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Short research contribution

Ayhan YILDIRIM¹, Murat ARSLAN¹, Mark A. PEGG²

¹University of Ataturk, Ispir Hamza Polat Vocational School, Ispir, Erzurum 25900 Turkey
e-mail: ayhanyildirim@yahoo.com

²University of Nebraska, School of Natural Resources, 402 Hardin Hall, Lincoln, NE, 68583 USA
e-mail: mpegg2@unl.edu

PATTERNS OF FISH COMMUNITIES ALONG A MOUNTAIN RIVER: THE UPPER CORUH RIVER (TURKEY)

ABSTRACT: Distribution of fish communities along the submountain river (upper Coruh River, Northeastern of Turkey) was assessed to evaluate course of the longitudinal pattern in fish species diversity. The watershed area of Coruh Basin is 21.000 km², river length 376 km and it flows into Black Sea in northeastern Turkey at average discharge of 149 m³ s⁻¹ (range: 45.2–1215 m³ s⁻¹). Fixed-site electrofishing sampling at five sites located 15–210 km from river source at 2100–950 m a.s.l (Q values ranged 5–200 m³ s⁻¹) was conducted from March 2001 to March 2002. A total of 12 species were collected. Number of species (8–10) did not differ among sites suggesting no longitudinal changes, but Shannon-Wiener biodiversity index (H') increased downstream from 1.23 to 1.82. Two distinct fish assemblages were identified. Most abundant species were *Leuciscus cephalus* and *Alburnoides bipunctatus*. Both *Onchorynchus mykiss* and *Cyprinus carpio* collected rarely are exotic fishes for Coruh River.

KEY WORDS: Large rivers, fish community, diversity, Coruh River

Several studies have addressed the influence of environmental features on fish assemblages along a river continuum as well as the implications of these changes for environmental and resource assessment. The

species life history and temporal variation in fish assemblages are affected by flow regime, channel morphology, physical-chemical factors, and resources availability. The relative influence of each variable varies with stream size, discharge, geomorphology and pollution (Horwitz 1978, Schlosser 1990, Edds 1993, Pegg and McClelland 2004). Longitudinal changes of fish assemblage along upstream to downstream gradients have been reported in some rivers in Poland and Great Britain (Penczak *et al.* 1991, Penczak and Koszalińska 1993). The positive relation between species richness and distance from headwater has been determined to be an effect of temporal variation of discharge (Horwitz 1978, Oberdorff *et al.* 1993). Significantly greater species richness at the downstream reach and greater biomass at the upstream reach was found in Mississippi River (Koel 2004). Similarly, Pegg and McClelland (2004) reported the considerable variability among the reaches and years along the Illinois River, and these differences were attributed to a combination of water quality and habitat availability.

We describe composition and distribution of fish assemblages along the upper Coruh River, a large river in northeastern

Turkey. Our objective was to test the changes of fish diversity over a spatial gradient and in successive seasons.

The Coruh River has been described (Yildirim and Aras 1999, Yildirim *et al.* 2001) as one of the largest rivers of Turkey, with a total length of 376 km (Fig. 1). The watershed area equals to 21.000 km² and the average discharge at the river outflow amounted 149 m³ s⁻¹ (range: 45.2–1215 m³ s⁻¹) (Anonymous 1996). Upper reaches of Coruh River are characterized by strong seasonal fluctuations in discharge and rainfall. Hydroelectric dams are constructed in two localities (Fig. 1). They could change the hydrology, habitat availability, and ultimately the composition of fish assemblages. Construction of two further dams is planned in middle section of river within the next two years. Further small impoundments are planned for the upstream section of the river.

Our study focused on the upper Coruh River where we collected fish data at five sites: Site 1 (Kirik), Site 2 (Maden), Site 3 (Bayburt), Site 4 (Kirazlı), and Site 5 (Nihak)

(Fig. 1). The sites differed in respect to altitude (2100 to 950 m asl), channel width (4–5 to 40–50 m), depth (10–25 to 40–180 cm), discharge (5 to 200 m³ s⁻¹), and human effect (fish farms, strong domestic pollution, mining, and number of residents) (Table 1). Fish samples were collected monthly at each site using electroshock equipment (ENDRESS ES 650, 220 V AC, 12 V DC) from March 2001 to March 2002. Sampling was not conducted in December and January for sites 1–4, and in December for site 5, because of ice cover. The electrofisher was used at all sites for 1-hr. All fish specimens were placed on ice and identified in the laboratory.

