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Length–weight relationships and condition factors of several endemic and native species of the genera *Alburnoides*, *Alburnus* and *Squalius*

by

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Abstract

The present study examined for the first time both length–to–weight relationships and condition factors of ten species belonging to three endemically rich genera: *Alburnoides* ($n_{specimens}$ = 361), *Alburnus* ($n_{specimens}$ = 36), and *Squalius* ($n_{specimens}$ = 205). Fish were sampled in several lakes and streams using electroshocking. Fish samples ranged from 3.60 cm to 27.40 cm in total length and from 38.00 g to 250.02 g in total weight. The coefficient of determination for all populations was $R^2 \geq 0.95$, while the *b* value varied between 3.0158 and 3.4957 for all sampling locations. The latter ranged from 3.0158 to 3.4957 for *Alburnoides*, from 3.0357 to 3.2327 for *Alburnus*, and from 3.0743 to 3.2143 for *Squalius* populations. Fulton's condition factor was calculated for all populations. The research presented here focused on data-deficient endemic and native species of Anatolian freshwater resources, and the results obtained may prove useful in biodiversity management strategies.

Key words: Anatolia, freshwater fish, biodiversity, regression constants, slope value

1. Introduction

Freshwaters play a critical role in both water cycling and nutrient density for biological life (Wetzel 2001), and their biodiversity is also greater than that of terrestrial and marine ecosystems per surface (Dudgeon et al. 2006; Balian et al. 2008). Their role is very important for biodiversity due to their diverse habitats (Smith et al. 2014). One of the most important areas in the world in this regard is Anatolia, which has three hotspots and is also the native area of approximately 400 freshwater fish species (Çiçek et al. 2020). Anatolia's freshwater resources are characterized by a high diversity of habitat conditions (Kaya 2019; Freyhof et al. 2022). Several new species identified in Anatolia in recent years are indicative of this high diversity (e.g. Turan et al. 2017; 2018; 2022; Bayçelebi et al. 2021; Kaya et al. 2024a; 2024b).

Fish population studies are an essential element contributing to understanding the health of fish populations, which is also needed for sustainable management strategies (Froese et al. 2011). Parameters of length–weight relationships (LWRs) and Fulton's Condition Factor (CF) play a key role in fish and fisheries biological studies (Oliveira et al. 2014). For this reason, different environmental parameters of water resources can result in differences in LWRs even for the same species. This is also beneficial in determining whether somatic growth is allometric or isometric and in comparing growth patterns between different species across various regions of a country (Froese 2006). Differences in *b* values are due to many factors, such as season, geographic region, habitat, sex, and species (Froese, Pauly 2023). As a rule, when the constant *b* is equal to 3, specimens have isometric growth (Froese 2006). Moreover, both biotic and abiotic factors can be assessed through the CF, which gives some indication of them. This index can be used to assess the overall health of the habitat in which the fish live (Anene 2005).

Alburnoides are widely distributed in almost all rivers of Türkiye, except the Mediterranean Basin (Kuru 2004; Geldiay, Balık 2007; Turan et al. 2014; 2017a; 2020; Çiçek et al. 2020; Kaya 2020a). *Alburnoides bipunctatus* is one of the best-known species of the genus, which has long been considered to be very widespread in Europe, as well as in North and West Asia (Bogutskaya, Coad 2009). However, some recent taxonomic studies have shown that *Alburnoides* is more diverse than expected, and it has even been claimed that the genus may be represented by more than one species in the same river catchment (Bogutskaya, Coad 2009; Turan et al. 2014). According to recent research, there are 14 species of *Alburnoides* in Turkish freshwaters (Turan et al. 2016; 2017a; 2020; Kaya 2020a; 2020b).

Alburnus, with 22 species, is one of the most diverse genera in Türkiye. Twelve of these species are endemic to Türkiye. Of the endemic species of Türkiye, *Alburnus demiri* and *A. kurui* were examined in this study (Bektaş et al. 2019; Kaya 2020a).

