

Conversions of Total, Fork and Standard Length Measurements Based on 42 Marine and Freshwater Fish Species (from Turkish Waters)

Özcan Gaygusuz¹, Çiğdem Gürsoy², Müfit Özuluğ³, Ali Serhan Tarkan^{1,*}, Hasan Acıpınar⁴, Gökçen Bilge⁵, Halit Filiz⁶

¹ İstanbul University, Faculty of Fisheries, Ordu Cad. No: 200, 34470 Laleli, İstanbul, Turkey.

² Çanakkale Onsekiz Mart University, Natural and Applied Sciences Institute, 17100, Çanakkale, Turkey.

³ İstanbul University, Faculty of Applied Science, Department of Biology, 34134, Vezneciler, İstanbul, Turkey.

⁴ İstanbul University, Natural and Applied Sciences Institute, 34850, Avcılar, İstanbul, Turkey.

⁵ Muğla University, Faculty of Fisheries, 48000, Kötekli, Muğla, Turkey.

⁶ Faculty of Fisheries, Ege University, Bornova, İzmir, Turkey.

* Corresponding Author: Tel.: +90. 212 4555700/16419; Fax: +90. 212 5140379;
E-mail: serhan@istanbul.edu.tr; serhantarkan@yahoo.com

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Abstract

Relationships between total (TL), fork (FL) and standard (SL) lengths belonging 19 families from Aegean and Marmara coast of Turkey were presented for 42 fish species. The relationships between TL, FL and SL were all linear and they were all highly significant ($P < 0.001$) with all r^2 values being > 0.90 . There were significant differences in the slope of length – length relationships between some localities and type of length conversions for the fish species.

Key Words: Standard length; Fork length, Total length, length-length relationships.

Introduction

A variety of morphological, physiological, behavioral and biochemical characteristics are used to identify and classify fishes. In practice though, it is more common to use morphometric measurements (i.e., body length, body depth, head length, eye diameter, jaw length) and meristics (i.e., fin ray, scale, teeth, gill raker, and lateral line pore counts). These morphometric measurements are usually presented as a proportion of standard, fork and total length (Howe, 2002). As many scientists have been using these different length measurements of fish species, a lack of standardized methods has hampered attempts to synthesize the data (Echeverria and Lenarz, 1984). It is very important especially in comparative studies which little information seems to be available for fish species (Froese and Pauly, 2005). The purpose of the present study is to contribute to the knowledge of the length - length relationships of some freshwater, estuarine and marine fish species. To provide the means to convert one of these length measurements to another, it is reported here the linear regression statistics necessary for conversions in 42 fish species.

Material and Methods

Samples were collected from various localities (Figure 1) by using different fishing gears (Table 1). Specimens were preserved in %5 solution of formaldehyde and then identified. Length measurements were taken to the nearest millimeter in a straight line via meter board. Standard length was measured from the anterior tip of the upper jaw to the tip of the hypural bone (urostyle). Fork length was measured from the anterior tip of the longest jaw to the median point of the caudal fin and the total length

was measured from the anterior tip of the longest jaw to the most posterior part of the tail (Laevastu, 1965).

Conversions among length measurements can generally be accomplished with simple linear regressions models. Therefore, length-length relationships were determined by the method of least squares to fit a simple linear regression model. Linear regressions were run on all combinations of the length measurements. The following relationships were established using linear regression analysis; (a) TL vs. FL; (b) TL vs. SL; (c) FL vs. SL.

The significance of the regression was assessed by analysis of variance (ANOVA) testing the hypothesis $H_0: \beta = 0$ against $H_A: \beta \neq 0$ (Zar, 1999). We used analysis of covariance (ANCOVA) to test between- locality differences of the slopes of the length - length relationships (Zar, 1999).

Results and Discussion

The species, the taxonomic authority (Froese and Pauly, 2005), sample size (n), size range (cm, TL-FL-SL), parameters of length - length relationships (a and b), the standard error (SE) and the correlation coefficient (r^2) are given in Tables 2, 3 and 4.

During the course of the study, 6259 individuals from 42 fish species representing 19 families were captured. Among them, the members of the Cyprinidae were the most abundant with the value of 43%. The sample size ranged from 10 for *N. melanostomus* and *P. marmoratus* to 683 for *C. gibelio*.

The length – length linear regressions were all highly significant ($P < 0.001$) with all r^2 values being > 0.90 . The high values of r^2 indicate that the length relationships are linear over the observed range of values.

