples collected during the study period (Ziliukas and Ziliukiene, 2009)

Shannon's diversity index (H') was determined as:

$$H' = -\sum_{i=1}^{S} p_i \log_e p_i$$

Where:

s = The number of species

p_i = The proportion of the total sample represented by the ith species

Evenness (J') for Shannon's diversity index (H') was calculated from equation:

$$J' = H'_{max} / \log_e S$$

Where:

S = The number of species
H'_{max} = The maximum value of Shannon's index
J' = Evenness based on Shannon's diversity index

Dominance for the two most abundant species (D_2) was calculated as:

$$D_2 = \sum_{i=1}^{2} p_i$$

where, p_i is the proportion of the total sample represented by the ith species (Kwak and Peterson, 2007).

In this study, population density (or population size) at each sampling site was estimated using Seber and Le Cren (1967) two-pass equation. For two-pass depletion estimates, fish are captured and removed during two capture sessions. Equations provided here are described in greater detail in Seber and Le Cren (1967). Population size ($\hat{N}$) and variance of this estimator (S^2_N) were calculated as:

$$\hat{N} = \frac{C_1^2}{(C_1 - C_2)} \text{ and } S^2_{\hat{N}} = \frac{C_1^2\ C_2^2\ (C_1 + C_2)}{(C_1 - C_2)^4}$$

where, C_1 and C_2 are the number of fish catched in first sample and second sample, recpectively. Validity of the estimation was tested by $\hat{N}\,\hat{p}^3 \geq 16\,\hat{q}^2(1+\hat{q})$. The capture efficiency ($\hat{p}$) and variance for $\hat{p}$ were calculated as (Seber, 1973):

$$\hat{p} = \frac{(C_1 - C_2)}{C_1}\ (\hat{q} = 1 - \hat{p} = 1 - \frac{C_2}{C_1}) \text{ and } S^2_{\hat{p}} = \frac{C_2(C_1 + C_2)}{C_1^3}$$

The biomass or standing crop was estimated using the equation by Mahon *et al.* (1979)

$$\hat{B} = B.\ \hat{N} / N$$

Where:

$\hat{B}$ = The estimated biomass
B = The total weight of fish caught
N = The number of fish caught

According to sampling sites, the differences between parameter values were tested by ANOVA using the MINITAB15.2 software package. Population size values were tested with 95% confidence interval.

RESULTS AND DISCUSSION

In total, 1030 fish specimens were caught from the Suveri Stream between August 25 and 27 in 2005. A total of 9 fish species representing 2 families; Cyprinidae and Cobitidae were recorded. Fish species identified were followed as: Chub (*Leuciscus cephalus*), barbel (*Barbus plebelejus escherichi*), *Capoeta tinca*, *Capoeta capoeta sieboldi*, spirlin (*Alburnoides bipunctatus*), tirgis-nase (*Chondrostoma regium*), bleak (*Alburnus orontis*), spiny loach (*Cobitis taenia*), angora-loach (*Noemacheilus angorae*). *C. tinca* was the most dominant species, constituting 77.96% of the total communities, followed by *A. orontis* (14.08%), *C. regium* (2.91%) and *L. cephalus* (2.62%). The proportion of *Barbus plebelejus escherichi*, *Capoeta capoeta sieboldi*, *A. bipunctatus*, *C. taenia* and *N. angorae* were below of 1% in abundance (Fig. 2).

Although, the most dominant species (V>75%) was *C. tinca*, *A. orontis* was common (V = 8-22%). Other seven species fell into the group of 'rare' and 'accidental' species (Table 2). Okur and Ozdilek (2008) found that *Capoeta barroisi* (42.2%) was the most abundant species and *Alburnus orontis* (4.6%) was abundant species in Amanos Mountain streams in Southern Part of Turkey, Antakya.

Table 2: Frequency of occurrence (V), % of each species in Suveri Stream

	Sampling sites		
Species	1	2	3
Capoeta tinca	87.10	66.05	82.94
Capoeta capoeta sieboldi	0.32	0.53	0.00
Alburnoides bipunctatus	0.65	1.05	0.00
Leuciscus cephalus	1.29	3.95	2.35
Barbus plebejus escherichi	0.65	0.00	0.00
Chondrostoma regium	1.29	4.21	2.94
Alburnus orontis	8.06	22.10	10.59
Cobitis taenia	0.00	0.53	0.00
Nemachelius angorae	0.64	1.58	1.18

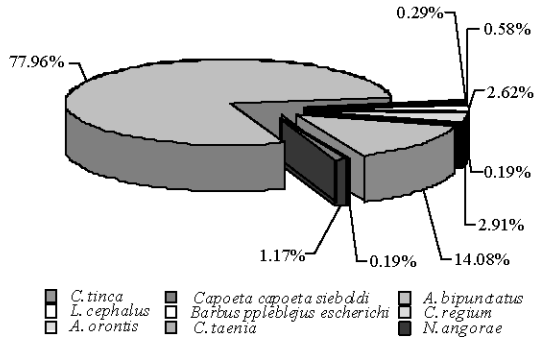

Fig. 2: Composition of fish community in Suveri Stream

Although, *C. tinca* was the most abundant species in this study, the locations of stream were highly different to compare. Thus, frequency of occurence partially shows the ability of the species to adapt to the living conditions and depends on the total abundance of fish (Ziliukas and Ziliukiene, 2009).

