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Current assessment of species composition and biological characteristics of fishes in the transboundary rivers in Turkey

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ABSTRACT.—The freshwater fishes of Turkey have been studied for more than 150 yr. However, a nation-wide inventory of freshwater fish occurrences in all transboundary river basins (Euphrates–Tigris, Coruh, Kura–Araks, Maritsa and Orontes) has been neither studied nor published. This work is the first extensive study of the composition and biological characteristics of the freshwater fish fauna of the transboundary rivers in Turkey, with special reference to the native and non-native status of species, and the spatial patterns of species e.g., abundance category, endemism, main threats, movement patterns, habitat guild, feeding guild, and reproductive guild. It is determined that a total of 184 fish species in 25 families (including 15 species which are not native, and 30 species are considered as endemic) live in the transboundary river basins in Turkey. Of the 184 fish species: 19 species are abundant, 57 species decrease, and 101 species are data deficient based on IUCN Red List (International Union for Conservation of Nature and Natural Resources). One of the main threats to freshwater fish occurrences in all transboundary river basins are dams. Most fish species in the area are threatened by dams, water extraction, and habitat degradation.

Keywords: Biodiversity, endemism, inland water fish, native fish, conservation

Transboundary rivers are defined as rivers that flow between two or more countries. Like other rivers, water pollution, water withdrawals, and dam construction alter transboundary river health and riverine community (Ewing 2003, Encon 2006, UNECE 2007, Kibaroglu et al. 2011, Freyhof et al. 2014, Koc 2014), but transboundary rivers differ from other rivers in that river management is split among multiple nations. For instance, in Europe, the basin of the Danube River is shared by nineteen countries while the Rhine River basin is shared by nine countries (UNECE 2007). Upstream–downstream resources allocation among neighboring countries is one of the main dilemmas facing conservation and management of transboundary rivers. Transboundary rivers pose sensitive issues among countries in terms of water pollution, dam construction, withdrawal of ground waters, and decisions related to flooding. The Ganges River is a transboundary river in the South East Asia shared by four countries (India, Bangladesh, Nepal and China) and there are conflicts between India and neighboring countries due to dam construction and water sharing (Rahaman 2009). There are

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similar cases in various parts of the world such as the Syr Darya in Central Asia (Siegfried & Bernauer 2007), the Danube river in Europe (Linnerooth-Bayer & Murcott 1996), the Rio Grande in North America (Lane et al. 2015), and the Euphrates and Tigris in Eastern Anatolia (Kibaroglu et al. 2011).

Turkey is a bridge between Europe and Asia. It has a rich diversity of freshwater fishes compared to many countries in Europe (Kuru et al. 2014) and its unique ichthyofauna has elements both from Europe and Asia (Tarkan et al. 2015). There are 368 fish species in inland waters of Turkey (153 endemic species) (Cicek et al. 2015), and they are threatened by a number of anthropogenic stressors such as construction of dams and HEPPs (Hydroelectric Power Plant), water extraction, habitat loss, increasing irrigation demands, pollution, destruction of fish spawning ground, introduction of foreign species, and poaching in Turkey (Fricke et al. 2007, Freyhof et al. 2014) and in neighboring countries (Bobori & Economidis 2006, Economou et al. 2007, Coad 2010, Kibaroglu et al. 2011). In Turkey, five of the country's 25 river basins are transboundary, spanning two continents (i.e., Europe and Asia) and 8 countries (Fig. 1) (Table 1). Several checklists of the freshwater fishes of Turkey exist (Geldiay & Balik 2007; Kuru 2004; Fricke et al. 2007; Kuru et al. 2014; Cicek et al. 2015); however, a nation-wide inventory of freshwater fish occurrences in transboundary river basins has not been published. Large-scale distributional survey work including all transboundary rivers was abandoned in favor of regional or local research, usually focusing on particular fish species or the fauna of a single river basin. Some researchers (Kuru 1971, Coad 1991, 1996; Ozturk et al. 2012, Ozcan 2013a, Baycelebi et al. 2015, Cicek & Birecikligil 2016, Kaya et al. 2016) have studied the fish community composition of selected transboundary rivers and their tributaries in Turkey.

The purpose of this study was to identify fish species inhabiting the transboundary river basins in Turkey, provide information about their current biological status, such as reproductive and feeding guilds and identify issues with transboundary waterways. Objectives of this study were i) to analyze general characteristics, current energy potential and water resources of the transboundary rivers in Turkey, ii) to characterize the provenance status (i.e., native or non-native in each basin area) and ranking of fish communities using guilds classifications considering their different biological characteristics such as habitat guild, migratory guild, feeding guild, reproductive guild, and human use among the transboundary waterways, iii) to identify any threatened fish species, and to recognize the causative factors of their decrease and to discuss protection measures, and iv) to identify healthy and unhealthy fish species in order to prioritize areas of international collaborative efforts. The determination of the health of fish communities is based on criteria such as the relative numbers of native versus non-native species and the proportion of threatened species. Unhealthy fish communities include a larger proportion of non-native species and proportionately more threatened species. Area-based compilation of fish data may help in understanding the assemblage structure of each transboundary river basin and other features of relevance to biogeography. This study might be considered to provide potential benefits in terms of biodiversity conservation, monitoring of changes in the fish populations and fishery exploitation. Descriptions of the main river basins are as follows.

I. Euphrates–Tigris Basins.—Euphrates and Tigris rivers (Fig. 1) contain approximately 29% of Turkey's surface water (DSI 2016) (Table 2). The Euphrates River originates in the eastern highlands of Turkey, between Lake Van and the Black Sea, and is formed by two major tributar-

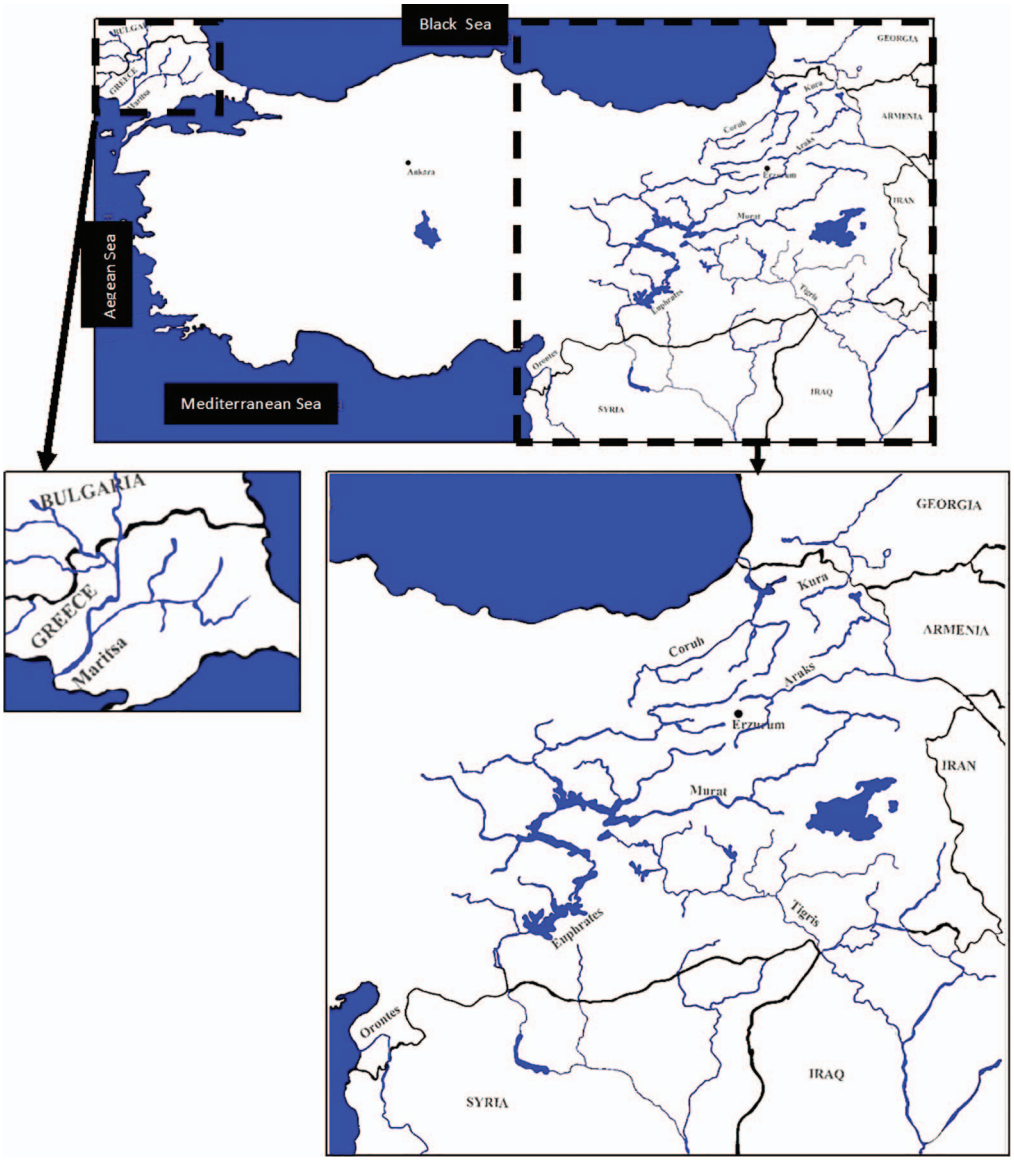

Fig. 1. Transboundary river basins in Turkey.

ies, the Murat and the Karasu rivers and several smaller and mountainous tributaries, such as the Peri Suyu, Goksu and Tohma rivers. The Tigris River, also originating in eastern Turkey, flows through the border city of Cizre and forms part of the border between Turkey and Syria, and farther downstream part of the border between Iraq and Syria. Its two major tributaries are the Great Zab and Lesser Zab including Karasu, Kurucay, Batman, Botan, Garzan, Hezil, and Yenice rivers. The Euphrates and Tigris rivers join to form the Shatt Al–Arab River in Iraq that continues to flow about 200 km to the Persian Gulf (FAO 2009). In Turkey, water-related development projects include the GAP (Southeastern Anatolia Project), consisting of 22 dams and 19 HEPPs on the Euphrates and Tigris rivers (Table 3).

Table 1.—River length, geographic origin, discharge location, and mean annual flow of the transboundary river basins in Turkey.

Basin	Total length (km)	Length in Turkey (km)	Origin	Discharge water body (country)	Mean annual flow in Turkey (billion m^3)
Euphrates	3000	1263	Turkey	Persian Gulf (Iran)	49.91[a]
Tigris	1850	523	Turkey	Persian Gulf (Iran)	
Coruh	427	400	Turkey	Black Sea (Georgia)	7.05
Kura	1364	189	Turkey	Caspian Sea (Azerbaijan)	4.18[b]
Araks	1264	548	Turkey	Caspian Sea (Azerbaijan)	
Maritsa	500	187	Bulgaria	Aegean Sea (Turkey and Greece)	1.84
Orontes	556	98	Lebanon	(Mediterranean Sea) (Turkey)	0.89

[a] Includes Euphrates and Tigris rivers
[b] Includes Kura and Araks rivers

As of 2017, 87% of the projects, funded by government and private partnerships, was completed (DSI 2016).