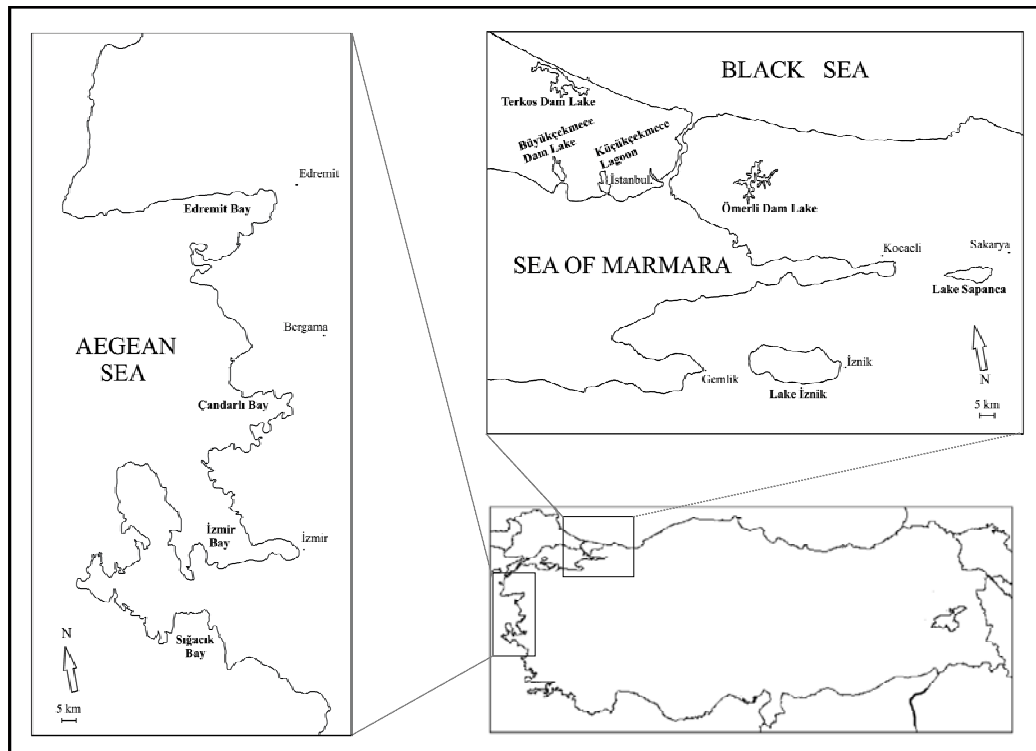


Figure 1. Map of the study sites.

Table 1. Localities, dates and fishing gears of the fish species caught from Aegean and Marmara coast of Turkey

Study area	Date of study	Fishing gear
Büyükçekmece Dam Lake	May 1995 - October 1995 April 2004	Gill net, cast net trammel net, scoop net
Çandarlı Bay	September 2004	Gill net
Edremit Bay	September 2004	Gill net
Lake İznik	October 2003 - August 2004	Beach seine, gill net
İzmir Bay	March 2003 - February 2004; November 2004; July 2004	Gill net, deep trawl, purse seine
Küçükçekmece Lagoon	November 1971 - October 1974; May 1981 - June 1981	Gill net, trammel net
Ömerli Dam Lake	January 2002 - August 2004	Gill net, trammel net electrofishing
Lake Sapanca	January 2002 - May 2003	Gill net, trammel net
Sığacık Bay	March 2004; July 2003; April 2004	Deep trawl
Terkos Dam Lake	September 2000 - June 2002	Gill net, electrofishing, cast net, trammel net
Lake Van	April 2003; July 2003	Gill net

Analysis of covariance (ANCOVA) revealed significant differences in the slope of length – length relationships between some localities and type of length conversions for the fish species (Table 5). A number of factors might affect the proportion of standard, fork and total length of fish including growth phase, food availability and quality, size range, health and general fish condition and preservation techniques. The observed difference could also be due to the sampling procedure, namely sample size and length range. However, the sample of the most studied fish was relatively large and covered

a reasonable size range, suggesting in slope could reflect the influence of differences in environmental or habitat factors. Hence, a further study about the effect of these factors on the length – length relationships in different places need to be conducted.

The equations for derivation of the different lengths measurements of 42 fish species presented above may enable researchers to gain helpful information about length conversions especially when the relevant equations are not suitable to establish for rare species in a specific locality.