Index of diversity (H′) at monitored sampling sites varied from 0.55-1.04 (Table 3). The Shannon diversity index was the highest in the sampling site 2 and the lowest sampling site 1. The indexes of diversity of all three sampling sites were relatively low due to the occurrence of a few abundant species and many rare species. Shannon index (H') is the value that combines species diversity and evenness where >3.99 is considered as non-impacted; 3.00-3.99, slightly impacted; 2.00-2.99, moderately impacted and <2.00, severely impacted (Namin and Spurny, 2004). Based on this category, the studied sections of the Suveri Stream are categorized as severely impacted. Okur and Ozdilek (2008) reported that Shannon's diversity index varied between 0.28 and 0.61. Shannon diversity index values in Suveri Stream were higher than that of Amanos Mountain streams, Antakya.

The evenness index (J') values mainly ranged between 0.27 and 0.50, revealing that the distribution of species at the sampling sites is not regular. The evenness index was the highest in the sampling site 2 and the lowest sampling site 1 (Table 3).

Species dominance showed low values between 0.882 and 0.952 (Table 3). One possible explanation could be that in summer species and individual have a stabilized distribution, but in winter some species disappeared in the area. Therefore, dominance index value may be very high in winter and very low in summer as stated by Matic-Skoto *et al.* (2007).

In Suveri Stream, density and biomass of fish were found to vary between 4843 and 6865 inds ha^{-1} and 40.70-60.26 kg ha^{-1}, respectively. The highest and the lowest density and biomass of fish were recorded at sampling site 2 and 1, respectively (Table 4).

Table 3: Indexes of fish community structure in Suveri Stream

Community structural index	Sampling sites 1	2	3
Richness			
Species	8	8	5
Family	2	2	2
Shannon diversity index	0.55	1.04	0.64
Evenness	0.27	0.50	0.40
Species dominance (2 species)	0.952	0.882	0.935

Table 4: Stock density and biomass per 1 ha of Suveri Stream

Species	Sampling sites	C_1	C_2	$\Sigma C = N$	B (g)	$\hat{N} \pm S_{\hat{N}}$	$\hat{B}$(g)	$\hat{p}$	$\hat{N}$ (inds ha^{-1})	$\hat{B}$ (kg ha^{-1})
Capoeta tinca	1	194	76	270	2249.87	319±34	2657.76	0.61	4175	34.79
	2	182	69	251	2190.94	293±31	2558.71	0.62	4482	39.12
	3	201	81	282	2420.52	337±37	2889.82	0.60	4612	39.59
Capoeta capoeta sieboldi	1	1	0	1	3.26	1*	3.26	1.00	13	0.04
	2	1	1	2	4.90	2*	4.90	0.00	31	0.07
	3	-	-	-	-	-	-	-	-	-
Alburnoides bipunctatus	1	1	1	2	20.72	2*	20.72	0.00	26	0.27
	2	2	2	4	24.06	4*	24.06	0.00	61	0.37
	3	-	-	-	-	-	-		-	-
Leuciscus cephalus	1	3	1	4	58.66	5±3	65.99	0.67	59	0.86
	2	11	4	15	224.68	17±7	258.92	0.64	264	3.96
	3	6	2	8	292.32	9±4	328.86	0.67	123	4.50
Barbus plebejus escherichi	1	1	1	2	38.75	2*	38.75	0.00	26	0.51
	2	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-
Chondrostoma regium	1	2	2	4	41.43	4*	41.43	0.00	52	0.54
	2	11	5	16	259.56	20±12	327.15	0.67	308	5.00
	3	7	3	10	207.74	12±08	254.48	0.57	168	3.49
Alburnus orontis	1	18	7	25	188.54	29±10	222.13	0.61	386	2.91
	2	61	23	84	593.96	98±17	692.39	0.56	1497	10.59
	3	26	10	36	251	42±12	294.58	0.62	579	4.03
Cobitis taenia	1	-	-	-	-	-	-	-	-	-
	2	1	1	2	26.40	2*	26.40	0.00	31	0.40
	3	-	-	-	-	-	-	-	-	-
Nemachelius angorae	1	1	1	2	4.28	2*	4.28	0.00	26	0.06
	2	4	2	6	11.32	8±5	15.09	0.50	122	0.23
	3	3	1	4	8.29	5±3	9.33	0.67	62	0.13
Total	1	221	89	310	2605.51	370±39	3109.80	0.60	4843	40.70
	2	273	107	380	3335.82	449±41	3941.53	0.61	6865	60.26

C_1 and C_2 are the catch from successive two electrofishing; N and B are total numbers and weights, respectively; $\hat{p}$ is the capture efficiency. *Absolute estimate

The density (4843-6865 inds ha^{-1}) and biomass (40.70-60.26 kg ha^{-1}) in the Suveri Stream is >1009 inds ha^{-1} and 48.47 kg ha^{-1} Sugul Brook (Firat River, Turkey) by Korkmaz and Atay (1997), 316-342 inds ha^{-1} and 6.75-39.54 kg ha^{-1} for Hatilla Brook (Coruh River, Turkey) by Korkmaz *et al.* (1998) and 32 inds ha^{-1} and 4.1 kg ha^{-1} for Kadincik Brook (Camliyayla-Mersin, Turkey) by Korkmaz (2005).

CONCLUSION

The results of this study contribute to the knowledge of fish communities in Suveri Stream. The actual fish community of the studied course of the Suveri Stream consists of 9 species from 2 families. *C. tinca* is dominant species by its density and biomass. Our results suggest that fish communities at each sampling sites of Suveri Stream exhibit same qualitative and quantitative composition when considered the environment. The values of species diversity indices (H' and J') were low in present study and these low values occur because of the presence of a few abundant and many rare species. Such information is fundamental to long-term monitoring programs of fish populations. Based on Shannon index, it is clear that the studied sections of Suveri Stream are severely impacted due to probably urban runoff.

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