The genus *Squalius* is considered a medium-sized midwater fish widely distributed in Europe and Western Asia. The genus *Squalius* is one of the important genera of Türkiye's freshwater resources, represented by more than 20 species (Özuluğ, Freyhof 2011; Turan et al. 2009; 2013; 2017b; Bayçelebi 2019; Bayçelebi et al. 2022). However, no detailed information is yet available, except for a few studies on their distribution and the ecology of members of the genus. Previous studies have mainly focused on the species *S. fellowesii* in terms of some biological parameters, such as growth and life history traits (Şaşı, Balık 2003; Balık et al. 2004; Şaşı 2004; Koç et al. 2007; Gianetto et al. 2012; Özdemir et al. 2015; Top et al. 2016). LWRs for the above-mentioned species are not yet available in FishBase (Froese, Pauly 2023).

In recent years, many studies have been conducted on the relationship between length and weight in both marine and freshwater fishes of Anatolia. However, according to the current knowledge provided by the available literature, data on most of the endemic fishes of the area are still missing. Although there are quite important genera that have many endemic species, biological data are needed to follow *Alburnus, Alburnoides,* and *Squalius* in their native habitats. To this end, some biological parameters of ten freshwater fish species, including eight endemics, were investigated to acquire comprehensive knowledge of their LWRs, growth types, and CF. This study provides a useful reference on some biological parameters of these species from Anatolian inland waters. The authors expect that the data from this study will be helpful in further research on fish conservation and fisheries management strategies that specifically address endemic fish fauna.

2. Materials and methods

2.1. Study area

Fish samples were collected from eight different basins in Anatolia. The names of the localities, their coordinates and the corresponding basins are listed in Table 1. The sampling locations are presented on the map (Fig. 1). Sample collection codes are also provided in Appendix 1 (Recep Tayyip Erdogan University Zoology Collection of the Faculty of Fisheries, Rize).

Table 1

Sampling locations for *Alburnus*, *Alburnoides* and *Squalius* populations from Anatolia.

Location	Dec Lat	Dec Long	Species
Tahtalı catchment	38.199	27.171	*Alburnus demiri**
Balaban Stream, Tahtalı catchment	38.214	27.102	
Yüksekova Wetland, Upper Tigris catchment	37.431	44.390	*Alburnus kurui**
Yüksekova Wetland, Upper Tigris	37.435	44.366	
Beyazsu Stream, Euphrates River	37.173	41.270	*Alburnoides emineae*
Devrez Stream, Kızılırmak River	40.984	34.099	*Alburnoides freyhofi**
Delice Stream, Kızılırmak River	41.453	34.888	
Devrez Stream, Kızılırmak River	40.904	33.637	
Delice Stream, Kızılırmak River	39.622	34.489	
Kırmir Stream, Sakarya River	40.237	32.261	*Alburnoides kosswigi**
Porsuk Stream, Sakarya River	39.349	30.038	
İlhanlı Stream, Sakarya River	40.094	32.248	
Tersakan Stream, Yeşilırmak River	40.989	35.718	*Alburnoides kurui**
Tifi Stream, Yeşilırmak River	40.799	36.731	
Yeşilırmak River	40.762	36.486	
Filyos River Drainage Basin	41.341	32.078	*Alburnoides turani**
Bolu Stream	41.034	31.877	
Çakıtsuyu Stream, Seyhan River	37.096	35.126	*Squalius adanaensis**
Üçürgesuyu Stream, Seyhan River	37.261	35.067	
Üçürgesuyu Stream, Seyhan River	37.273	35.055	
Ölçeksuyu Stream, Kura River	41.071	42.484	*Squalius agdamicus*
Ölçeksuyu Stream, Kura River	41.126	42.854	
Açıkyazı Stream, Kura River	41.144	42.591	
Kura River	41.116	42.701	
Hanaksuyu Stream, Kura River	41.226	42.847	
Kura River	41.120	42.726	
Murat River	38.866	41.000	*Squalius semae**
Karasu Stream, Murat River	38.649	41.783	
Pülümür Stream, Euphrates River	39.140	39.639	
Kaynarca Stream, Euphrates River	38.068	41.529	
Toprakkale Stream, Euphrates River	40.242	40.995	
Sırlı Stream, Euphrates River	40.218	41.101	