Table 2. Results of linear regressions of total length versus standard length for the fish species caught from several Turkish waters

Family	Species	Locality	n	r ²	Standard length (mm)		Total length vs. standard length TL = a + bSL		
					min	max	a	b	SE(b)
Atherinidae	<i>Atherina boyeri</i> Risso, 1810	K	15	0.999	3.5	9.8	0.0414	1.1302	0.0048
		Ö	240	0.959	6.6	10.8	0.6099	1.0875	0.0118
Belonidae	<i>Belone belone</i> (Linnaeus, 1761)	Ç	20	0.996	30.3	55	0.4120	1.0778	0.0143
		İzm	56	0.992	22.7	42.5	-0.0546	1.0431	0.0062
Blenniidae	<i>Belone svetovidovi</i> Collette & Parin, 1970	İzm	173	0.993	24.9	42.6	-0.1599	1.0885	0.0060
		İ	89	0.953	1.9	3.1	0.0661	1.1580	0.0195
Centriscidae	<i>Salarias fluviatilis</i> (Asso, 1801)	Sı	43	0.991	6.2	10.1	0.1975	1.1024	0.0132
Clupeidae	<i>Macroramphosus scolopax</i> (Linnaeus, 1758)	K	21	0.998	8.4	21.4	0.1561	1.1396	0.0088
		B	20	0.952	7.7	9.3	0.3874	1.1149	0.0451
Cobitidae	<i>Alosa tanaica</i> (Grimm, 1901)	K	11	0.999	8	13.2	-0.3212	1.1787	0.0099
		B	26	0.988	3.5	9.2	-0.0398	1.1508	0.0193
Cobitidae	<i>Cobitis vardarensis</i> Karaman, 1928	İ	32	0.974	4.3	7.9	0.2601	1.0883	0.0266
		Ö	49	0.982	5.1	9.6	0.1072	1.1302	0.0171
Cyprinidae	<i>Abramis brama</i> (Linnaeus, 1758)	T	25	0.993	4.4	8.8	0.1267	1.1222	0.0151
		T	28	0.996	6.1	33.6	0.5199	1.2306	0.0190
Cyprinidae	<i>Alburnoides bipunctatus</i> (Bloch, 1782)	T	11	0.999	4.3	8	0.4021	1.1318	0.0111
		B	28	0.985	8.7	16.1	-0.5988	1.2411	0.0195
Cyprinidae	<i>Alburnus chalcoides</i> (Güldenstädt, 1772)	Ö	89	0.997	7.3	24	0.3352	1.1756	0.0047
		S	21	0.971	14.7	21.2	1.6870	1.0989	0.0349
Cyprinidae	<i>Alburnus tarichi</i> (Güldenstädt, 1814)	T	57	0.998	6.2	19.5	0.2204	1.1649	0.0053
		V	62	0.970	16	20.6	0.0480	1.1850	0.0187
Cyprinidae	<i>Barbus escherichii</i> Steindachner, 1897	Ö	12	0.999	4.1	19.4	0.1882	1.1552	0.0048
		S	106	0.955	8.9	17	1.1765	1.1735	0.0173
Cyprinidae	<i>Blicca bjoerkna</i> (Linnaeus, 1758)	İ	352	0.994	6.8	24.3	0.3279	1.2281	0.0034
		Ö	683	0.995	2.5	26.4	0.1465	1.2411	0.0022
Cyprinidae	<i>Carassius gibelio</i> (Bloch, 1782)	İ	12	0.999	11.7	40.9	0.2635	1.1937	0.0069
		Ö	49	0.997	10.4	74	1.9500	1.1223	0.0068
Cyprinidae	<i>Cyprinus carpio</i> Linnaeus, 1758	B	12	0.993	5.7	9.6	0.4488	1.1157	0.0239
		Ö	20	0.997	3.1	7.7	0.1381	1.1601	0.0121
Cyprinidae	<i>Gobio gobio</i> (Linnaeus, 1758)	T	27	0.985	5.3	9.4	0.3207	1.1265	0.0215
		B	14	0.969	5.6	9.5	-0.1495	1.2066	0.0412
Cyprinidae	<i>Petroleuciscus borysthenicus</i> (Kessler, 1859)	K	15	0.942	7.7	9.2	0.7802	1.0818	0.0599