II. Coruh Basin.—The Coruh River (Fig. 1) is located in northeast Turkey and shared by Turkey and Georgia. The river originates in the western part of the Mescit mountains at the Erzurum–Kars Plateau and flows to the Black Sea. The main tributaries of the Coruh River are the Tortum and Oltu rivers in Turkey. The Coruh River has the highest gradient of the rivers in Turkey and is susceptible to the highest rate of erosion (Akpinar et al. 2011, Sume et al. 2017). The Coruh Basin Development Plan involves 103 dams and HEPPs. Currently, 27 dams and HEPPs are in operation (Kankal et al. 2016) with 10 of the larger dams on the main tributary of the Coruh River (DSI 2016).

III. Kura–Araks Basin.—The Kura River (Fig. 1) originates in the Kızılgedik Mountains of the Ardahan province in Northeast Turkey, and the Araks River originates in the Erzurum province in eastern Turkey. Three major tributaries

Table 2.—Statistics and water usage of the transboundary river basins in Turkey and riparian countries.

Basin	Total area (km^2)	Country within basin	Area (km^2)	Percent of basin	Water usage
Euphrates-Tigris	789,000	Turkey	195,700	28.5	irrigation, hydropower, flood control
		Syria	116,300	15	irrigation, hydropower
		Iraq	319,400	40	irrigation, marshes, hydropower
		Iran	155,400	20	irrigation, hydropower
		Jordan	2000	<1	insufficient information
		Saudi Arabia	80	<1	insufficient information
Coruh	22,000	Turkey	20,000	91	irrigation, hydropower, recreation
		Georgia	2000	9	small-scale agriculture, recreation, fishery
Kura - Araks	193,200	Turkey	27,700	14	irrigation, hydropower, domestic
		Georgia	34,300	18	irrigation, industrial, domestic
		Azerbaijan	56,600	32	irrigation, industry, hydropower, domestic
		Iran	39,700	21	irrigation, hydropower, industry, domestic
		Armenia	34,800	15	irrigation, industrial, domestic
		Russia	60	<1	insufficient information
Maritsa	49,600	Turkey	12,800	26	Irrigation
		Bulgaria	33,000	66	irrigation, hydropower
		Greece	3,700	8	irrigation, conservation area
Orontes	37,900	Turkey	18,900	50	irrigation, domestic, hydropower, flood control
		Syria	16,800	44	domestic, irrigation, hydropower
		Lebanon	2200	6	domestic, irrigation, hydropower

Table 3.—The number of dams and hydroelectric power plants (HEPPs) on the transboundary rivers in Turkey.

Basin	Dams and HEPPs in operation	Dams and HEPPs in construction stage	Dams and HEPPs in development stage	Total
Euphrates-Tigris	56	98	174	328
Coruh	13	52	96	161
Kura-Araks	7	23	32	62
Maritsa	0	0	4	4
Orontes	1	4	13	18

within the basin are the Arpacay, Karasu and Sarısu rivers. The Kura–Araks Basin is located in the South Caucasus with five countries (i.e., Turkey, Iran, Armenia, Georgia, and Azerbaijan) having a watershed within the basin. The Kura and Araks Rivers both merge in Azerbaijan before entering the Caspian Sea. The Kura–Araks basin has 35 large dams and more than 130 major reservoirs among all bordering countries (FAO 2009).

IV. Maritsa Basin.—Located in northwestern Turkey, the Maritsa River (Fig. 1), whose catchment is shared by Bulgaria, Turkey and Greece, is the longest river in the Balkan Peninsula forming the majority of the border between Greece and Turkey. The Maritsa River originates in Bulgaria and flows along the Turkish–Greek border and into the Aegean Sea. Major tributaries include the Arda and Tundja Rivers that mainly flow into Bulgaria, the Erithropotamos River flowing into Bulgaria and Greece, and the Ergene River that is located entirely within Turkey (UNECE 2007, Nikolaou et al. 2008). In the upper part of the basin, HEPPs are common serving multiple purposes, such as energy production, irrigation, industry, and sources of drinking-water (UNECE 2007).

V. Orontes Basin.—The Orontes River (Fig. 1) originates in the eastern part of the Beqaa Valley in Lebanon and flows northward from Lebanon, through Syria, and into Turkey before entering the Mediterranean Sea south of Samandag, Turkey. The Orontes River has two major tributaries (Afrin and Karasu rivers). In Turkey, 10 dams and HEPPs are in operation and three dams and HEPPs are under construction within the Orontes river basin (DSI 2017).

Materials and Methods

Data were gathered for all species distributed in the transboundary river basins of Turkey from published sources and presented in this paper. These data include all endemic, native, and non-native fish species. The literature citations for on this ichthyofauna includes the following: Kuru 1971, Coad 1996, Turan et al. 2006a, 2006b; Fricke et al. 2007, Geldiay & Balık 2007, Dagli 2008, Okur & Yalcin-Ozdilek 2008, Van Neer et al. 2008, Naseka 2010, Birecikligil & Cicek 2011, Turan et al. 2012b, Innal 2012, Kottelat 2012, Ozcan 2013a, 2013b; Bilecenoglu et al. 2014, Kucuk & Guclu 2014, Kuru et al. 2014, Smith et al. 2014, Baycelebi et al. 2015, Cicek et al. 2015, Tarkan et al. 2015, Yildirim et al. 2015, Cicek & Birecikligil 2016, and Kaya et al. 2016. Since there was limited information on the Maritsa river basin in Turkey, the study of the fauna conducted by Economou et al. (2007) in neighboring Greece was evaluated and used in this study. Accepted scientific names and their authorities were checked with Fishbase (Froese & Pauly 2016) and Eschmeyer's Catalog of Fishes (Fricke et al. 2020).

Fish species are grouped by family following Nelson (2006) and Van Der Laan et al. (2014). The IUCN Red List (The International Union for Conservation of Nature) was the source of criteria for the conservation status of fish species (IUCN 2020). The Red List categories are NE (not evaluated), DD (data deficient), LC (least concern), NT (near threatened), VU (vulnerable), EN (endangered), CR (critically endangered), and EX (extinct). While no species in this study can be

considered extinct, some are considered extirpated, i.e., are locally extinct in the transboundary rivers of Turkey. For this reason, we choose to use the term extirpated in place of extinct.

Fishes living in the transboundary river basins in Turkey are categorized according to their different biological guilds (available as Appendix A and B, Supplementary data) such as habitat, migratory, feeding, and reproductive guilds, and human use.

Habitat and migratory guilds.—Dam construction, droughts, reduce in streamflow, etc. have negative impacts on fish habitats. For instance, dams reduce water level and the flow rate of rivers and are an obstacle for fish migration. Migratory fishes (e.g., anadromous, potamodromous, semi-anadromous) are listed separately and their current status are presented. The habitat and migratory guilds of fishes were discussed for each transboundary river basin in order to categorize fishes according to their habitat and demonstrate the extent to which each species is affected by negative factors.

Feeding guild.—Some factors such as, pollution, food competition, and habitat loss may have a negative effect on feeding biology of fishes. The feeding guilds of fishes are discussed for each river basin.

Reproductive guild.—In this study, reproductive guilds of fishes were described, for some of them were more susceptible to human threats than others. The ova and developing larvae of broadcast-spawners are susceptible to the vagaries of environmental changes such as streamflow and temperature since they release ova onto unmanipulated substrata (Durham & Wilde 2009). Eight three percent of fishes living in the transboundary rivers in Turkey were broadcast spawners that release their gametes into the water and do not protect them. First-year survival rates of broadcast-spawners are strongly related to stream discharge (Wilde & Durham 2008). Dams are thought to cause reduced streamflow in many streams in North America, so members of the broadcast-spawning reproductive guild have declined in abundance or have been extirpated (Cross et al. 1985, Cross & Moss 1987). There are 77 dams in operation on the transboundary rivers of Turkey (Koc 2014) and they might cause reduced flows in the affected rivers. The reproductive guilds of fishes are discussed for each river basin.

Human use.—There are many threats for freshwater fishes in Turkey and neighboring countries. Most threats are human-induced such as construction of dams, overfishing, pollution of freshwater systems, irrigation and water extraction, all of which have caused habitat loss and pollution of river systems (Fricke et al. 2007, Freyhof et al. 2014). Human-induced changes were examined and tabulated for each river basin.

Supplementary material of fish species recorded in the transboundary river basins in Turkey is presented in Appendix A and Appendix B. The list of fishes living in each transboundary river basin by endemic, native, introduced status, IUCN and abundance categories are given in Appendix A. Habitat guild, migratory guild, feeding guild, reproductive guild, and human use criteria of fishes are given in Appendix B.

Results

Among the 368 freshwater fish species reported in Turkey (Cicek et al. 2015), 184 of these, representing 25 families, occurred within the five transboundary basins (Table 4). Family Cyprinidae was the most speciose family with 104 species, followed by Nemacheilidae (24 spp.), Salmonidae (11 spp.) and Cobitidae (8 spp.). The fish community of the Euphrates–Tigris basin was the most speciose with 83 species. The Coruh basin was the least speciose with 24 species (Appendix A, Supplementary data).

Table 4.—Number of species per by family for each transboundary river basin in Turkey. "-" indicates information is not available.

Family Name	Among transboundary basins	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes
Petromyzontidae	1	-	-	1	-	-
Acipenseridae	5	-	-	1	4	1
Anguillidae	1	-	-	-	1	-
Clupeidae	2	-	-	1	1	-
Cyprinidae	104	44	17	26	25	34
Cobitidae	8	3	-	2	3	1
Nemacheilidae	24	18	1	3	-	8
Bagridae	1	1	-	-	-	-
Siluridae	2	2	1	1	1	-
Sisoridae	4	4	-	-	-	-
Clariidae	1	-	-	-	-	1
Heteropneustidae	1	1	-	-	-	-
Loricariidae	1	-	-	-	-	1
Salmonidae	11	5	4	3	2	-
Esocidae	1	-	-	-	1	-
Gobiidae	4	-	1	2	2	-
Mugilidae	2	1	-	-	1	1
Cichlidae	1	-	-	-	-	1
Blenniidae	1	-	-	-	-	1
Atherinidae	1	-	-	-	-	1
Cyprinodontidae	2	1	-	-	1	1
Poeciliidae	2	2	-	1	1	2
Mastacembelidae	1	1	-	-	-	-
Centrarchidae	1	-	-	-	1	-
Percidae	2	-	-	1	2	-
# of families	25	12	5	11	14	12
# of species	184	83	24	42	46	53

Among the 184 species, 88% (162 spp.) of the species are native and 16% (30 spp.) are basin endemics. Percent of native species within basin ranged from 76% (35 spp.) in the Maritsa basin to 96% (23 spp.) in the Coruh basin (Fig. 2). Percent of endemic species ranged from 0% (0 spp.) in the Maritsa basin to 18% (15 spp.) in the Euphrates–Tigris basin. Maritsa basin did not have any endemic fish species. Percent of introduced species within basin ranged from 4.2% (1 sp.) in Coruh basin to 22% (10 spp.) in the Maritsa basin. Native or introduced status was uncertain for up to 7% of the species per basin and 4% (7 spp.) of the species overall.