We used the Shannon-Wiener biodiversity index (H') to characterize fish species diversity at each site.

$$H' = \sum_{i=1}^{i=S} (P_i * \ln(P_i))$$

where S is the number of species and P is the ratio of species i , (Ludwig and Reynolds 1988). Spatial differences were tested for fish assemblages among five sites as well

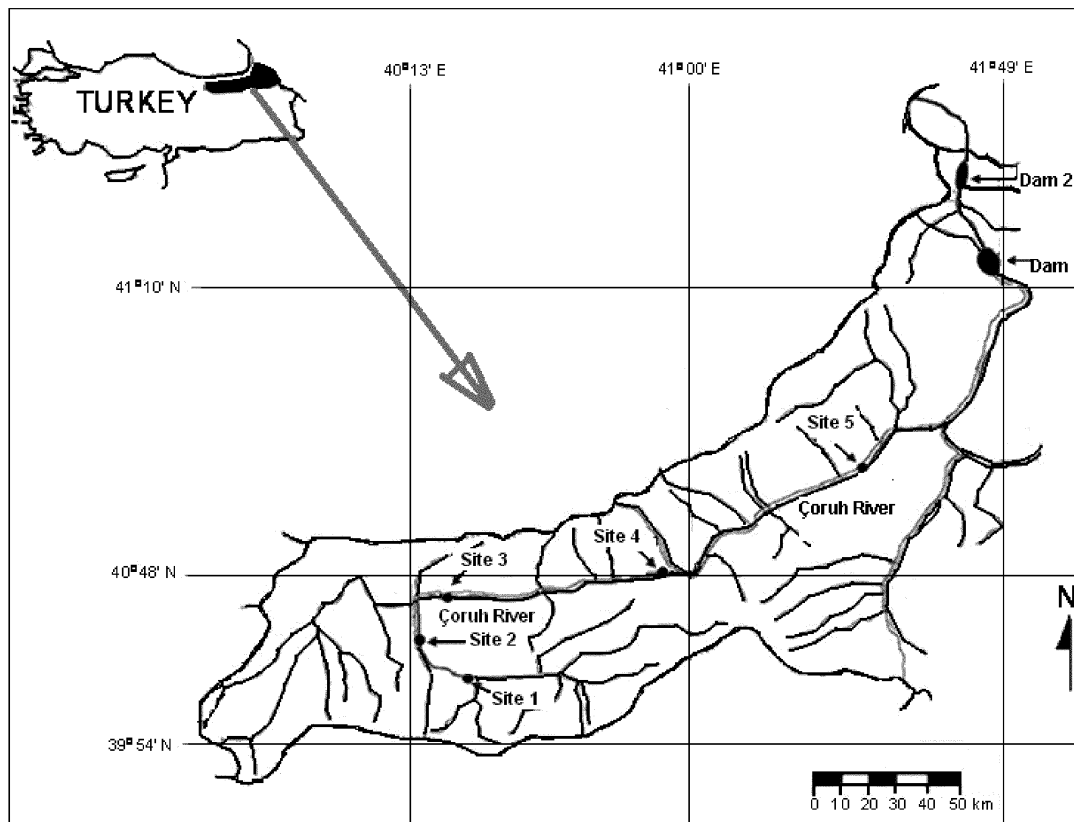


Fig. 1. Upper Coruh River (Turkey) and location of fish sampling sites (1–5).

Table 1. Physical characteristics of sampling sites from the upper Coruh River (see Fig. 1).

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5
Altitude (m)	2100	1700	1550	1250	950
Distance from source (km)	15	45	95	165	210
Mean water temperature (°C)	9.3	10.5	10.5	12.5	13.9
Width (m)	4–5	10–12	30–40	35–45	40–50
Depth (cm)	10–25	15–40	20–50	30–120	40–180
Substrate	Sand-gravel	Sand-gravel	Sand-gravel	Pebble-cobble	Pebble-cobble
Range of discharge (m ³ s ⁻¹) [*]	Not available	4.79–50.4	Not available	12.0–134.0	17.4–214.0
Mining sand	Absent	Intensively	Rarely	Rarely	Seldom
Residents (close to river)	1000	1000	30000	7000	10000
Domestic pollution	Weak	Weak	Strong	Modest	Modest
Agriculture (close to river)	Pasture areas	Small-scale arable areas	Large arable areas	Medium-scale arable areas	Small-scale arable areas

^{*}Anonymous (1996)

Table 2. Average number of fish individuals collected per one hour with elektrofish at 1–5 sites (see Fig. 1) along the upper Coruh River, from March 2001 to March 2002 (n=13–14).