		Ö	82	0.994	5.7	12.5	0.2059	1.1832	0.0072
Cyprinidae	<i>Phoxinus phoxinus</i> (Linnaeus, 1758)	T	55	0.996	5	13.2	0.1767	1.1539	0.0079
		T	14	0.990	4.6	7.3	-0.0207	1.1678	0.0249
Cyprinidae	<i>Rhodeus amarus</i> (Bloch, 1782)	B	41	0.928	4.7	5.7	0.0323	1.2024	0.0344
		Ö	266	0.975	4.6	7.3	0.1737	1.1924	0.0080
Cyprinidae	<i>Rutilus frisii</i> (Nordmann, 1840)	T	46	0.963	3.4	8.2	0.4962	1.1020	0.0259
		T	16	0.999	12.2	32.2	1.1431	1.1327	0.0076
Cyprinidae	<i>Rutilus rutilus</i> (Linnaeus, 1758)	B	217	0.998	6.7	18.2	0.1868	1.2017	0.0026
		İ	15	0.978	12.4	22.2	2.9059	1.0252	0.0400
Cyprinidae	<i>Scardinius erythrophthalmus</i> (Linnaeus, 1758)	S	245	0.938	12	21.1	1.5242	1.1229	0.0138
		B	19	0.984	5.8	15.7	0.1143	1.1943	0.0105
Cyprinidae	<i>Squalius cephalus</i> (Linnaeus, 1758)	Ö	632	0.995	5.4	24.3	0.2499	1.2235	0.0023
		S	105	0.993	11.1	24.1	0.2611	1.1888	0.0072
Cyprinidae	<i>Tinca tinca</i> (Linnaeus, 1758)	T	35	0.997	11.1	20.9	0.2619	1.1904	0.0079
		İ	25	0.985	15.9	29.3	1.9804	1.0779	0.0237
Cyprinidae	<i>Vimba vimba</i> (Linnaeus, 1758)	Ö	44	0.995	7.3	25.8	0.3888	1.1567	0.0091
		T	27	0.999	6	18.4	0.3460	1.1492	0.0057
Cyprinidae	<i>Vimba vimba</i> (Linnaeus, 1758)	T	13	0.999	14.5	26.8	-0.0208	1.1769	0.0085
		Ö	370	0.996	6	23.7	0.3966	1.2108	0.0027
Cyprinidae	<i>Vimba vimba</i> (Linnaeus, 1758)	S	78	0.968	12.8	19.6	0.4309	1.2153	0.0166
		T	25	0.996	6.5	21	0.6455	1.1594	0.0108
Cyprinodontidae	<i>Aphanius fasciatus</i> (Valenciennes, 1821)	K	11	0.980	3.2	4.6	0.4167	1.0433	0.0446
Engraulidae	<i>Engraulis encrasicolus</i> (Linnaeus, 1758)	İzm	88	0.996	9.9	14.9	0.6260	1.0887	0.0066
Esocidae	<i>Esox lucius</i> Linnaeus, 1758	T	39	0.939	28.9	54.1	2.8931	1.0489	0.0376
Gadidae	<i>Gadiculus argenteus argenteus</i> Guichenot, 1850	Sı	110	0.993	5.5	9.2	0.0601	1.1418	0.0069
Gasterosteidae	<i>Gasterosteus aculeatus</i> Linnaeus, 1758	İ	229	0.977	1.9	7	0.1627	1.1086	0.0090
Gobiidae	<i>Neogobius gymnotrachelus</i> (Kessler, 1857)	T	14	0.976	4.7	7.5	0.4556	1.1462	0.0384
		B	15	0.943	6	8.9	1.6217	0.9406	0.0682
Gobiidae	<i>Neogobius melanostomus</i> (Pallas, 1814)	Ö	33	0.981	5.7	11.4	0.1805	1.1680	0.0209
		S	10	0.995	8.8	15	-0.6311	1.2524	0.0207
Gobiidae	<i>Knipowitschia caucasica</i> (Berg, 1916)	T	17	0.991	2.8	12.1	0.2364	1.1580	0.0211
		B	11	0.974	1.8	2.9	0.1883	1.0851	0.0494
Gobiidae	<i>Proterorhinus marmoratus</i> (Pallas, 1814)	B	16	0.971	2.3	3.6	0.2560	1.1048	0.0406
		İ	210	0.980	2.4	6.6	0.3532	1.1373	0.0085
Gobiidae	<i>Proterorhinus marmoratus</i> (Pallas, 1814)	T	10	0.987	2.8	5	0.3510	1.1251	0.0363