*Endemic species of Anatolia

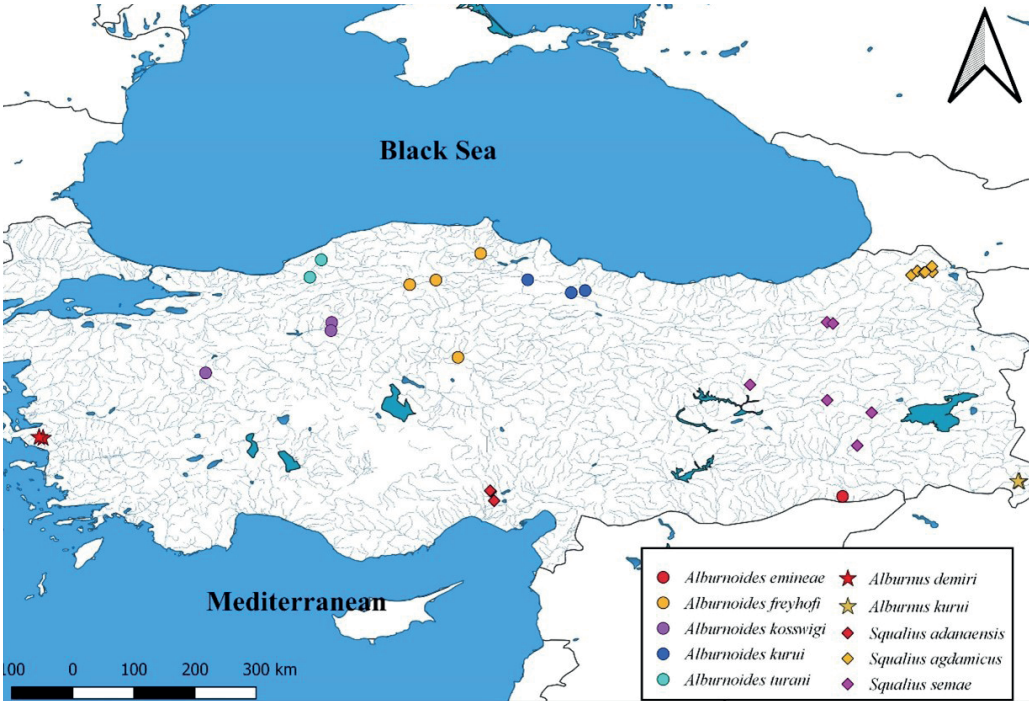

Figure 1

Distribution map of the fish populations presented in this study.

2.2. Sampling procedure and sampling period

Fish samples for the study were collected between 2004 and 2021 using Samus 1000 in lotic habitats and gill and cast nets in lentic habitats located in different river basins (Fig. 1). Ten species from the three genera (n_{total} = 602) were investigated. After the anesthesia processes, fish were fixed in 5% formaldehyde.

2.3. Laboratory process and analysis

Eschmeyer's Catalog of Fishes was the primary resource for nomenclature and taxonomy in this study (Fricke et al. 2023). Due to the lack of sexual dimorphism in specimens, the data were analyzed for female and male individuals together. Fish measurements were recorded as total length (*L*) with an accuracy of ± 0.1 cm and total weight (*W*) with an accuracy of ± 0.01 g. LWRs of the fish samples were determined using the following cube law equation: $W = aL^b$, where *W* is the total weight (g), *L* is the total length (cm), *a* is the intercept and *b* is the slope (Le Cren 1951). The coefficient of determination (r^2) was calculated (Zar 1999). The correlation coefficient significance test was applied. The standard error of constants *b* was calculated for 95% confidence intervals. Student's t-test (*ts*) was used to calculate whether parameter *b* differed significantly from the anticipated or theoretical value of 3 (i.e. $b = 3$, $p < .05$) using the equation $t_c = b - 3/se_{(b)}$ (Sokal, Rohlf 1987; Pajuelo, Lorenzo 1998). The equation $CF = 100WL^{-3}$ was used to calculate the *CF* for all fish populations (Froese 2006). MS Excel 2016 was used for statistical analysis.

3. Results

Ten different species (n_{total} = 602) endemic to Anatolia's freshwater resources were investigated in the current study. Statistical results, including length and weight distributions for the species in question, are shown in Tables 2–4.