The majority (75%; 138 spp.) of the transboundary fish species have been evaluated by the IUCN Red List, whereas 25% have not been evaluated (37 spp.) or are data deficient (9 spp.) Percent of fishes classified as imperiled among basins and all fishes, including not evaluated and data deficient species, was 22% (40 spp.), consisting of 3.8% (7 spp.) categorized as extirpated, 4.9% (9 spp.) categorized as critically endangered, 4.3% (7 spp.) categorized as endangered, 4.9% (9 spp.) categorized as vulnerable, and 3.8% (7 spp.) as near threatened. Percent of fishes classified as imperiled within basin ranged from 17% (4 spp.) in the Coruh basin to 28% (15 spp.) in the Orontes basin.

Population status is provided for 45% (83 spp.) of the transboundary fish community. Among these 83 species, 3.8% (7 spp.) were reported as extirpated, 0.5% (1 sp.) was reported as rare, 30% (56 spp.) were reported as decreasing, and 10% (19 spp.) were reported as common (Fig. 3). Percent of species with population status of extirpated ranged from 0% in the

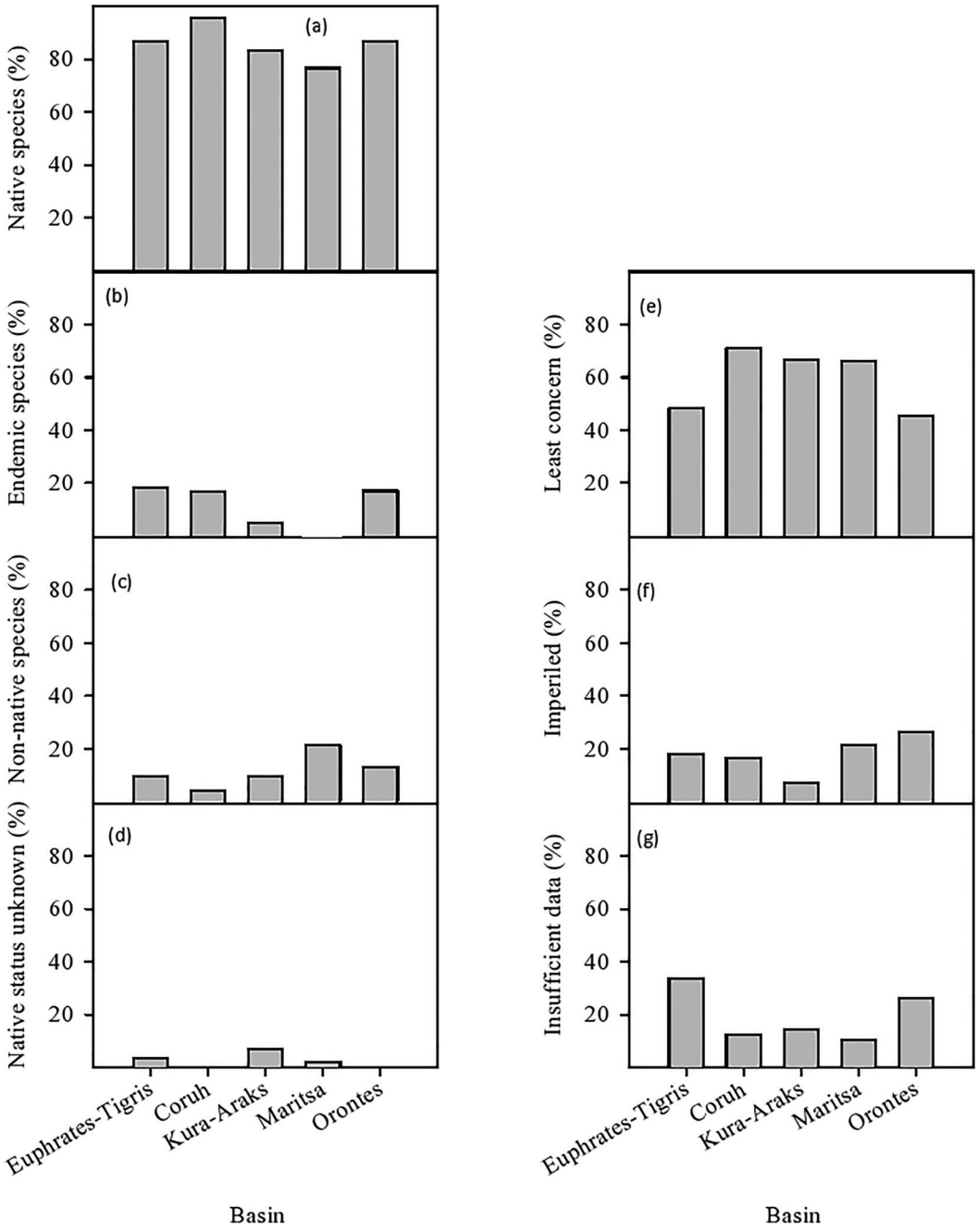

Fig. 2. Origin and endemism of fish species and species of concern for: (a) Native species, (b) Endemic species, (c) Non-native species, (d) Native status unknown, (e) Least concern, (f) Imperiled (i.e., sum of Near threatened, Vulnerable, Endangered and Critically endangered) fish species based on IUCN Red List and (g) Insufficient data for each transboundary basin.

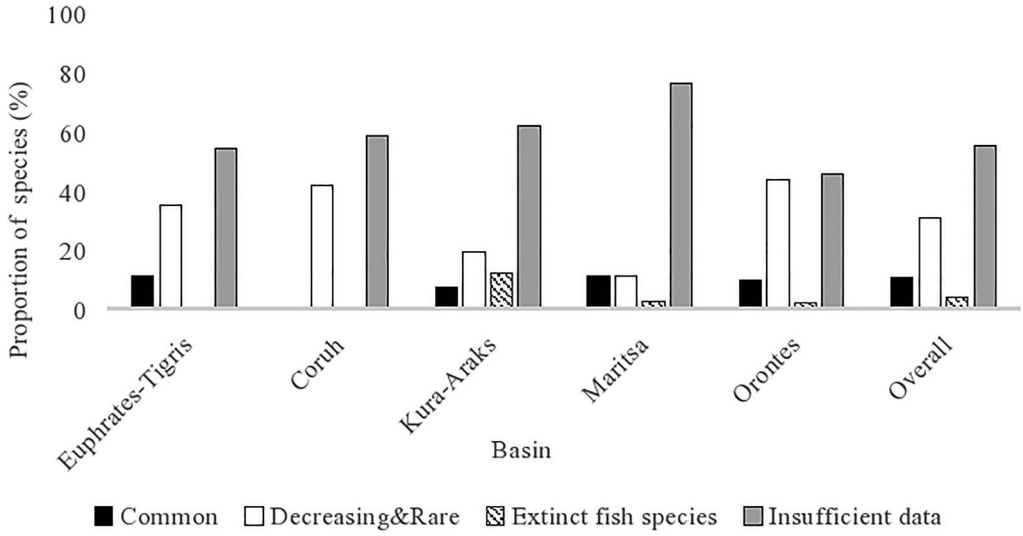

Fig. 3. Fish occurrence and population status for each transboundary river basin in Turkey.

Euphrates–Tigris basin to 12% (5 spp.) in the Kura–Araks basin. Percent of species with population status of decreasing ranged from 11% (5 spp.) in the Maritsa basin to 43% (23 spp.) in the Orontes basin.

Available information was sufficient to categorize habitat, migratory, trophic, and reproductive guilds for the majority of the species occurring in the transboundary fish community (Appendix B, Supplementary data). The transboundary fish community consisted primarily of species associated with both lentic and lotic habitats (54%) and lotic only habitats (46%) (Fig. 4). Only one species was associated with lentic only habitats. By drainage, the percent of species characterized as associated with lotic only habitats ranged from 26% (12 spp.) in the Maritsa basin to 51% (42 spp.) in the Euphrates–Tigris basin. The transboundary fish community consisted primarily of non-migrant fishes (57%; 105 spp.). The percent of migrant fishes, consisting of anadromous, catadromous, potamodromous, semi-anadromous, and amphidromous, was 28% (51 spp.). By drainage, the percent of migrant fish species ranged from 15% (12 spp.) in the Euphrates–Tigris basin to 50% (23 spp.) in the Maritsa basin. Omnivore was the most common trophic guild (28%; 52 spp.) among all basins and by basin, ranging from 29% in the Coruh (7 spp.) and Kura–Araks basins (12 spp.) to 37% (17 spp.) in the Maritsa basin (Fig. 5). Benthivore was the second most common trophic guild (23%) among all basins. By basin, the benthivore trophic guild ranged between 13% (3 spp.) in the Coruh basin to 27% (22 spp.) in the Euphrates–Tigris basin. Herbivore was the least common trophic guild (0.5%; 1 sp.) among all basins and by basin, ranging from 0% in Coruh, Kura–Araks, and Orontes basins to 2.1% in the Marista basin. Non-guarder was the most common reproductive guild (83%; 153 spp.) among all basins and by basin, ranging from 79% (33 spp.) in the Kura–Araks basin to 88% (21 spp.) in the Coruh basin.

Human usage was reported for 76% (139 spp.) of the transboundary fish community (Fig. 6). Fishes of economic importance was the most common human usage (51%; 94 spp.), followed by no human usage (23%; 42 spp.), and sportfish (1.6%; 3 spp.). Fishes of economic importance

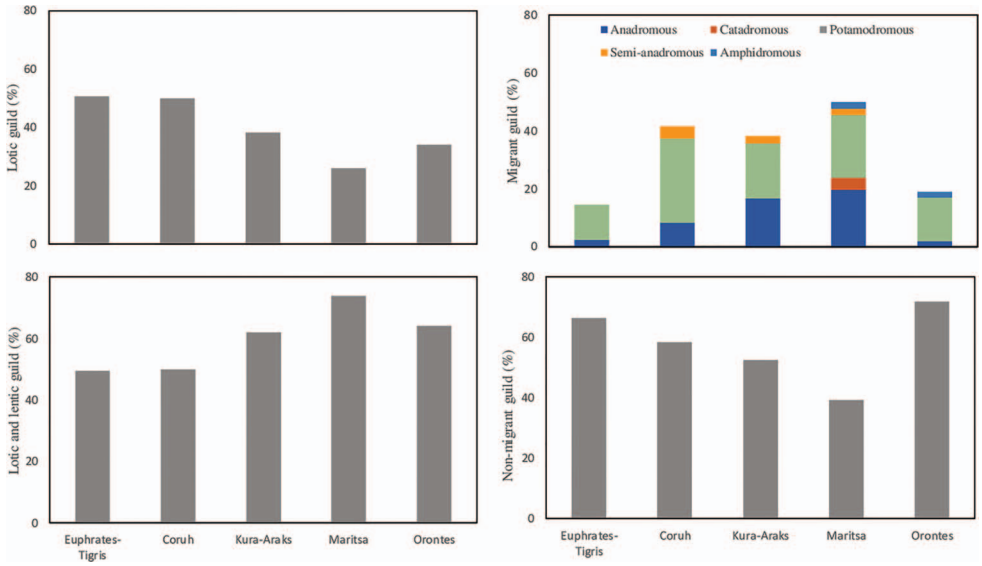

Fig. 4. Habitat and migrant guilds of fish species for each transboundary river basin in Turkey

ranged from 45% (24 spp.) in the Orontes basin to 71% (17 spp.) in the Coruh basin. Sportfishes ranged from 1.2% (1 sp.) in the Euphrates–Tigris basin to 4% (2 spp.) in the Maritsa basin.