B: Büyükçekmece Dam Lake, Ç: Çandarlı Bay, E: Edremit Bay, İ: Lake İznik, İzm: İzmir Bay, K: Küçükçekmece Lagoon, Ö: Ömerli Dam Lake, S: Lake Sapanca, Sı: Sığacık Bay, T: Terkos Dam Lake, V: Lake Van.

Table 2. (Continue)

Family	Species	Locality	n	r ²	Standard length (mm)		Total length vs. standard length TL = a + bSL		
					min	max	a	b	SE(b)
Phycidae	<i>Phycis blennoides</i> (Brünnich, 1768)	S ₁	12	0.990	11	13.4	0.2913	1.1042	0.0285
Poeciliidae	<i>Gambusia holbrooki</i> Girard, 1859	B	15	0.999	2.6	4	0.2145	1.1213	0.0246
		Ö	19	0.992	1.6	3.7	0.1571	1.1380	0.0185
Pomacentridae	<i>Chromis chromis</i> (Linnaeus, 1758)	Ç	34	0.948	10.4	12.8	0.1946	1.3033	0.0302
Serranidae	<i>Serranus hepatus</i> (Linnaeus, 1758)	İzm	93	0.985	5.3	8.4	0.2975	1.1709	0.0109
Sparidae	<i>Boops boops</i> (Linnaeus, 1758)	E	27	0.971	14.3	23.6	-0.2633	1.1959	0.0279
Trachichthyidae	<i>Hoplostethus mediterraneus</i> Cuvier, 1829	S ₁	458	0.987	5.8	14	1.0753	1.2298	0.0043

Table 3. Results of linear regressions of fork length versus standard length for the fish species caught from several Turkish waters