Members of the genera *Alburnus, Alburnoides*, and *Squalius* are medium-length fish (Fig. 2). In this study, the maximum length and weight in the genus

Table 2

Length and weight distribution parameters (min., max, and mean) of the species along with standard deviations.

Species	*n*	L_{min}	L_{max}	L_{mean}	W_{min}	W_{max}	W_{mean}	SD
Alburnoides emineae	16	4.3	8.8	6.82	0.95	8.38	4.06	0.545
*Alburnoides freyhofi**	121	4.4	11.6	8.39	0.87	18.25	7.14	0.343
*Alburnoides kosswigi**	113	4.2	11.9	8.29	0.60	24.49	7.46	0.479
*Alburnoides kurui**	61	5.2	10.4	7.6	1.20	11.02	4.79	0.317
*Alburnoides turani**	50	6.7	10.1	8.34	2.87	11.16	5.80	0.301
*Alburnus demiri**	22	3.6	8.2	6.58	0.38	4.430	2.12	0.251
*Alburnus kurui**	14	5.4	8.8	7.11	1.90	7.840	5.06	0.662
*Squalius adanaensis**	68	5.7	19.7	10.02	2.17	88.58	14.29	1.515
Squalius agdamicus	50	9.2	27.4	16.32	8.47	250.02	55.25	6.604
*Squalius semae**	87	6.5	25.1	14.12	2.39	229.83	47.05	5.429

*Endemic species of Anatolia, *n* – the number of individuals, *min.* – minimum, *max* – maximum.

Table 3

Length–weight relationship parameters of the species with the coefficient of determination (R^2), a value, 95% confidence interval (*b* ± SE) of specimens measured, *t*-test results, and growth type.

Species	r^2	*a*	*b*	SE(b)	95% CL(b)	t_{test}	GT
Alburnoides emineae	0.95	0.0092	3.1089	0.013	2.86 – 3.35	$t_{cal} = 8.38 > t_{0.05,\ n=15} = 2.131$	A(+)
*Alburnoides freyhofi**	0.98	0.0104	3.0158	0.001	2.95 – 3.07	$t_{cal} = 15.80 > t_{0.05,\ n=120} = 1.962$	A(+)
*Alburnoides kosswigi**	0.96	0.0059	3.2996	0.001	3.14 – 3.45	$t_{cal} = 299.60 > t_{0.05,\ n=112} = 1.962$	A(+)
*Alburnoides kurui**	0.97	0.0077	3.1214	0.002	3.01 – 3.22	$t_{cal} = 60.70 > t_{0.05,\ n=60} = 2.000$	A(+)
*Alburnoides turani**	0.97	0.0033	3.4957	0.006	3.33 – 3.65	$t_{cal} = 82.61 > t_{0.05,\ n=49} = 2.009$	A(+)
*Alburnus demiri**	0.96	0.0061	3.0357	0.001	2.81 – 3.26	$t_{cal} = 35.70 > t_{0.05,\ n=21} = 2.080$	A(+)
*Alburnus kurui**	0.95	0.0080	3.2327	0.030	2.85 – 3.61	$t_{cal} = 7.75 > t_{0.05,\ n=13} = 2.160$	A(+)
*Squalius adanaensis**	0.98	0.0099	3.0743	0.001	2.99 – 3.15	$t_{cal} = 74.30 > t_{0.05,\ n=67} = 1.990$	A(+)
Squalius agdamicus	0.99	0.0058	3.2143	0.002	3.11 – 3.30	$t_{cal} = 107.15 > t_{0.05,\ n=49} = 2.009$	A(+)
*Squalius semae**	0.97	0.0065	3.2004	0.001	3.12 – 3.27	$t_{cal} = 200.40 > t_{0.05,\ n=86} = 1.984$	A(+)

*Endemic species of Anatolia, *n* – the number of individuals, *min.* – minimum, *max* – maximum.

Table 4

CF parameters (max, min., mean) for the species belonging to the three genera.