Comparing the relative numbers of native versus non-native species, high endemism rate, population status, and the proportion of threatened species of transboundary river basins in Turkey, the healthiest fish communities occur in the Euphrates–Tigris and Coruh river basins, respectively. On the contrary, the unhealthiest fish communities of transboundary river basins were determined to be in the Orontes, Maritsa and Kura–Araks river basins based on a larger proportion of non-native species and proportionately more threatened species.

Discussion

It is determined from our review of the literature and analysis that the transboundary river basins of Turkey host habitats for 50% of the freshwater fish species and have sources of 26% and 8%, respectively, for fish species of economic importance and endemic. This study reveals that the number of fish species living in the transboundary river basins of Turkey is determined to be more than the total number of fishes in some neighboring countries due to the transboundary river basins of Turkey having a rich biodiversity. Based on the published data; a total of 257 (73 endemic) (Jouladeh-Roudbar et al. 2015), 53 (Coad 2010), 161 (47 endemic) (Economou et al. 2007), 39 (Gabrielyan 2001), and 61 (Ninua & Japoshvili 2008) freshwater species occur in Iran, Iraq, Greece, Armenia and Georgie, respectively, in comparison to 368 freshwater fish species (Cicek et al. 2015) reported for Turkey.

The population status of fish communities in the transboundary rivers of Turkey were found to be 4% (7 spp.) extirpated, one fish rare, 30% (56) decreasing and 10% (19) common. Although seven fish species are thought to be extirpated, how many species lost in these systems are not determined exactly since historical records are lacking. The healthiest fish community based on the presence of a large proportion of native species, few threatened

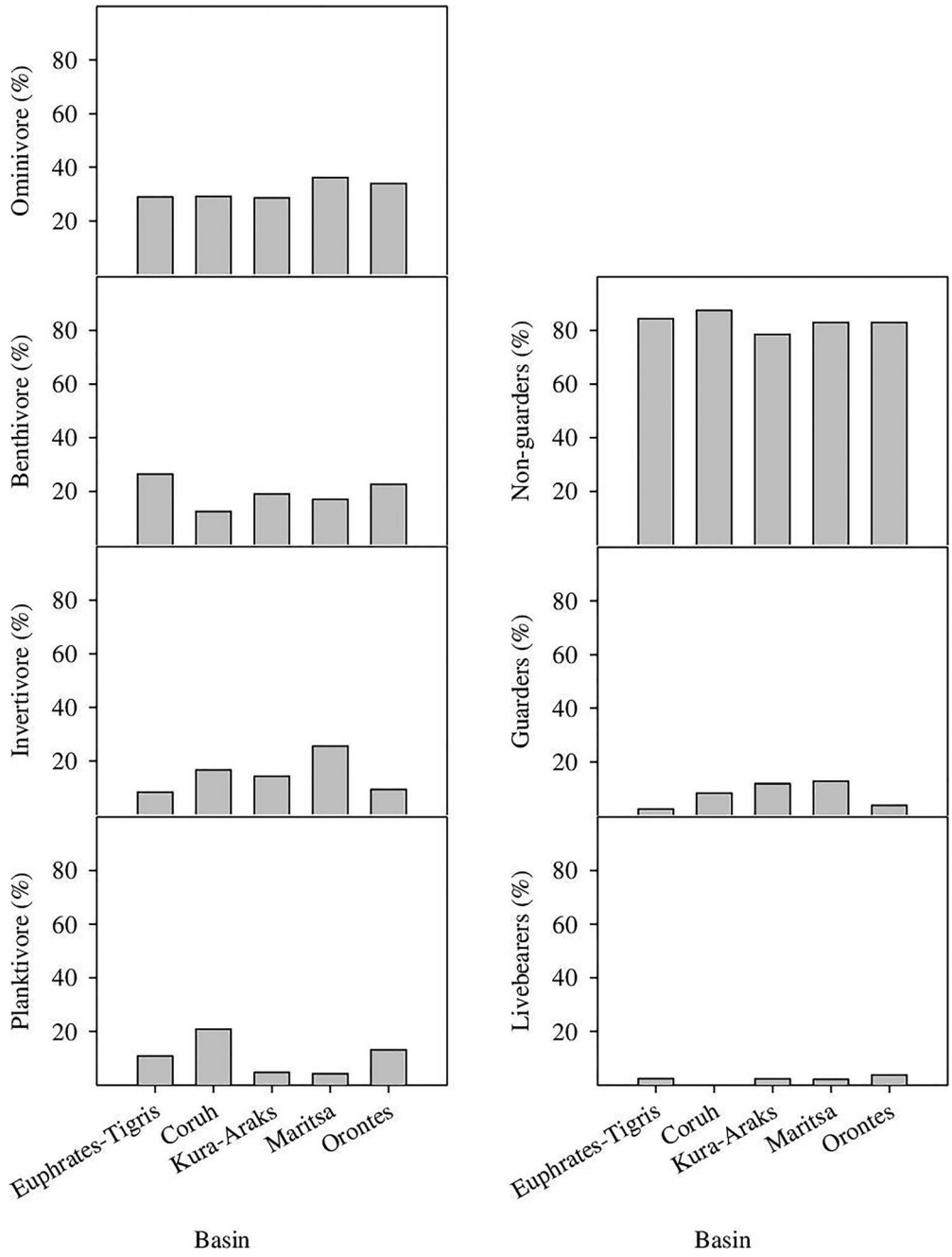

Fig. 5. Trophic and reproductive guilds of fish species for each transboundary river basin in Turkey

species, abundance category, and endemism has measured in the Euphrates–Tigris, Coruh, Kura–Araks, Maritsa and Orontes river basins, respectively. Although the ratio of endemism and native fish species were high in the Orontes river, most fishes were threatened by drought, habitat degradation and non-native species (Ozcan 2013a). This order may change since these river basins are under risk due

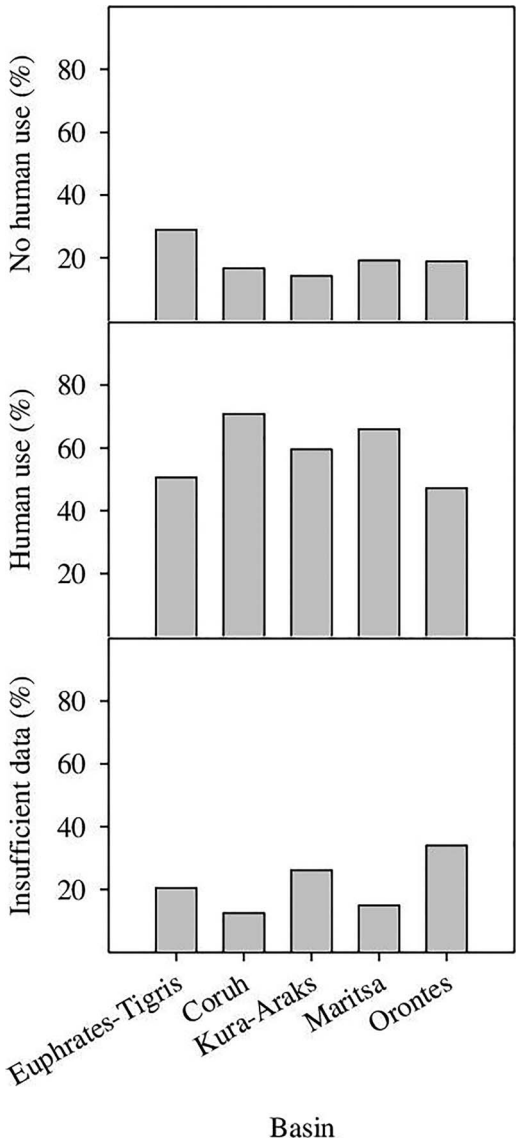

Fig. 6. Human use of fish species for each transboundary river basin in Turkey.

to dam constructions, introduction of non-native fish species and habitat degradation (Fricke et al. 2007, Freyhof et al. 2014, Koc 2014). The transboundary rivers in Turkey host a large number of fishes (184 species in 25 families), many of which are of economic importance (51%), and some endemic forms (16%). In order to manage these valuable resources, migrant and lotic/non-guarders fishes should be monitored for they are more prone to anthropogenic impacts (Freyhof et al. 2014) and population status for the 55% of fishes unknown should be quantified.

Our findings for the transboundary rivers of Turkey were compared with five major inland rivers of Turkey namely, Büyük Menderes (western), Sakarya (northern), Kizilirmak (northern), Seyhan (southern) and Ceyhan (southern) in terms of the population status of the fish community (number of fishes listed as extirpated, common, and decreasing) (Demirak et al. 2006, Canbek et al. 2007, Polat et al. 2008, Erguden & Goksu 2009, Erk'akan & Ozdemir 2011, Erguden & Goksu 2012, Guclu et al. 2013, Turan et al. 2013, Akmirza & Yardimci 2014, Kirankaya et al. 2014, Kupeli et al. 2014, Pfleiderer et al. 2014, Cicek et al. 2015, Tarkan et al. 2015, Ablak-Gurbuz 2017, Cicek et al. 2018). It is found that the population status of the fish communities of five major non-transboundary rivers of Turkey, similar to the transboundary rivers, have 43% of fishes decreasing, 12% common, and 45% data deficient. However, numbers of extirpated species in the transboundary rivers of Turkey are higher than these in non-transboundary rivers. Assessment of the population status of 55 % of the fish species in this study was not done due to a lack of published information for many species living in the transboundary rivers in Turkey. Hence, population status studies in the future might be necessary for the transboundary river basins to fill this gap.

Migrant forms may be good indicators of river health (Soto-Galera et al. 1998, Whitfield & Elliot 2002) to monitor any human induced changes. Likewise, lotic/non-guarders are good indicators of flow changes in the future (Cross et al. 1985, Cross & Moss 1987, Wilde & Durham 2008). The population status of migratory fishes in the transboundary rivers is not only dependent on data from Turkey but

also from adjacent countries. In this study, based on our extensive literature research, it is determined that transboundary river basins host Turkey's 14% of migrant forms. Despite the lack of information on movement patterns of 16% fish in the transboundary rivers in Turkey, 28% of the fishes is determined as migrant. The rates of extirpated, common or decreasing migrant forms in the transboundary rivers basins in Turkey are assessed as 10%, 10% and 33%, respectively. Also, the findings in the transboundary rivers of Turkey on migrant forms were also compared with five major Turkish non-transboundary river basins (Büyük Menderes, Sakarya, Kizilirmak, Seyhan and Ceyhan rivers) for the purpose of comparison. It is found that 18% of the fish populations in the five inland river basins are migrant forms. The levels of decreasing (19%) and extirpated (0%) migrant forms in the five non-transboundary river basins are found to be less than those in the transboundary river basins. The reason for the high level of decreasing/extirpated fish in the transboundary river basins in Turkey might be the result of numerous dams in those drainages (Berkun 2010a, Koc 2014, Kankal & Uzlu 2014), water extraction (Kibaroglu et al. 2011), habitat degradation (Fricke et al. 2007, Freyhof et al. 2014) and/or pollution (FAO 2009). Turkey has a rather large number of dams on its rivers and hardly any river is unaffected (GegenStrömung 2011, Freyhof et al. 2014). Alteration of rivers specifically due to dam construction affect migrant forms negatively (Jackson et al. 2001, Malmqvist & Rundle 2002, Fricke et al. 2007, Aydemir 2013) and give rise to habitat loss. Dams might disrupt habitat structure of rivers and force fishes living in lotic water to adapt to slower moving water. Additionally, multi-dam projects impose serious blockage to the movements of migratory fishes. Furthermore, most migratory species need unrestricted access both to the sea and freshwater to complete their life-cycle. Installation of suitable fish ladders in rivers may allow migratory fishes to pass dams and continue their migration upriver. Fish ladders in Turkey's dams are either not present or not appropriate for all fish species (Koc 2014).