Family	Species	Locality	n	r ²	Fork length (mm)		Fork length vs. standard length FL = a + bSL		
					min	max	a	b	SE(b)
Atherinidae	<i>Atherina boyeri</i> Risso, 1810	K	15	0.999	3.7	10.4	0.0917	1.0516	0.0092
		Ö	240	0.968	7.5	11.8	0.2454	1.0513	0.0109
Belonidae	<i>Belone belone</i> (Linnaeus, 1761)	Ç	20	0.996	31.8	57.9	0.7851	1.0267	0.0151
		İzm	56	0.993	24	44.9	0.6632	1.0294	0.0111
Clupeidae	<i>Belone svetovidovi</i> Collette & Parin, 1970	İzm	173	0.993	25.9	44.3	0.5109	1.0325	0.0064
		K	21	0.998	8.7	22.1	0.3031	1.0142	0.0109
Clupeidae	<i>Alosa tanaica</i> (Grimm, 1901)	B	20	0.978	8.2	9.8	0.4921	1.0015	0.0344
		K	11	0.998	8.3	13.8	0.1697	1.0304	0.0138
Cyprinidae	<i>Sardina pilchardus</i> (Walbaum, 1792)	T	28	0.992	7.1	36.3	0.5169	1.0635	0.0166
		B	11	0.998	4.8	8.6	0.4049	1.0271	0.0153
Cyprinidae	<i>Alburnoides bipunctatus</i> (Bloch, 1782)	T	28	0.995	9.4	17.2	0.2513	1.0515	0.0138
		B	28	0.995	9.4	17.2	0.2513	1.0515	0.0138
Cyprinidae	<i>Alburnus chalcoides</i> (Güldenstädt, 1772)	Ö	89	0.998	8	25.8	0.3204	1.0589	0.0043
		S	21	0.984	16.1	22.3	1.0184	1.0192	0.0281
Cyprinidae	<i>Alburnus tarichi</i> (Güldenstädt, 1814)	T	57	0.999	6.6	20.6	0.1511	1.0577	0.0037
		V	62	0.953	17.4	22.5	0.7925	1.0422	0.0263
Cyprinidae	<i>Barbus escherichii</i> Steindachner, 1897	Ö	12	0.999	4.4	20.9	0.0753	1.0757	0.0105
		S	106	0.980	10.6	18.6	0.5498	1.0634	0.0129
Cyprinidae	<i>Blicca bjoerkna</i> (Linnaeus, 1758)	S	106	0.980	10.6	18.6	0.5498	1.0634	0.0129
		İ	352	0.995	7.8	27.8	0.3617	1.1190	0.0032
Cyprinidae	<i>Carassius gibelio</i> (Bloch, 1782)	Ö	683	0.996	2.8	30.7	0.1107	1.1316	0.0022
		İ	12	0.999	12.7	44.4	0.1224	1.0805	0.0073
Cyprinidae	<i>Cyprinus carpio</i> Linnaeus, 1758	Ö	49	0.999	11.5	79	0.6881	1.0613	0.0051
		B	12	0.977	6.3	10.6	0.4107	1.0433	0.0453
Cyprinidae	<i>Gobio gobio</i> (Linnaeus, 1758)	Ö	20	0.999	3.5	8.4	0.2149	1.0694	0.0084
		T	27	0.994	5.9	10.1	0.1446	1.0755	0.0148
Cyprinidae	<i>Petroleuciscus borysthenicus</i> (Kessler, 1859)	B	14	0.963	6	10.2	-0.0033	1.0918	0.0500
		K	15	0.983	8.3	9.9	0.2467	1.0580	0.0340
Cyprinidae	<i>Phoxinus phoxinus</i> (Linnaeus, 1758)	Ö	82	0.996	6.5	13.9	0.0924	1.1057	0.0064
		T	55	0.997	5.5	14.4	0.0759	1.0792	0.0068
Cyprinidae	<i>Rhodeus amarus</i> (Bloch, 1782)	T	14	0.973	5	8	-0.1369	1.1298	0.0414
		B	41	0.914	5.6	6.9	0.2578	1.0552	0.0426
Cyprinidae	<i>Rutilus rutilus</i> (Linnaeus, 1758)	Ö	266	0.979	5.1	8.3	-0.0792	1.1361	0.0078
		T	46	0.969	3.5	9.2	0.0796	1.0791	0.0244
Cyprinidae	<i>Rutilus frisii</i> (Nordmann, 1840)	T	16	0.999	13.1	34	0.3783	1.0448	0.0081
		B	217	0.997	7.3	19.6	0.0645	1.0834	0.0033
Cyprinidae	<i>Rutilus rutilus</i> (Linnaeus, 1758)	İ	15	0.996	13.4	24.6	-0.4018	1.1133	0.0163
		S	245	0.969	13	22.7	0.7276	1.0391	0.0107
Cyprinidae	<i>Scardinius erythrophthalmus</i> (Linnaeus, 1758)	B	19	0.989	6.5	17.1	0.1045	1.0847	0.0098
		Ö	632	0.996	6	26.4	0.3911	1.0768	0.0024
Cyprinidae	<i>Squalius cephalus</i> (Linnaeus, 1758)	S	105	0.993	12.1	26.3	0.3108	1.0760	0.0078
		T	35	0.998	12.1	22.3	0.0845	1.0772	0.0069
Cyprinidae	<i>Tinca tinca</i> (Linnaeus, 1758)	İ	25	0.990	18.5	31.2	2.0440	0.9977	0.0211
		Ö	44	0.999	8.3	28.6	0.1513	1.0949	0.0044
Cyprinidae	<i>Vimba vimba</i> (Linnaeus, 1758)	T	27	0.999	6.6	20	0.1916	1.0799	0.0064
		T	13	0.999	16.6	30.6	0.0197	1.1429	0.0093
Cyprinidae	<i>Vimba vimba</i> (Linnaeus, 1758)	Ö	370	0.997	6.7	25.7	0.3812	1.0631	0.0025
		S	78	0.983	14.2	21.2	0.3244	1.0742	0.0138
Cyprinidae	<i>Hoplostethus mediterraneus</i> Cuvier, 1829	T	25	0.998	7	22.4	0.4391	1.0443	0.0081
		İzm	88	0.996	10.4	15.6	0.1691	1.0344	0.0070
Engraulidae	<i>Engraulis encrasicolus</i> (Linnaeus, 1758)	İzm	88	0.996	10.4	15.6	0.1691	1.0344	0.0070
Esocidae	<i>Esox lucius</i> Linnaeus, 1758	T	39	0.982	30.8	57.3	1.5250	1.0217	0.0213
Pomacentridae	<i>Chromis chromis</i> (Linnaeus, 1758)	Ç	34	0.960	8.8	10.8	-0.2784	1.1448	0.0303
Sparidae	<i>Boops boops</i> (Linnaeus, 1758)	E	27	0.992	15.1	25	0.3185	1.0399	0.0169
Trachichthyidae	<i>Hoplostethus mediterraneus</i> Cuvier, 1829	S ₁	458	0.993	6.9	15.1	1.1170	1.0002	0.0038

B: Büyükçekmece Dam Lake, Ç: Çandarlı Bay, E: Edremit Bay, İ: Lake İznik, İzm: İzmir Bay, K: Küçükçekmece Lagoon, Ö: Ömerli Dam Lake, S: Lake Sapanca, S₁: Sığacık Bay, T: Terkos Dam Lake, V: Lake Van.