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Percent Contribution, %
European chub (<i>Leuciscus cephalus</i> , Linnaeus, 1758)	615	277	622	541	265	24
Spirilin (<i>Alburnoides bipunctatus</i> , Bloch 1782)	82	576	60	779	675	22
Anatolian khramulya (<i>Capoeta tinca</i> Heckel, 1843)	826	120	238	332	544	21
Brond-snout (<i>Chondostroma regium</i> Heckel, 1843)	18	238	305	181	326	11
Barb (<i>Barbus plebejus escherichi</i> Steindachner, 1897)	34	66	59	420	472	11
Colchic khramulya (<i>Capoeta capoeta sieboldi</i> Steindachner, 1864)			153	73	196	4
Danuba bleak (<i>Chalcalburnus calcooides</i> Guldenstaedt, 1772)	3	14	132	177	42	4
<i>Neamecilus sp.</i>	95	51	1	13	23	2
Brown trout (<i>Salmo trutta</i> Linnaeus, 1766)	19	126		1	5	1.5
Bulatmai barbell (<i>Barbus capito capito</i> (Guldenstaedt, 1773)			4	5	6	>1
Rainbow trout ¹ (<i>Oncorhynchus mykiss</i>)	4					>1
Common carp ¹ (<i>Cyprinus carpio</i> Linnaeus, 1758)			1			>1
Total	1696	1468	1575	2522	2554	
Number of species	9	8	10	10	10	
Shannon-Wiener biodiversity index	1.23 ±0.016	1.69 ±0.038	1.68 ±0.039	1.78 ±0.035		1.82 ±0.014

¹Non-native in the Coruh Basin

as for seasonal assemblages among the five periods: early spring (March–April), late spring (May–June), summer (July–August), fall (September–November), and winter (December–February) with a two-way crossed analysis of similarity (ANOSIM) using Primer software (Primer-E Ltd. 2001, Clarke and Warwick 2001). The data of fish relative abundance (number of fish caught hr^{-1}) were used to develop a Bray-Curtis matrix. A group-averaged cluster analysis was made to identify fish assemblages having similar community characteristics. The mean similarity (%) was used among sites as the minimum grouping threshold for selecting similar groups to account the variability of the data (Primer-E Ltd. 2001). We also identified the contribution of each species to differences among the site assemblages using the SIMPER procedure from PRIMER (Clarke and Warwick 2001). This procedure was used to assess which species contributes most to the differences between sites using species abundance data.

A total of 12 species were collected between March 2001 and March 2002 (Table 2). Cyprinidae species were the most common. The most common species in sites 2, 4, and 5 was *Alburnoides bipunctatus* (Spirlin), in Site 1 it was *Capoeta tinca* (Anatolian khramulya) and in Site 3 it was *Leuciscus cephalus* (European chub). *Capoeta capoeta sieboldi* (Colchid khramulya) and *Barbus capito capito* (Bulatmai barbel) were caught only in sites 3–5. Non-native species were not abundant throughout the river and only *Oncorhynchus mykiss* (Rainbow trout) (Site 1) and *Cyprinus carpio* (Common carp) (Site 3) were caught in low numbers.

Number of species did not vary considerably (8–10) from upstream to downstream sites and Shannon-Wiener biodiversity index was slightly lower in upstream than in downstream (Table 2).

The ANOSIM tests suggested that there were significant spatial and temporal differences among the communities (spatial; $R = 0.532$; $P = 0.01$ and temporal; $R = 0.119$ and $P = 0.047$). Post-hoc comparison identified differences among particular seasons and sites. Seasonal differences between early-spring and late-spring and winter were statistically significant ($P < 0.05$) suggesting a possible

influence of spawning migrations. Comparisons for all other season combinations were not statistically different ($P > 0.05$). Spatial differences between Site 1 and Site 3, between Site 2–3 and Site 4, between Site 4 and Site 5 were not statistically significant ($P > 0.05$). Comparisons for all other spatial combinations were different to each other ($P < 0.05$).