Fishing is a livelihood for many residences along the transboundary river basin areas in Turkey. However, river basins can have biological and economic consequences when rivers face pollution, fragmentation and introduction of non-native fishes. Just like most fish species, fish species of economic importance (Berkun 2010a) and correspondingly local economies are negatively affected by dams due to river alterations and the presence of non-native fish species. Economically important species rate (51%) is quite high in the transboundary river basins area in Turkey. However, building dams on the transboundary rivers resulted in changes in water conditions (Barannik et al. 2004, GEF 2014), restrictions of fish movements (Encon 2006, Koc 2014) and decrease in some fish populations (Kayam 2006). Besides, due to its geographical location and large transboundary river systems, the risk of introduction of non-native fishes to river basins also increases in Turkey (Fricke et al. 2007, Tarkan et al. 2014) and 15 species (8%) were determined as non-native in the transboundary river basins in Turkey. Introduction of non-native fishes has strong direct and indirect negative effects on several aquatic ecosystems (Tarkan et al. 2015, Vilizzi & Tarkan 2015). Therefore, enforcement should be implemented by governments to lessen both human influences and any effects on the biota in order to avoid introduction of noxious non-native species. Significant efforts should be taken to protect freshwater fishes but, breeding and stocking a few commercially important species and size-regulations for anglers and fishermen are not enough precautions to achieve the targets (Freyhof et al. 2014). Future management actions should strive to avoid

all these affects in Turkey's transboundary river basins. By targeting guilds susceptible to changes in water quantity, more ecological work can be done (Encon 2006) to mitigate the influence of dams and to allow planning for future dams and dewatering efforts.

Upstream–downstream resource allocation between Turkey and the neighboring countries is one of the main conflicts for the transboundary rivers due to rising water demand on the transboundary river basins. The management of shared water resources requires innovative and flexible approaches to provide collaboration between neighboring countries. Improving baseline information and data exchange on watersheds between neighboring countries is crucial for making informed decisions and management plans (e.g., the hydrology, the topography, the biological composition, human impacts). Moreover, climate change and the growing globalized economy are thought to present new challenges in managing transboundary rivers. Neighboring countries might participate in conflict resolution systems and invest in institutional capacity with their neighbors to be suitably prepared (Petersen-Perlman et al. 2017). For instance, early warning monitoring systems are essential (Tserunyan 2009) to track and identify floods, short-term and long-term alterations in water quality. Multi-party water-saving technology policies might be helpful to solve the water sharing conflict (Kucukmehmetoglu & Geymen 2014). Even though sustainable water policies in transboundary river basins is challenging (Lane et al. 2015) due to the existence of international agreements signed in different years (Kibaroglu et al. 2011) and multiple operational systems, there is no regulation in international agreement yet between Turkey and the neighboring countries (Tombul 2014).

Consequently, Turkey is a freshwater fish biodiversity hotspot (Tarkan et al. 2015). Transboundary river basins provide habitats for 50% of Turkey's fishes and each transboundary basin has endemics. Lotic/non-guarders species and especially migrant fishes are adversely affected by several anthropogenic stressors, such as dams and dewatering in the transboundary river basins.

Monitoring and management of transboundary water is a complex problem in any region of the world (Campana et al. 2008) yet, mutual data exchange and coordinated efforts among neighboring countries are required in the management and monitoring of fish species. Human-induced impacts can be identified and monitored. It is necessary to describe the variable and susceptible structure of fish communities across the transboundary rivers and to design successful, science-based management strategies for providing their continued survival.

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Appendix A.—Annotated checklist of fishes living in each transboundary river basin based on native status, IUCN, and abundance categories (N: Native; E: Endemic; I: Introduced/Non-native fish). For each fish species, literature cited are given below as a secondary source. "O" indicates presence of fish; "-" indicates an absence of information on that category or basin.

Family	Species	Native status	IUCN category	Abundance category	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes	Source
Petromyzontidae	*Caspiomyzon wagneri*	-	extirpated	extirpated	-	-	O	-	-	(20; 36; 7; 6)
Acipenseridae	*Acipenser gueldenstaedtii*	N	critically endangered	decreasing	-	-	-	O	-	(11; 20; 36; 7)
	Acipenser persicus	-	extirpated	extirpated	-	-	O	-	-	(20; 36; 7)
	Acipenser stellatus	N	critically endangered	decreasing	-	-	-	O	-	(11; 20; 36; 7)
	Acipenser sturio	-	extirpated	extirpated	-	-	-	O	-	(11; 20; 36; 7)
	Huso huso	N	critically endangered	decreasing	-	-	-	O	-	(11; 20; 36; 2; 7)
Anguillidae	*Anguilla anguilla*	N	critically endangered	decreasing	-	-	-	O	O	(20; 48; 20; 41; 36; 7)
Clupeidae	*Alosa caspia*	-	extirpated	extirpated	-	-	O	-	-	(20; 22; 36; 2; 6)
	Alosa fallax	N	least concern	common	-	-	-	O	-	(22; 20; 36; 48; 7)
Cyprinidae	*Abramis brama*	N	least concern	-	-	-	O	O	-	(20; 22; 36; 7; 48)
	Acanthobrama centisquama	N	critically endangered	-	-	-	-	-	O	(20; 36; 7)
	Acanthobrama marmid	N	least concern	-	O	-	-	-	O	(20; 32; 36; 7; 62)
	Acanthobrama microlepis	N	least concern	-	-	-	O	-	-	(34; 20; 36; 7; 6)
	Acanthobrama orontis	N, E	-	-	-	-	-	-	O	(18; 32)
	Acanthobrama thisbeae	N, E	-	-	-	-	-	-	O	(18; 7)
	Alburnoides bipunctatus	N	vulnerable	-	O	O	O	O	O	(22; 20; 3; 7; 1; 54; 30; 36)
	Alburnoides diclensis	-	-	-	O	-	-	-	-	(27)
	Alburnoides eichwaldii	N	least concern	common	-	-	O	-	-	(20; 36; 7; 6)
	Alburnoides emineae	N, E	-	-	O	-	-	-	-	(56)
	Alburnoides fasciatus	N	least concern	decreasing	O	O	O	-	-	(34; 1)
	Alburnoides recepi	N, E	-	-	O	-	-	-	-	(56)
	Alburnoides velioglui	N, E	-	-	O	-	-	-	-	(56)
	Alburnus adanensis	N, E	-	-	-	-	-	-	O	(3)
	Alburnus alburnus	N	least concern	common	-	-	-	O	-	(22; 11; 20; 36; 7)
	Alburnus caeruleus	N	least concern	common	O	-	-	-	-	(22; 20; 36; 7)
	Alburnus chalcoides	N	least concern	-	-	-	O	-	-	(20; 36; 7; 6)
	Alburnus derjugini	N	least concern	decreasing	-	O	-	-	-	(34; 1)
	Alburnus filippii	N	least concern	-	-	-	O	-	-	(34; 20; 36; 7; 6)
	Alburnus heckeli	N, E	least concern	-	O	-	-	-	-	(22; 20; 36; 7)
	Alburnus hohenackeri	N	least concern	-	-	-	O	-	-	(20; 36; 7)
	Alburnus mossulensis	N	-	-	O	-	-	-	-	(22; 20; 36; 7)
	Alburnus orontis	N	vulnerable	decreasing	-	-	-	-	O	(20; 36; 43; 7)

Appendix A.—Continued.

Family	Species	Native status	IUCN category	Abundance category	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes	Source
	Alburnus selcuklui	N, E	-	-	O	-	-	-	-	(13)
	Alburnus sellal	N	least concern	common	O	-	-	-	O	(22; 20; 36; 7)
	Arabibarbus grypus	N	vulnerable	decreasing	O	-	-	-	-	(62; 27)
	Barbus cyclolepis	N	least concern	common	-	-	-	O	-	(20; 30; 11)
	Barbus lacerta	N	least concern	decreasing	O	-	O	-	O	(22; 20; 37; 36; 7)
	Barbus lorteti	N, E	data deficient	-	-	-	-	-	O	(20; 36; 7)
	Barbus tauricus	N	vulnerable	-	-	O	-	-	-	(60; 20)
	Barilius mesopotamicus	N	least concern	decreasing	O	-	-	-	-	(20; 36; 7; 27)
	Blicca bjoerkna	N	least concern	-	-	-	O	O	-	(20; 22; 36; 7)
	Capoeta angorae	N, E	data deficient	decreasing	-	-	-	-	O	(59)
	Capoeta banarescui	N, E	least concern	decreasing	-	O	-	-	-	(51; 20; 1; 7)
	Capoeta barroisi	N	endangered	decreasing	O	-	-	-	O	(22; 20; 36; 7; 37; 43)
	Capoeta capoeta	N	least concern	common	-	-	O	-	-	(20; 22; 37; 36; 7)
	Capoeta damascina	N	least concern	decreasing	O	-	-	-	O	(20; 3; 36; 43; 7)
	Capoeta ekmekciae	N, E	near threatened	decreasing	-	O	-	-	-	(50; 20; 1; 36; 7)
	Capoeta sieboldii	N	least concern	decreasing	-	O	-	-	-	(20; 36; 1; 7)
	Capoeta tinca	N	least concern	decreasing	-	O	-	-	-	(34; 20; 7)
	Capoeta trutta	N	least concern	common	O	-	-	-	-	(22; 20; 37; 36; 7)
	Capoeta umbla	N	least concern	common	O	-	-	-	-	(36; 7; 62)
	Carasobarbus chantrei	N	near threatened	decreasing	-	-	-	-	O	(20; 36; 7)
	Carasobarbus kosswigi	N	vulnerable	rare	O	-	-	-	-	(20; 7;
	Carasobarbus luteus	N	least concern	common	O	-	-	-	O	(22; 20; 36; 7; 43)
	Carassius auratus	I	least concern	-	O	-	-	O	O	(20; 24; 62; 23; 41)
	Carassius carassius	I	least concern	-	-	-	-	O	O	(23; 20; 24)
	Carassius gibelio	I	-	-	O	-	O	O	O	(62; 7; 36; 6; 44; 23; 48; 42)
	Chondrostoma colchicum	N	least concern	decreasing	-	O	-	-	-	(34; 1)
	Chondrostoma cyri	N	least concern	decreasing	-	-	O	-	-	(20; 36; 7; 6)
	Chondrostoma kinzelbachi	N	endangered	decreasing	-	-	-	-	O	(20; 36; 41; 7;
	Chondrostoma regium	N	least concern	decreasing	O	-	-	-	-	(22; 20; 36; 7)
	Chondrostoma vardarense	N	near threatened	decreasing	-	-	-	O	-	(20; 30; 22; 36; 7)
	Crossocheilus caudomaculatus	N, E	extirpated	extirpated	-	-	-	-	O	(20; 7)
	Ctenopharyngodon idella	I	-	extirpated	O	-	-	O	-	(22; 20; 36; 7)
	Cyprinion kais	N	least concern	extirpated	O	-	-	-	-	(20; 36; 7)
	Cyprinion macrostomum	N	least concern	decreasing	O	-	-	-	O	(22; 20; 37; 36; 7; 59)
	Cyprinus carpio	N	vulnerable	-	O	O	O	O	-	(3; 62; 36; 1; 6; 20; 22; 36; 48; 7)

Appendix A.—Continued.