Species	CF_{min}	CF_{max}	CF_{mean}
Alburnoides emineae	0.856	1.181	1.005
*Alburnoides freyhofi**	0.724	1.108	0.911
*Alburnoides kosswigi**	0.734	1.298	1.007
*Alburnoides kurui**	0.837	1.266	1.006
*Alburnoides turani**	0.903	1.130	1.014
*Alburnus demiri**	0.833	1.275	1.007
*Alburnus kurui**	0.774	1.115	1.009
*Squalius adanaensis**	0.830	1.257	1.006
Squalius agdamicus	0.782	1.165	0.997
*Squalius semae**	0.652	1.257	0.963

*Endemic species of Anatolia.

Alburnoides were determined as L_{max} = 11.9 cm and W_{max} = 24.49 g for *A. kosswigi* (from the Kırmir Stream and the Sakarya River, Black Sea Basin). In the genus *Alburnus*, the maximum length and weight were measured as L_{max} = 8.8 cm and W_{max} = 7.840 g for *A. kurui* (from the Yeşilırmak River, Black Sea Basin). In the genus *Squalius*, the maximum length and weight were measured as L_{max} = 27.4 cm and W_{max} = 250.02 g for *S. agdamicus* (from the Kura River, Caspian Sea Basin; Table 2).

In the present study, Student's *t*-test was applied to calculate the growth type of the species in their locations. According to the results, positive allometric growth was observed in all species, while negative allometric/isometric growth was never observed.

According to the current study, the coefficient of determination, r^2, was highly correlated for all sampling locations and it varied from 0.95 to 0.99. The *a* constant varied between 0.0033 and 0.0104 for *A. turani* and *A. freyhofi*, respectively. The maximum *b* value was determined for *A. turani* as $b = 3.4957$, while the minimum *b* value was determined for *A. freyhofi* as $b = 3.0158$ (Table 3).

CF_{mean} values of the ten species ranged from 0.911 ± 0.005 (*Alburnoides freyhofi*) to 1.014 ± 0.007 (*Alburnoides turani*). Among the *Alburnoides* species, the highest CF_{mean} was 1.014 ± 0.007 for *A. turani*, while in the genus *Squalius* a value of 1.006 ± 0.009 was determined for *S. adanaensis*. The highest CF_{mean} in the genus *Alburnus* was found for *A. kurui* with a value of 1.009 ± 0.027 (Table 4).

Figure 2

Live appearance of some of the species investigated in the study: Left column from top: *Alburnus demiri*, *Alburnoides kosswigi*, *A. emineae*. Right column from top: *Squalius adanaensis*, *S. agdamicus*, *S. semae*.

4. Discussion

To fill the knowledge gap about freshwater fish in Anatolia, an attempt was made to examine data based on the current parameters of ten species found in lakes and streams across the country. To this end, this study updated the recent knowledge about the LWR, growth types, and *CF* of the ten fish species occurring in Anatolia, including the first biological data on eight endemic fish species. While environmental factors play an important role in the health of fish populations, stress, food resources and maturity also affect the biological parameters (Liang, Cai 2020).

In the present study, *Alburnoides* specimens (n = 361) belonging to five species were investigated. There are still no data on LWRs for *A. emineae*, *A. freyhofi*, *A. kosswigi*, *A. kurui*, and *A. turani*, four of which are known to be endemic to Anatolia, with the exception of *A. emineae* listed in FishBase (Froese, Pauly 2023). For members of the genus *Alburnus* (n = 36) included in this study, no data are available in the latest literature for either *A. demiri* or *A. kurui*. Similarly, for the genus *Squalius* (n = 205), *S. adanaensis*, *S. agdamicus* and *S. semae* were investigated for the first time in terms of their biological parameters.

Of the samples analyzed, the maximum length was observed in the *S. agdamicus* population (L_{max} = 27.4 cm). While *A. kosswigi* has the highest L_{max} = 11.9 cm among the species of the genus *Alburnoides*, *A. kurui* has the highest L_{max} = 8.8 cm among the species of the genus *Alburnus*. The maximum b value in all populations of the ten species was determined for *A. turani* and amounted to 3.4957, whereas the expected range varied from 2.5 to 3.5 for constant b (Froese 2006). Moreover, the highest CF_{mean} (1.014) was determined for *A. turani*.