The spatial compositions were further analyzed using cluster analysis. The mean Bray-Curtis similarity among sites was 56%. A minimum similarity group selection criterion was established. This criterion resulted in identifying two discrete groups in the Upper Coruh River (Fig. 2). The first group encompassed all data from Site 1 and Site 3; whereas, the second group was made of sites 2, 4, and 5. The SIMPER analysis indicated that five dominant species contributed over 85% of the differences among the sites (Table 2). Shifts in abundances of European chub, Anatolian khramulya, and Spirlin contributed most to the spatial among sites changes of the fish communities.

The observed spatial differences where higher fish diversity was found at downstream sites followed the common paradigm in river biogeography that streams and rivers generally hold a greater diversity as they increase in size. This greater diversity is a result of greater habitat diversity that can support more fishes with diverse life-histories than upstream reaches that have lower habitat complexity (Schlosser 1990, Toth *et al.* 1982).

Domestic pollution can also influence on spatial and temporal differences and may further explain the cluster analysis grouping among sites (Fig. 2). Waste water from villages and towns near the upper Coruh River is likely to affect the fish community composition. The relation of fish communities to various types of natural and man-made disturbance has been discussed by Petts (1985), Penczak and Koszalińska (1993), and Pegg and Pierce (2002). They identify disturbed areas as being dominated by a few generalist species, with few or no specialist species occurred. Our data support this premise. Spirlin prefers the more clear waters (Geldiay and Balik 1996), being more abundant in Site 1 and Site 3 than the other sites (Table 2). Site 2 is likely less influenced by waste water due to the dilution effect from

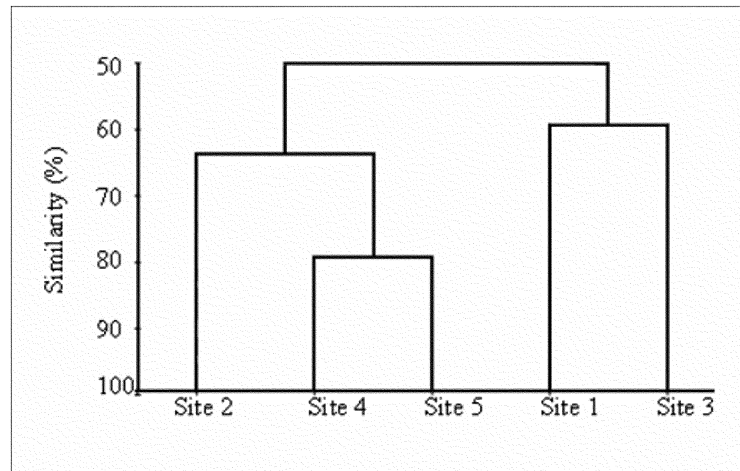


Fig. 2. Cluster analysis of fish community assemblages for all sites (see Fig. 1) from the upper Coruh River using a Bray–Curtis similarity matrix.

a tributary that enters in the Coruh River just upstream of this site (Fig. 1). According to local residents, brown trout was one of the most common species in the Coruh River about 30 years ago. Our data show this is no longer the case and it is presumably due to pollution. However, waste water is not the only concern in the Coruh River. Sand mining has been a substantial activity near Site 2 and likely it had influenced the fish assemblage structure.

All fish were native except the rainbow trout (Salmonidae) and common carp (Cyprinidae) which were both encountered infrequently. Both non-native species were believed to be introduced by aquacultures near Site 1 (Rainbow trout) or through reservoir stockings (Common carp). Currently, neither of species is thought to be a threat because their population levels are rather low and they did not show the signs of establishing populations beyond their localized introduction. However, they could cause competition for resources like food items and habitat if they become established in large numbers. Competition from non-native species has been documented around the world (e.g., Pimental *et al.* 2000, Radke and Kahl 2002).

Our results suggest that the fish communities in upper Coruh River still reflect a riverine system that has not yet been subjected to major flow alterations or biological alteration through introduced species. However,

large-scale human activities planned in the Coruh Valley with the construction of several new reservoirs could change this situation.

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