Family	Species	Native status	IUCN category	Abundance category	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes	Source
	Garra rufa	N	least concern	decreasing	O	-	-	-	O	(22; 20; 36; 7; 62; 41)
	Garra variabilis	N	least concern	decreasing	O	-	-	-	O	(22; 20; 36; 7; 62)
	Gobio bulgaricus	N	least concern	-		-	-	O	-	(30; 54)
	Gobio caucasicus	N	least concern	decreasing	-	O	-	-	-	(39; 36)
	Hemigrammocapoeta culiciphaga	N	least concern	decreasing	-	-	-	-	O	(59; 7)
	Hypophthalmichthys molitrix	I	near threatened	-	-	-	-	O	-	(11; 25; 49)
	Leucalburnus satunini	N	least concern	-	-	-	O	-	-	(20; 36; 6)
	Leucaspius delineatus	N	least concern	-	-	-	O	O	-	(20; 11; 21)
	Leuciscus aspius	N	least concern	-	-	-	O	O	-	(34; 20; 22; 30; 36; 7)
	Leuciscus vorax	N	least concern	-	O	-	-	-	O	(22; 20; 36; 7)
	Luciobarbus capito	N	vulnerable	decreasing	-	-	O	-	-	(34; 20; 22; 36; 7)
	Luciobarbus caspius	N	-	-	-	-	O	-	-	(20; 6)
	Luciobarbus escherichii	N	least concern	decreasing	-	O	-	-	-	(35; 47; 36; 7)
	Luciobarbus esocinus	N	vulnerable	decreasing	O	-	-	-	-	(22; 20; 36; 7; 62)
	Luciobarbus kersin	N	data deficient	-	O	-	-	-	O	(20; 7)
	Luciobarbus kosswigi	N	-	-	O	-	-	-	-	(22; 20; 36; 7)
	Luciobarbus mursa	N	least concern	decreasing	-	-	O	-	-	(34; 20; 22; 36; 7; 6)
	Luciobarbus mystaceus	N	-	-	O	-	-	-	-	(20; 36; 7; 62)
	Luciobarbus pectoralis	N	least concern	common	-	-	-	-	O	(20; 41; 36; 7)
	Luciobarbus subquincunciatus	N	critically endangered	decreasing	O	-	-	-	-	(22; 62; 7)
	Luciobarbus xanthopterus	N	vulnerable	decreasing	O	-	-	-	O	(22; 20; 37; 36; 7; 10)
	Petroleuciscus borysthenicus	N	least concern	-	-	-	-	O	-	(11; 30; 20)
	Petroleuciscus kurui	N, E	data deficient	-	O	-	-	-	-	(22; 20; 36; 7)
	Phoxinus colchicus	N	least concern	-	-	O	-	-	-	(30; 1)
	Phoxinus phoxinus	N	least concern	-	-	-	-	O	-	(11; 20; 36; 7)
	Pseudophoxinus firati	N, E	endangered	decreasing	O	-	-	-	-	(4)
	Pseudophoxinus kervillei	N	-	-	-	-	-	-	O	(22; 20; 33; 36; 7)
	Pseudophoxinus turani	N	-	-	-	-	-	-	O	(33)
	Pseudophoxinus zeregi	N	least concern	decreasing	-	-	-	-	O	(22; 36; 7)
	Pseudorasbora parva	I	least concern	-	-	-	O	O	-	(20; 22; 36; 7; 6; 12)
	Rhodeus amarus	N	least concern	-	-	-	-	O	-	(20; 30; 22; 36; 7)
	Romanogobio macropterus	N	least concern	decreasing	-	-	O	-	-	(39; 6)
	Rutilus kutum	N	extirpated	extirpated	-	-	O	-	-	(20)
	Rutilus rutilus	N	least concern	extirpated	-	-	-	O	-	(30; 48)
	Scardinius erythrophthalmus	N	least concern	extirpated	-	-	-	O	-	(30; 48)

Appendix A.—Continued.

Family	Species	Native status	IUCN category	Abundance category	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes	Source
	Squalius berak	N	least concern	decreasing	O	-	-	-	-	(55)
	Squalius cephalus	N	least concern	-	O	O	O	-	-	(34; 20; 3; 36; 62)
	Squalius kottelati	N	near threatened	decreasing	O	-	-	-	O	(52; 7)
	Squalius lepidus	N	least concern	-	O	-	-	-	O	(22; 20; 36; 7)
	Squalius orientalis	N	-	-	O	O	O	-	-	(34; 1; 22; 6)
	Squalius orpheus	N	least concern	-	-	-	-	O	-	(29; 11)
	Squalius spurius	N	data deficient	-	-	-	-	-	O	(20; 36; 7)
	Squalius turcicus	N, E	least concern	-	-	-	O	-	-	(6)
	Tinca tinca	N	least concern	-	-	O	-	O	-	(22; 30; 11; 20; 36; 7)
	Vimba melanops	N	data deficient	-	-	-	-	O	-	(11; 30; 20; 36; 7)
	Vimba vimba	N	least concern	-	-	O	-	O	-	(22; 30; 20; 36; 48; 7)
Cobitidae	*Cobitis elazigensis*	N	least concern	common	O	-	-	-	-	(20; 36; 7; 62)
	Cobitis kellei	N, E	critically endangered	-	O	-	-	-	-	(22; 20; 36; 7)
	Cobitis levantina	N	endangered	decreasing	-	-	-	-	O	(20; 41; 36; 7
	Cobitis puncticulata	N	endangered	-	-	-	-	O	-	(30; 19)
	Cobitis strumicae	N	least concern	-	-	-	-	O	-	(14; 20; 22; 36; 7)
	Sabanejewia aurata	N	least concern	decreasing	O	-	O	-	-	(34; 6)
	Sabanejewia balcanica	N	least concern	-	-	-	-	O	-	(20; 30; 11; 7)
	Sabanejewia caspia	N	-	-	-	-	O	-	-	(20; 6)
Nemacheilidae	*Oxynoemacheilus angorae*	N	least concern	decreasing	O	O	-	-	-	(20; 36; 7; 62; 34)
	Oxynoemacheilus araxensis	N	data deficient	-	O	-	O	-	-	(20; 36; 7; 38; 6)
	Oxynoemacheilus argyrogramma	N	least concern	decreasing	O	-	-	-	O	(38; 20; 36; 7; 41)
	Oxynoemacheilus banarescui	N, E	near threatened	decreasing	-	-	-	-	O	(59)
	Oxynoemacheilus bergianus	N	least concern	decreasing	O	-	-	-	-	(27)
	Oxynoemacheilus brandtii	N	least concern	decreasing	-	-	O	-	-	(20; 36; 7; 6)
	Oxynoemacheilus ceyhanensis	N, E	data deficient	-	-	-	-	-	O	(3)
	Oxynoemacheilus chomanicus	-	-	-	O	-	-	-	-	(27)
	Oxynoemacheilus cyri	N, E	least concern	-	-	-	O	-	-	(20; 36; 7; 6)
	Oxynoemacheilus erdali	N, E	-	-	O	-	-	-	-	(15)
	Oxynoemacheilus frenatus	N	least concern	common	O	-	-	-	-	(20; 27)
	Oxynoemacheilus hamwii	N	endangered	decreasing	-	-	-	-	O	(3; 46; 36)
	Oxynoemacheilus insignis	N	near threatened	decreasing	O	-	-	-	-	(20; 36; 7; 62)
	Oxynoemacheilus kaynaki	N, E	least concern	-	O	-	-	-	-	(16)
	Oxynoemacheilus kurdistanicus	-	-	-	O	-	-	-	-	(27)

Appendix A.—Continued.

Family	Species	Native status	IUCN category	Abundance category	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes	Source
	Oxynoemacheilus namiri	N, E	least concern	decreasing	-	-	-	-	O	(3; 7)
	Oxynoemacheilus panthera	N	endangered	decreasing	O	-	-	-	O	(20; 36; 7; 9)
	Oxynoemacheilus samanticus	N, E	least concern	decreasing	O	-	-	-	-	(36; 7)
	Oxynoemacheilus tigris	N	critically endangered	decreasing	O	-	-	-	O	(38; 20; 36; 7; 62; 43)
	Paracobitis malapterura	N	-	-	O	-	-	-	O	(20; 3; 9)
	Paracobitis zabgawraensis	N	-	-	O	-	-	-	-	(27)
	Paraschistura chrysicristinae	N	critically endangered	-	O	-	-	-	-	(20; 28)
	Turcinoemacheilus kosswigi	N, E	least concern	decreasing	O	-	-	-	-	(5; 20; 36; 7)
	Turcinoemacheilus minimus	N	-	-	O	-	-	-	-	(17)
Bagridae	*Mystus pelusius*	N	least concern	-	O	-	-	-	-	(22; 20; 36; 7; 62)
Siluridae	*Silurus glanis*	N	least concern	-	O	O	O	O	-	(8; 20; 36; 1; 7; 6; 30; 48)
	Silurus triostegus	N	least concern	decreasing	O	-	-	-	-	(20; 36; 7)
Sisoridae	*Glyptothorax armeniacus*	N	-	-	O	-	-	-	-	(22; 20; 36; 7)
	Glyptothorax cous	N	-	-	O	-	-	-	-	(20; 36; 7)
	Glyptothorax kurdistanicus	N	data deficient	-	O	-	-	-	-	(22; 20; 36; 7)
	Glyptothorax steindachneri	N	-	-	O	-	-	-	-	(20; 36; 7)
Clariidae	*Clarias gariepinus*	N	least concern	-	-	-	-	-	O	(41; 36; 7)
Heteropneustidae	*Heteropneustes fossilis*	I	least concern	-	O	-	-	-	-	(58; 7)
Loricariidae	*Pterygoplichthys disjunctivus*	I	-	-	-	-	-	-	O	(61)
Salmonidae	*Stenodus leucichthys*	N	extirpated	extirpated	-	-	O	-	-	(20; 6)
	Oncorhynchus mykiss	I	-	-	O	-	-	O	-	(62; 11; 22; 20; 36; 7)
	Salmo caspius	N	-	-	-	-	O	-	-	(20; 22; 36; 7; 6)
	Salmo coruhensis	N, E	-	-	-	O	-	-	-	(52; 1)
	Salmo euphrataeus	N, E	-	-	O	-	-	-	-	(57)
	Salmo labrax	N	least concern	-	-	O	-	-	-	(20; 36; 7)
	Salmo okumusi	N, E	-	-	O	-	-	-	-	(57)
	Salmo rizeensis	N, E	-	-	-	O	-	-	-	(52; 1)
	Salmo tigridis	N, E	-	-	O	-	-	-	-	(53)
	Salmo trutta	I	least concern	-	O	O	O	-	-	(34)
	Salvelinus fontinalis	I	-	-	-	-	-	O	-	(26; 11)
Esocidae	*Esox lucius*	N	least concern	-	-	-	-	O	-	(20; 30; 36; 48; 7)
Gobiidae	*Knipowitschia caucasica*	N	least concern	-	-	-	-	O	-	(11; 20; 7)
	Ponticola constructor	N	least concern	-	-	O	O	-	-	(31; 36; 1; 7; 34)
	Ponticola cyrius	N	least concern	common	-	-	O	-	-	(20; 31; 7)
	Proterorhinus semilunaris	N	least concern	-	-	-	-	O	-	(30; 11; 7)

Appendix A.—Continued.