Five species of the genus *Alburnoides* were investigated in the present study. None of the following species of this genus: *A. emineae, A. freyhofi, A. kosswigi, A. kurui* and *A. turani* have yet been listed with their biological parameters. While the a value varied in the genus from 0.0033 to 0.0104, the b value ranged from 3.0158 to 3.4957. The maximum CF_{mean} was 1.014 for *A. turani*, which was also the highest *CF* value among all the studied species. The CF shows the power accumulated in the body, which can also be used by the stock (Gücü et al. 2018) and is affected by various biological processes involved in reproduction (Ferrer-Maza et al. 2016).

Although several species of the genus *Alburnus* from Türkiye's inland waters have already been studied, e.g. *A. mossulensis* (now valid as *A. sellal*) (Yıldırım et al. 2003; Serdar et al. 2017), both *A. demiri* and *A. kurui* were investigated for the first time in this study for their biological parameters. Regression constants a and b of the studied fishes were a = 0.0061 and b = 3.0357 for *A. demiri* and a = 0.0080 and b = 3.2327 for *A. kurui* (both species are from the Tahtalı drainage basin). The current study determined CF_{mean} = 1.007 for *A. demiri* and CF_{mean} = 1.009 for *A. kurui*, which are very closed to each other.

Squalius fellowesii is endemic to the aquatic resources of Western Anatolia. There are some limited studies on LWRs for this species from Lake Işıklı (Balık et al. 2004), the İkizcetepeler Reservoir (Koç et al. 2007), the Muğla Province (Top et al. 2016), and a recent study from the Gediz River (Güçlü, Küçük 2021). In the above-mentioned studies, the b constant ranged from 2.597 to 3.400. To date, however, no data on LWRs, growth types, and *CF* for the species included in this study are available in the relevant literature. In the present study, the coefficient of determination for all *Squalius* populations was $R^2 \geq 0.97$ ($p < 0.05$). Parameters a and b of the studied *Squalius* species were a = 0.0099 and b = 3.0743 for *S. adanaensis* (Seyhan River), a = 0.0058 and b = 3.2143 for *S. agdamicus* (Kura River), and a = 0.00565 and b = 3.2004 for *S. semae* (Euphrates River). For all populations, the b value was greater than 3. Due to the high value of b, it is therefore assumed that the habitats of the fish fauna are in good condition.

According to this study, all populations of the ten species show positive allometric growth. This is likely due to the fact that the habitats of these species are natural food-rich areas. A good strategy should be to monitor the populations with regular research.

Among the *Alburnoides* species, the highest CF_{mean} value of 1.014 ± 0.007 was determined for *A. turani* (Filyos River basin and Bolu stream), while the lowest CF_{mean} value of 0.911 ± 0.005 was determined for *A. freyhofi* (Kızılırmak River). For the genus *Squalius*, the highest CF_{mean} value of 1.006 ± 0.009 was determined for *S. adanaensis* (Seyhan River). For the genus *Alburnus*, the highest CF_{mean} value of 1.009 ± 0.027 was determined for *Alburnus kurui* (upper Tigris drainage basin). The differences in CF_{mean} reflect the ecological characteristics of the habitats of species belonging to the genera. The condition and well-being of species within the same genus can be compared using the condition factor. In this study, the populations of *A. turani*, *S. adanaensis* and *A. kurui* from the catchments of the Filyos, Seyhan and Tigris rivers, respectively, are characterized by better condition than the populations of other fish species representing the respective genera.

5. Conclusions

The river basin systems of Anatolia have a diverse fish fauna (Freyhof et al. 2014; Çiçek et al. 2018; Kaya 2019). *Alburnus, Alburnoides* and *Squalius* stocks are important components of this richness that should be carefully protected in terms of endemism. Therefore, the main objective of the present study is to reveal the lack of biological information on the endemic species, most of which are an important part of the biological diversity in Anatolia. To this end, the presented research included ten freshwater fish species occurring with high frequency in several water reservoirs of Anatolia. A classical methodology was applied in this study, using limited data. The results may be useful in management strategies for endemic fish populations. Research on biological parameters of fish should continue and parameters across populations (size at sexual maturity, spawning time, fecundity, etc.) should be monitored. This strategy will prove beneficial to the development of fishery management systems and ecosystem conservation. Although biological parameters of fish vary from species to species, there are several factors that contribute to the fact that length and weight vary depending on the habitat and season. It is suggested to study the impact of climate change and anthropogenic pressure on the above-mentioned stocks.