Table 4. Results of linear regressions of total length versus fork length for the fish species caught from several Turkish waters

Family	Species	Locality	n	r ²	Total length (mm)		Total length vs. fork length TL = a + bFL		
					min	max	a	b	SE(b)
Atherinidae	<i>Atherina boyeri</i> Risso, 1810	K	15	0.989	3.9	11.1	-0.0532	1.0742	0.0082
Belonidae	<i>Belone belone</i> (Linnaeus, 1761)	Ö	240	0.974	7.7	12.9	0.4410	1.0255	0.0101
		Ç	20	0.999	33.2	60.5	-0.3949	1.0495	0.0059
Clupeidae	<i>Belone svetovidovi</i> Collette & Parin, 1970	İzm	56	0.998	24.7	46.6	-0.0546	1.0431	0.0062
		İzm	173	0.999	27	46.3	-0.3489	1.0533	0.0028
		K	21	0.998	9.6	24.6	-0.1650	1.1224	0.0086
Cyprinidae	<i>Alosa tanaica</i> (Grimm, 1901)	K	21	0.998	9.6	24.6	-0.1650	1.1224	0.0086
	<i>Clupeonella cultriventris</i> (Nordmann, 1840)	B	20	0.943	8.9	10.7	-0.0035	1.0956	0.0497
Cyprinidae	<i>Sardina pilchardus</i> (Walbaum, 1792)	K	11	0.999	9	15.3	-0.5069	1.1432	0.0085
	<i>Abramis brama</i> (Linnaeus, 1758)	T	28	0.992	7.7	41.5	0.1137	1.1498	0.0156
	<i>Alburnoides bipunctatus</i> (Bloch, 1782)	T	11	0.997	5.2	9.4	-0.0311	1.0999	0.0163
	<i>Alburnus chalcoides</i> (Güldenstädt, 1772)	B	28	0.989	10.1	19.3	-0.8920	1.1800	0.0170
		Ö	89	0.999	8.8	28.4	-0.0149	1.1101	0.0038
		S	21	0.988	18	24.7	0.5807	1.0787	0.0235
		T	57	0.998	7.3	22.6	0.0574	1.1011	0.0051
	<i>Alburnus tarichi</i> (Güldenstädt, 1814)	V	62	0.955	19.1	24.6	-0.1416	1.1012	0.0243
	<i>Barbus escherichii</i> Steindachner, 1897	Ö	12	0.999	4.9	22.6	0.1154	1.0729	0.0083
	<i>Blicca bjoerkna</i> (Linnaeus, 1758)	S	106	0.972	12	21.2	0.5921	1.1019	0.0147
	<i>Carassius gibelio</i> (Bloch, 1782)	İ	352	0.997	8.6	30.2	-0.0512	1.0963	0.0029
		Ö	683	0.997	3	33.3	0.0546	1.0953	0.0021
	<i>Cyprinus carpio</i> Linnaeus, 1758	İ	12	0.998	14.2	48.8	0.1512	1.1037	0.0125
		Ö	49	0.998	12.8	84	1.2271	1.0573	0.0057
	<i>Gobio gobio</i> (Linnaeus, 1758)	B	12	0.977	6.7	11.2	0.1977	1.0485	0.0455
		Ö	20	0.998	3.7	9	-0.0960	1.0850	0.0093
		T	27	0.980	6.3	10.9	0.2178	1.0414	0.0268
	<i>Petroleuciscus borysthenicus</i> (Kessler, 1859)	B	14	0.994	6.5	11.1	-0.0861	1.0981	0.0203
		K	15	0.937	9	10.6	0.6338	1.0109	0.0668
		Ö	82	0.997	6.8	14.9	0.1150	1.0691	0.0061
	T	55	0.997	6	15.5	0.1021	1.0685	0.0071	
<i>Phoxinus phoxinus</i> (Linnaeus, 1758)	T	14	0.996	5.2	8.4	0.0693	1.0478	0.0172	
<i>Rhodeus amarus</i> (Bloch, 1782)	B	41	0.943	5.6	6.9	-0.0299	1.0980	0.0339	
	Ö	266	0.982	5.6	9	0.3033	1.0419	0.0078	
	T	46	0.983	4.1	9.7	0.4481	1.0156	0.0191	
<i>Rutilus frisii</i> (Nordmann, 1840)	T	16	0.998	15	37.5	0.7608	1.0831	0.0107	
<i>Rutilus rutilus</i> (Linnaeus, 1758)	B	217	0.997	8.3	22	0.1351	1.1071	0.0034	
	İ	15	0.968	15	25.6	3.3985	0.9144	0.0532	
	S	245	0.957	14.6	25.2	0.8508	1.0742	0.0122	
<i>Scardinius erythrophthalmus</i> (Linnaeus, 1758)	B	19	0.981	7.1	19	0.0628	1.0929	0.0126	
	Ö	632	0.996	6.7	29	-0.1666	1.1345	0.0022	
	S	105	0.991	13.5	29.1	0.0080	1.0996	0.0088	
	T	35	0.999	13.4	24.7	0.1719	1.1048	0.0060	
<i>Squalius cephalus</i> (Linnaeus, 1758)	İ	25	0.992	19.3	33	-0.1970	1.0790	0.0169	
	Ö	44	0.997	8.9	30.5	0.2224	1.0568	0.0078	
	T	27	0.999	7.1	21.3	0.1500	1.0636	0.0063	
<i>Tinca tinca</i> (Linnaeus, 1758)	T	13	0.999	17	31.4	-0.0293	1.0292	0.0082	
<i>Vimba vimba</i> (Linnaeus, 1758)	Ö	370	0.997	7.5	29.4	-0.0223	1.1380	0.0025	
	S	78	0.979	15.8	24.2	0.1180	1.1283	0.0145	
	T	25	0.998	7.6	24.8	0.1553	1.1104	0.0075	
Engraulidae	<i>Engraulis encrasicolus</i> (Linnaeus, 1758)	İzm	88	0.996	11.4	16.8	0.4793	1.0502	0.0067
Esocidae	<i>Esox lucius</i> Linnaeus, 1758	T	39	0.985	32.5	60	0.6813	1.0423	0.0190
Pomacentridae	<i>Chromis chromis</i> (Linnaeus, 1758)	C	34	0.964	10.4	12.8	0.6452	1.1247	0.0294
Sparidae	<i>Boops boops</i> (Linnaeus, 1758)	E	27	0.972	16.5	28.1	-0.5485	1.1461	0.0287
Trachichthyidae	<i>Hoplostethus mediterraneus</i> Cuvier, 1829	Sı	458	0.984	8	18.3	-0.2236	1.2235	0.0049