Family	Species	Native status	IUCN category	Abundance category	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes	Source
Mugilidae	*Liza abu*	N	least concern	common	O	-	-	-	O	(20; 36; 41)
	Mugil cephalus	N	least concern	common	-	-	-	O	-	(22; 20; 36; 48; 7)
Cichlidae	*Coptodon zillii*	I	-	-	-	-	-	-	O	(20; 41; 36)
Blenniidae	*Salaria fluviatilis*	N	least concern	common	-	-	-	-	O	(40)
Atherinidae	*Atherina boyeri*	N	least concern	-	-	-	-	-	O	(3)
Cyprinodontidae	*Aphanius fasciatus*	N	least concern	common	-	-	-	O	-	(22;30; 11; 20; 36; 7)
	Aphanius mento	N	least concern	decreasing	O	-	-	-	O	(3; 20; 41; 36; 7)
Poeciliidae	*Gambusia affinis*	I	least concern	-	O	-	-	-	O	(27; 20; 41; 36; 43)
	Gambusia holbrooki	I	least concern	-	O	-	O	O	O	(3; 27; 6; 11; 20; 36; 7; 45)
Mastacembeliade	*Mastacembelus mastacembelus*	N	least concern	common	O	-	-	-	-	(20; 3; 7; 62)
Centrarchidae	*Lepomis gibbosus*	I	least concern	-	-	-	-	O	-	(20; 36; 48; 7)
Percidae	*Perca fluviatilis*	N	least concern	-	-	-	-	O	-	(22; 30; 20; 36; 48; 7)
	Sander lucioperca	N	least concern	-	-	-	O	O	-	(6; 22; 30; 20; 36; 48; 7)
N of species	184				83	24	42	46	53	

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Appendix B.— Annotated checklist of fishes living in each transboundary river basin based on habitat guild, migratory guild, feeding guild, reproductive guild main threats and human use criteria. "O" indicates presence of fish; "-" indicates an absence of information on that category or basin.

Family	Species	Habitat guild	Migratory guild	Feeding guild	Reproductive guild	Human use	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes
Petromyzontidae	*Caspiomyzon wagneri*	lotic	anadromous	-	nonguarder	-	-	-	O	-	-
Acipenseridae	*Acipenser gueldenstaedtii*	lotic	anadromous	invertivore	nonguarder	economic	-	-	-	O	-
	Acipenser persicus	lotic	anadromous	piscivore	nonguarder	economic	-	-	O	-	-
	Acipenser stellatus	lotic	anadromous	piscivore	nonguarder	economic	-	-	-	O	-
	Acipenser sturio	lotic	anadromous	invertivore	nonguarder	economic	-	-	-	O	-
	Huso huso	lotic	anadromous	piscivore	nonguarder	economic	-	-	-	O	-
Anguillidae	*Anguilla anguilla*	len/lot	catadromous	invertivore	nonguarder	economic	-	-	-	O	O
Clupeidae	*Alosa caspia*	lotic	anadromous	invertivore	nonguarder	economic	-	-	O	-	-
	Alosa fallax	lotic	anadromous	piscivore	nonguarder	economic	-	-	-	O	-
Cyprinidae	*Abramis brama*	len/lot	anadromous	benthivore	nonguarder	economic	-	-	O	O	-
	Acanthobrama centisquama	lentic	not migrant	omnivore	nonguarder	-	-	-	-	-	O
	Acanthobrama marmid	len/lot	not migrant	-	nonguarder	economic	O	-	-	-	O
	Acanthobrama microlepis	len/lot	not migrant	omnivore	nonguarder	-	-	-	O	-	-
	Acanthobrama orontis	len/lot	-	omnivore	nonguarder	-	-	-	-	-	O
	Acanthobrama thisbeae	lotic	-	omnivore	nonguarder	-	-	-	-	-	O
	Alburnoides bipunctatus	lotic	potamodromous	omnivore	nonguarder	none	O	O	O	O	O
	Alburnoides diclensis	lotic	-	omnivore	nonguarder	-	O	-	-	-	-
	Alburnoides eichwaldii	len/lot	not migrant	invertivore	nonguarder	none	-	-	O	-	-
	Alburnoides emineae	lotic	-	omnivore	nonguarder	-	O	-	-	-	-
	Alburnoides fasciatus	lotic	not migrant	omnivore	nonguarder	economic	O	O	O	-	-
	Alburnoides recepi	lotic	-	omnivore	nonguarder	-	O	-	-	-	-
	Alburnoides velioglui	lotic	-	omnivore	nonguarder	-	O	-	-	-	-
	Alburnus adanensis	lotic	not migrant	omnivore	nonguarder	economic	-	-	-	-	O
	Alburnus alburnus	len/lot	potamodromous	invertivore	nonguarder	economic	-	-	-	O	-
	Alburnus caeruleus	lotic	not migrant	omnivore	nonguarder	economic	O	-	-	-	-
	Alburnus chalcoides	len/lot	potamodromous	invertivore	nonguarder	economic	-	-	O	-	-
	Alburnus derjugini	lotic	not migrant	omnivore	nonguarder	economic	-	O	-	-	-
	Alburnus filippii	len/lot	not migrant	omnivore	nonguarder	economic	-	-	O	-	-
	Alburnus heckeli	len/lot	not migrant	omnivore	nonguarder	economic	O	-	-	-	-
	Alburnus hohenackeri	len/lot	not migrant	omnivore	nonguarder	economic	-	-	O	-	-
	Alburnus mossulensis	lotic	not migrant	omnivore	nonguarder	economic	O	-	-	-	-
	Alburnus orontis	len/lot	not migrant	omnivore	nonguarder	economic	-	-	-	-	O
	Alburnus selcuklui	lotic	-	-	nonguarder	economic	O	-	-	-	-
	Alburnus sellal	len/lot	not migrant	omnivore	nonguarder	economic	O	-	-	-	O

Appendix B.—Continued.

Family	Species	Habitat guild	Migratory guild	Feeding guild	Reproductive guild	Human use	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes
	Arabibarbus grypus	len/lot	potamodromous	omnivore	nonguarder	economic	O	-	-	-	-
	Barbus cyclolepis	lotic	not migrant	benthivore	nonguarder	-	-	-	-	O	-
	Barbus lacerta	len/lot	not migrant	benthivore	nonguarder	-	O	-	O	-	O
	Barbus lorteti	lotic	not migrant	benthivore	nonguarder	-	-	-	-	-	O
	Barbus tauricus	lotic	not migrant	benthivore	nonguarder	none	-	O	-	-	-
	Barilius mesopotamicus	lotic	not migrant	-	nonguarder	-	O	-	-	-	-
	Blicca bjoerkna	len/lot	not migrant	benthivore	nonguarder	economic	-	-	O	O	-
	Capoeta angorae	len/lot	potamodromous	planktivore	nonguarder	economic	-	-	-	-	O
	Capoeta banarescui	len/lot	potamodromous	planktivore	nonguarder	economic	-	O	-	-	-
	Capoeta barroisi	len/lot	potamodromous	planktivore	nonguarder	economic	O	-	-	-	O
	Capoeta capoeta	len/lot	potamodromous	planktivore	nonguarder	economic	-	-	O	-	-
	Capoeta damascina	len/lot	not migrant	planktivore	nonguarder	sportfish	O	-	-	-	O
	Capoeta ekmekciae	lotic	potamodromous	planktivore	nonguarder	economic	-	O	-	-	-
	Capoeta sieboldii	len/lot	potamodromous	planktivore	nonguarder	economic	-	O	-	-	-
	Capoeta tinca	len/lot	not migrant	planktivore	nonguarder	economic	-	O	-	-	-
	Capoeta trutta	len/lot	not migrant	planktivore	nonguarder	economic	O	-	-	-	-
	Capoeta umbla	len/lot	not migrant	planktivore	nonguarder	economic	O	-	-	-	-
	Carasobarbus chantrei	len/lot	not migrant	-	-	economic	-	-	-	-	O
	Carasobarbus kosswigi	lotic	not migrant	omnivore	-	-	O	-	-	-	-
	Carasobarbus luteus	len/lot	not migrant	omnivore	-	economic	O	-	-	-	O
	Carassius auratus	len/lot	not migrant	omnivore	nonguarder	economic	O	-	-	O	O
	Carassius carassius	len/lot	not migrant	omnivore	nonguarder	economic	-	-	-	O	O
	Carassius gibelio	len/lot	not migrant	omnivore	nonguarder	economic	O	-	O	O	O
	Chondrostoma colchicum	lotic	not migrant	planktivore	nonguarder	-	-	O	-	-	-
	Chondrostoma cyri	lotic	not migrant	planktivore	nonguarder	economic	-	-	O	-	-
	Chondrostoma kinzelbachi	len/lot	potamodromous	planktivore	nonguarder	economic	-	-	-	-	O
	Chondrostoma regium	len/lot	potamodromous	planktivore	nonguarder	economic	O	-	-	-	-
	Chondrostoma vardarense	lotic	not migrant	planktivore	nonguarder	sportfish	-	-	-	O	-
	Crossocheilus caudomaculatus	len/lot	-	-	-	-	-	-	-	-	O
	Ctenopharyngodon idella	len/lot	potamodromous	herbivore	nonguarder	economic	O	-	-	O	-
	Cyprinion kais	len/lot	not migrant	planktivore	nonguarder	none	O	-	-	-	-
	Cyprinion macrostomum	len/lot	not migrant	planktivore	nonguarder	economic	O				O
	Cyprinus carpio	len/lot	not migrant	omnivore	nonguarder	economic	O	O	O	O	-
	Garra rufa	len/lot	not migrant	planktivore	nonguarder	economic	O	-	-	-	O
	Garra variabilis	len/lot	not migrant	planktivore	nonguarder	-	O	-	-	-	O

Appendix B.—Continued.