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Appendix

Basin	Dec_Lat	Dec_Long	Date	Species	FFR	n
Tahtalı catchment, Aegean Sea Basin	38.199	27.171	14 July 2018	*Alburnus demiri**	4700	22
Balaban Stream, Tahtalı Drainage, Aegean Sea Basin	38.214	27.102	15 Nov. 2018		4682	
Yüksekova Wetland, Upper Tigris catchment, Persian Gulf Basin	37.431	44.390	16 May 2017	*Alburnus kurui**	4660	14
Yüksekova Wetland, Upper Tigris catchment, Persian Gulf Basin	37.435	44.366	16 May 2017		4662	
Beyazsu Stream, Euphrates River Drainage, Persian Gulf Basin	37.173	41.270	18 Dec. 2007	*Alburnoides emineae*	1073	16
Devrez Stream, Kızılırmak River, Black Sea Basin	40.984	34.099	30 Sept. 2015	*Alburnoides freyhofi**	7000	121
Delice Stream, Kızılırmak River, Black Sea Basin	41.453	34.888	29 Sept. 2015		7001	
Devrez Stream, Kızılırmak River, Black Sea Basin	40.904	33.637	30 Sept. 2015		7004	
Delice Stream, Kızılırmak River, Black Sea Basin	39.622	34.489	2 Oct. 2015		1149	
Kırmir Stream, Sakarya River, Black Sea Basin	40.237	32.261	4 Sept. 2014	*Alburnoides kosswigi**	1133	113
Porsuk Stream, Sakarya River, Black Sea Basin	39.349	30.038	17 Aug. 2014		1135	
İlhanlı Stream, Sakarya River, Black Sea Basin	40.094	32.248	15 June 2005		1060	
Tersakan Stream, Yeşilırmak River, Black Sea Basin	40.989	35.718	5 Sept. 2014	*Alburnoides kurui**	1126	61
Tifi Stream, Yeşilırmak River, Black Sea Basin	40.799	36.731	3 Sept. 2012		1104	
Yeşilırmak River, Black Sea Basin	40.762	36.486	20 Sept. 2012		1097	
Filyos River Drainage, Black Sea Basin	41.341	32.078	8 Nov. 2016	*Alburnoides turani**	7035	50
Bolu Stream, Black Sea Basin	41.034	31.877	7 Nov. 2016		7032	
Çakıtsuyu Stream, Seyhan River, Mediterranean Basin	37.096	35.126	10 June 2014	*Squalius adanaensis**	777	68
Üçürgesuyu Stream, Seyhan River, Mediterranean Basin	37.261	35.067	10 June 2014		772	
Üçürgesuyu Stream, Seyhan River, Mediterranean Basin	37.273	35.055	4 July 2007		1995	
Ölçeksuyu Stream, Kura River, Caspian Sea Basin	41.071	42.484	19 July 2012	*Squalius agdamicus*	687	50
Ölçeksuyu Stream, Kura River, Caspian Sea Basin	41.126	42.854	18 July 2004		637	
Açıkyazı Stream, Kura River, Caspian Sea Basin	41.144	42.591	17 July 2004		638	
Kura River, Caspian Sea Basin	41.116	42.701	13 July 2010		754	
Hanaksuyu Stream, Kura River, Caspian Sea Basin	41.226	42.847	5 Aug. 2007		639	
Kura River, Caspian Sea Basin	41.12	42.726	23 Sept. 2010		595	
Murat River, Persian Gulf Basin	38.866	41.000	22 Sept. 2013	*Squalius semae**	703	87
Karasu Stream, Murat River, Persian Gulf Basin	38.649	41.783	22 Sept. 2013		700	
Pülümür Stream, Euphrates River, Persian Gulf Basin	39.140	39.639	27 Sept. 2013		727	
Kaynarca Stream, Euphrates River, Persian Gulf Basin	38.068	41.529	22 Sept. 2013		722	
Toprakkale Stream, Euphrates River, Persian Gulf Basin	40.242	40.995	15 Aug. 2009		593	
Sırlı Stream, Euphrates River, Persian Gulf Basin	40.218	41.101	23 Apr. 2005		669	