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Table 5. Results from ANCOVA for the slope of length – length relationships between areas and length conversions.

Species	Study sites	FL - TL	SL - TL	SL - FL
<i>Atherina boyeri</i>	K – Ö	o	xx	xx
<i>Belone belone</i>	Ç – İzm	o	xx	xx
<i>Alburnus chalcoides</i>	S – Ö	o	o	o
	S – B	o	o	o
	S – T	o	o	o
	Ö – B	xx	xx	o
	Ö – T	o	xxx	xxx
	B – T	o	o	xx
	Ö – İ	xxx	x	xxx
<i>Carassius gibelio</i>	Ö – B		o	
	Ö – İ		o	
	Ö – T		o	
	B – İ		o	
<i>Cobitis vardarensis</i>	B – T		o	
	İ – T		o	
	I – Ö	o	o	o
<i>Cyprinus carpio</i>	Ö – B		xxx	
	Ö – B	o	xx	o
<i>Gambusia holbrooki</i>	Ö – T	o	x	xx
	B – T	o	o	o
<i>Gobio gobio</i>	S – Ö		o	
	S – T		o	
	S – B		xxx	
	Ö – T		o	
	Ö – B		xxx	
	B – T		x	
	K – Ö	o	xxx	xxx
<i>Petroleuciscus borysthenicus</i>	K – B	o	o	o
	K – T	o	o	o
	Ö – B	o	xx	xxx
	Ö – T	o	xxx	xxx
	B – T	x	o	o
<i>Proterorhinus marmoratus</i>	B – T		o	
	B – İ		xx	
	T – İ		xxx	
	Ö – B	o	xxx	xxx
<i>Rhodeus amarus</i>	Ö – T	o	xxx	xxx
	B – T	o	xx	x
	S – B	o	o	xxx
<i>Rutilus rutilus</i>	S – İ	xxx	xxx	o
	İ – B	xxx	xxx	o
	S – Ö	xxx	xxx	xxx
	S – B	o	o	o
<i>Scardinius erythrophthalmus</i>	S – T	xxx	o	xxx
	Ö – B	xxx	xxx	xxx
	Ö – T	xxx	xxx	xxx
	B – T	xxx	o	xxx
	T – Ö	o	o	xxx
	T – İ	o	o	o
	Ö – İ	o	o	o
<i>Vimba vimba</i>	S – Ö	o	xx	xxx
	S – T	xxx	xxx	xxx
	Ö – T	xxx	xxx	xx

xxx=P<0.001; xx=P<0.01; x=P<0.05; o=P>0.05.

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