Family	Species	Habitat guild	Migratory guild	Feeding guild	Reproductive guild	Human use	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes
	Gobio bulgaricus	lotic	-	benthivore	-	none	-	-	-	O	-
	Gobio caucasicus	lotic	not migrant	benthivore	-	-	-	O	-	-	-
	Hemigrammocapoeta culiciphaga	lotic	not migrant	-	-	-	-	-	-	-	O
	Hypophthalmichthys molitrix	len/lot	potamodromous	planktivore	nonguarder	economic	-	-	-	O	-
	Leucalburnus satunini	lotic	not migrant	-	-	-	-	-	O	-	-
	Leucaspius delineatus	len/lot	potamodromous	omnivore	guarder	none	-	-	O	O	-
	Leuciscus aspius	len/lot	potamodromous	piscivore	nonguarder	economic	-	-	O	O	-
	Leuciscus vorax	len/lot	potamodromous	piscivore	nonguarder	economic	O	-	-	-	O
	Luciobarbus capito	len/lot	semi-anadromous	omnivore	nonguarder	economic	-	-	O	-	-
	Luciobarbus caspius	len/lot	-	-	nonguarder	economic	-	-	O	-	-
	Luciobarbus escherichii	len/lot	potamodromous	-	nonguarder	economic	-	O	-	-	-
	Luciobarbus esocinus	len/lot	potamodromous	omnivore	nonguarder	economic	O	-	-	-	-
	Luciobarbus kersin	lotic	not migrant	omnivore	nonguarder	economic	O	-	-	-	O
	Luciobarbus kosswigi	lotic	-	-	nonguarder	economic	O	-	-	-	-
	Luciobarbus mursa	len/lot	potamodromous	omnivore	nonguarder	economic	-	-	O	-	-
	Luciobarbus mystaceus	len/lot	-	-	nonguarder	economic	O	-	-	-	-
	Luciobarbus pectoralis	lotic	not migrant	-	nonguarder	economic	-	-	-	-	O
	Luciobarbus subquincunciatus	len/lot	not migrant	omnivore	nonguarder	economic	O	-	-	-	-
	Luciobarbus xanthopterus	len/lot	potamodromous	omnivore	nonguarder	economic	O	-	-	-	O
	Petroleuciscus borysthenicus	len/lot	not migrant	omnivore	nonguarder	-	-	-	-	O	-
	Petroleuciscus kurui	lotic	not migrant	-	nonguarder	-	O	-	-	-	-
	Phoxinus colchicus	lotic	not migrant	omnivore	nonguarder	none	-	O	-	-	-
	Phoxinus phoxinus	len/lot	not migrant	omnivore	nonguarder	none	-	-	-	O	-
	Pseudophoxinus firati	lotic	not migrant	-	nonguarder	-	O	-	-	-	-
	Pseudophoxinus kervillei	lotic	not migrant	omnivore	nonguarder	-	-	-	-	-	O
	Pseudophoxinus turani	lotic	not migrant	-	nonguarder	-	-	-	-	-	O
	Pseudophoxinus zeregi	lotic	not migrant	-	nonguarder	-	-	-	-	-	O
	Pseudorasbora parva	len/lot	-	omnivore	nonguarder	-	-	-	O	O	-
	Rhodeus amarus	len/lot	not migrant	omnivore	nonguarder	none	-	-	-	O	-
	Romanogobio macropterus	lotic	not migrant	-	-	-	-	-	O	-	-
	Rutilus kutum	len/lot	-	-	-	-	-	-	O	-	-
	Rutilus rutilus	len/lot	potamodromous	omnivore	nonguarder	economic	-	-	-	O	-
	Scardinius erythrophthalmus	len/lot	potamodromous	omnivore	nonguarder	economic	-	-	-	O	-
	Squalius berak	lotic	not migrant	-	nonguarder	economic	O	-	-	-	-
	Squalius cephalus	len/lot	potamodromous	omnivore	nonguarder	economic	O	O	O	-	-

Appendix B.—Continued.

Family	Species	Habitat guild	Migratory guild	Feeding guild	Reproductive guild	Human use	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes
	Squalius kottelati	len/lot	not migrant	-	nonguarder	economic	O	-	-	-	O
	Squalius lepidus	len/lot	not migrant	-	nonguarder	economic	O	-	-	-	O
	Squalius orientalis	lotic	not migrant	-	nonguarder	economic	O	O	O	-	-
	Squalius orpheus	lotic	-	omnivore	nonguarder	-	-	-	-	O	-
	Squalius spurius	len/lot	-	-	nonguarder	-	-	-	-	-	O
	Squalius turcicus	len/lot	not migrant	-	nonguarder	economic	-	-	O	-	-
	Tinca tinca	len/lot	not migrant	omnivore	nonguarder	economic	-	O	-	O	-
	Vimba melanops	len/lot	-	omnivore	nonguarder	sportfish	-	-	-	O	-
	Vimba vimba	len/lot	semi-anadromous	invertivore	nonguarder	economic	-	O	-	O	-
Cobitidae	*Cobitis elazigensis*	len/lot	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Cobitis kellei	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Cobitis levantina	lotic	not migrant	benthivore	nonguarder	none	-	-	-	-	O
	Cobitis puncticulata	lotic	not migrant	benthivore	nonguarder	none	-	-	-	O	-
	Cobitis strumicae	len/lot	not migrant	benthivore	nonguarder	none	-	-	-	O	-
	Sabanejewia aurata	lotic	not migrant	benthivore	nonguarder	-	O	-	O	-	-
	Sabanejewia balcanica	lotic	not migrant	benthivore	nonguarder	-	-	-	-	O	-
	Sabanejewia caspia	lotic	not migrant	benthivore	nonguarder	-	-	-	O	-	-
Nemacheilidae	*Oxynoemacheilus angorae*	len/lot	not migrant	benthivore	nonguarder	none	O	O	-	-	-
	Oxynoemacheilus araxensis	lotic	not migrant	benthivore	nonguarder	none	O	-	O	-	-
	Oxynoemacheilus argyrogramma	len/lot	not migrant	benthivore	nonguarder	none	O	-	-	-	O
	Oxynoemacheilus banarescui	lotic	not migrant	benthivore	nonguarder	none	-	-	-	-	O
	Oxynoemacheilus bergianus	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Oxynoemacheilus brandtii	lotic	not migrant	benthivore	nonguarder	none	-	-	O	-	-
	Oxynoemacheilus ceyhanensis	lotic	not migrant	benthivore	nonguarder	none	-	-	-	-	O
	Oxynoemacheilus chomanicus	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Oxynoemacheilus cyri	lotic	not migrant	benthivore	nonguarder	none	-	-	O	-	-
	Oxynoemacheilus erdali	lotic	not migrant	benthivore	nonguarder	none	O				
	Oxynoemacheilus frenatus	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Oxynoemacheilus hamwii	lotic	not migrant	benthivore	nonguarder	none	-	-	-	-	O
	Oxynoemacheilus insignis	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Oxynoemacheilus kaynaki	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Oxynoemacheilus kurdistanicus	lotic	-	benthivore	nonguarder	none	O	-	-	-	-
	Oxynoemacheilus namiri	lotic	not migrant	benthivore	nonguarder	none	-	-	-	-	O
	Oxynoemacheilus panthera	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	O
	Oxynoemacheilus samanticus	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-

Appendix B.—Continued.

Family	Species	Habitat guild	Migratory guild	Feeding guild	Reproductive guild	Human use	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes
	Oxynoemacheilus tigris	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	O
	Paracobitis malapterura	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	O
	Paracobitis zabgawraensis	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Paraschistura chrysicristinae	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Turcinoemacheilus kosswigi	lotic	not migrant	benthivore	nonguarder	none	O	-	-	-	-
	Turcinoemacheilus minimus	lotic	-	benthivore	nonguarder	none	O	-	-	-	-
Bagridae	*Mystus pelusius*	len/lot	not migrant	invertivore	-	none	O	-	-	-	-
Siluridae	*Silurus glanis*	len/lot	not migrant	invertivore	guarder	economic	O	O	O	O	-
	Silurus triostegus	len/lot	not migrant	-	-	economic	O	-	-	-	-
Sisoridae	*Glyptothorax armeniacus*	lotic	-	-	-	-	O	-	-	-	-
	Glyptothorax cous	lotic	-	-	-	-	O	-	-	-	-
	Glyptothorax kurdistanicus	lotic	not migrant	invertivore	-	none	O	-	-	-	-
	Glyptothorax steindachneri	lotic	-	-	-	-	O	-	-	-	-
Clariidae	*Clarias gariepinus*	len/lot	not migrant	benthivore	nonguarder	economic	-	-	-	-	O
Heteropneustidae	*Heteropneustes fossilis*	len/lot	-	omnivore	guarder	economic	O	-	-	-	-
Loricariidae	*Pterygoplichthys disjunctivus*	len/lot	-	omnivore	-	-	-	-	-	-	O
Salmonidae	*Stenodus leucichthys*	len/lot	anadromous	piscivore	nonguarder	economic	-	-	O	-	-
	Oncorhynchus mykiss	len/lot	anadromous	invertivore	nonguarder	economic	O	-	-	O	-
	Salmo caspius	len/lot	anadromous	-	nonguarder	economic	-	-	O	-	-
	Salmo coruhensis	lotic	potamodromous	-	nonguarder	economic	-	O	-	-	-
	Salmo euphrataeus	lotic	-	-	nonguarder	economic	O	-	-	-	-
	Salmo labrax	len/lot	anadromous	invertivore	nonguarder	economic	-	O	-	-	-
	Salmo okumusi	lotic	-	-	nonguarder	economic	O	-	-	-	-
	Salmo rizeensis	lotic	not migrant	-	nonguarder	economic	-	O	-	-	-
	Salmo tigridis	lotic	-	-	nonguarder	economic	O	-	-	-	-
	Salmo trutta	len/lot	anadromous	invertivore	nonguarder	economic	O	O	O	-	-
	Salvelinus fontinalis	len/lot	anadromous	invertivore	nonguarder	economic	-	-	-	O	-
Esocidae	*Esox lucius*	len/lot	not migrant	piscivore	nonguarder	economic	-	-	-	O	-
Gobiidae	*Knipowitschia caucasica*	len/lot	amphidromous	invertivore	guarder	economic	-	-	-	O	-
	Ponticola constructor	lotic	not migrant	-	guarder	-	-	O	O	-	-
	Ponticola cyrius	lotic	-	-	guarder	economic	-	-	O	-	-
	Proterorhinus semilunaris	len/lot	-	benthivore	guarder	-	-	-	-	O	-
Mugilidae	*Liza abu*	len/lot	potamodromous	omnivore	nonguarder	economic	O	-	-	-	O
	Mugil cephalus	len/lot	catadromous	omnivore	nonguarder	economic	-	-	-	O	-
Cichlidae	*Coptodon zillii*	len/lot	potamodromous	omnivore	guarder	-	-	-	-	-	O

Appendix B.—Continued.

Family	Species	Habitat guild	Migratory guild	Feeding guild	Reproductive guild	Human use	Euphrates-Tigris	Coruh	Kura-Araks	Maritsa	Orontes
Blenniidae	*Salaria fluviatilis*	len/lot	not migrant	invertivore	guarder	-	-	-	-	-	O
Atherinidae	*Atherina boyeri*	len/lot	amphidromous	invertivore	nonguarder	economic	-	-	-	-	O
Cyprinodontidae	*Aphanius fasciatus*	len/lot	not migrant	omnivore	nonguarder	none	-	-	-	O	-
	Aphanius mento	len/lot	not migrant	omnivore	nonguarder	-	O	-	-	-	O
Poeciliidae	*Gambusia affinis*	len/lot	not migrant	invertivore	livebearer	-	O	-	-	-	O
	Gambusia holbrooki	len/lot	not migrant	invertivore	livebearer	-	O	-	O	O	O
Mastacembeliade	*Mastacembelus mastacembelus*	len/lot	not migrant	-	-	economic	O	-	-	-	-
Centrarchidae	*Lepomis gibbosus*	len/lot	potamodromous	invertivore	guarder	none	-	-	-	O	-
Percidae	*Perca fluviatilis*	len/lot	anadromous	invertivore	nonguarder	economic	-	-	-	O	-
	Sander lucioperca	len/lot	potamodromous	piscivore	guarder	economic	-	-	O	O	-
N of species	Total= 184						83	24	42	46	53