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

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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 Ho: $\beta = 0$ 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.

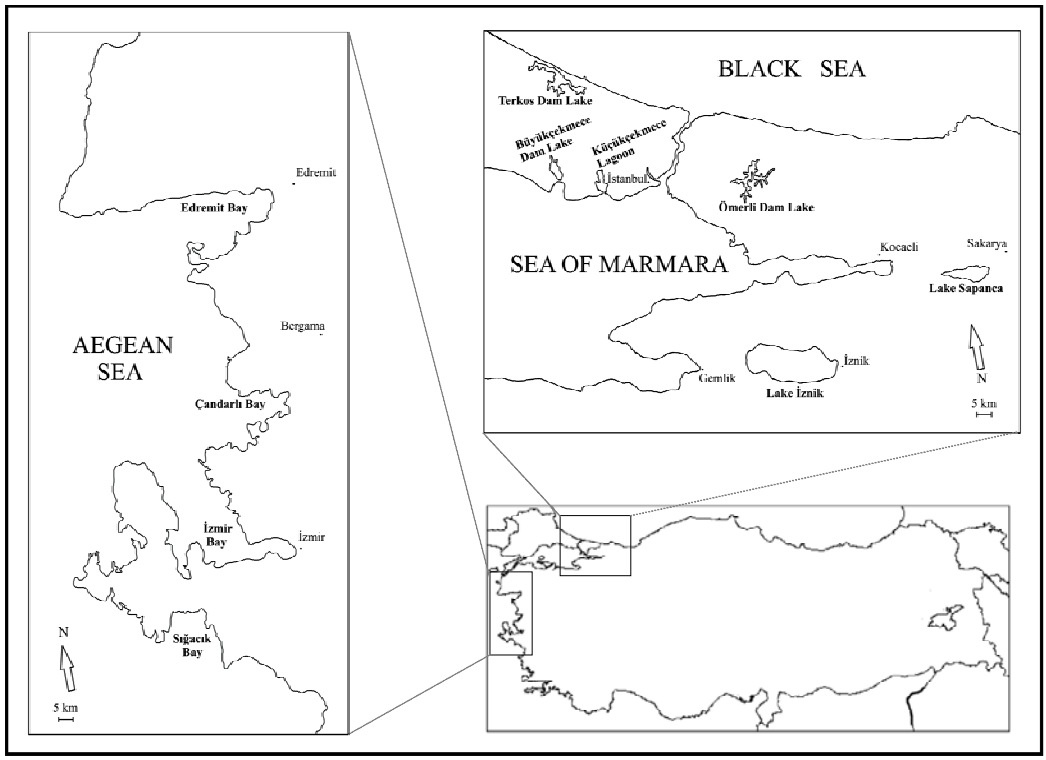

Figure 1. Map of the study sites.

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	Gill net, cast net
	April 2004	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* + *b*SL		
					min	max	*a*	*b*	SE(*b*)
Atherinidae	*Atherina boyeri* 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	*Belone belone* (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
	Belone svetovidovi Collette & Parin, 1970	İzm	173	0.993	24.9	42.6	0.1599	1.0885	0.0060
Blenniidae	*Salaria fluviatilis* (Asso, 1801)	İ	89	0.953	1.9	3.1	0.0661	1.1580	0.0195
Centriscidae	*Macroramphosus scolopax* (Linnaeus, 1758)	Sı	43	0.991	6.2	10.1	0.1975	1.1024	0.0132
Clupeidae	*Alosa tanaica* (Grimm, 1901)	K	21	0.998	8.4	21.4	0.1561	1.1396	0.0088
	Clupeonella cultriventris (Nordmann, 1840)	B	20	0.952	7.7	9.3	0.3874	1.1149	0.0451
	Sardina pilchardus (Walbaum, 1792)	K	11	0.999	8	13.2	-0.3212	1.1787	0.0099
Cobitidae	*Cobitis vardarensis* Karaman, 1928	B	26	0.988	3.5	9.2	-0.0398	1.1508	0.0193
		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
		T	25	0.993	4.4	8.8	0.1267	1.1222	0.0151
Cyprinidae	*Abramis brama* (Linnaeus, 1758)	T	28	0.996	6.1	33.6	0.5199	1.2306	0.0190
	Alburnoides bipunctatus (Bloch, 1782)	T	11	0.999	4.3	8	0.4021	1.1318	0.0111
	Alburnus chalcoides (Güldenstädt, 1772)	B	28	0.985	8.7	16.1	-0.5988	1.2411	0.0195
		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
		T	57	0.998	6.2	19.5	0.2204	1.1649	0.0053
	Alburnus tarichi (Güldenstädt, 1814)	V	62	0.970	16	20.6	0.0480	1.1850	0.0187
	Barbus escherichii Steindachner, 1897	Ö	12	0.999	4.1	19.4	0.1882	1.1552	0.0048
	Blicca bjoerkna (Linnaeus, 1758)	S	106	0.955	8.9	17	1.1765	1.1735	0.0173
	Carassius gibelio (Bloch, 1782)	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
	Cyprinus carpio Linnaeus, 1758	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
	Gobio gobio (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
		T	27	0.985	5.3	9.4	0.3207	1.1265	0.0215
	Petroleuciscus borysthenicus (Kessler, 1859)	B	14	0.969	5.6	9.5	-0.1495	1.2066	0.0412
		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
		T	55	0.996	5	13.2	0.1767	1.1539	0.0079
	Phoxinus phoxinus (Linnaeus, 1758)	T	14	0.990	4.6	7.3	-0.0207	1.1678	0.0249
	Rhodeus amarus (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
		T	46	0.963	3.4	8.2	0.4962	1.1020	0.0259
	Rutilus frisii (Nordmann, 1840)	T	16	0.999	12.2	32.2	1.1431	1.1327	0.0076
	Rutilus rutilus (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
		S	245	0.938	12	21.1	1.5242	1.1229	0.0138
	Scardinius erythrophthalmus (Linnaeus, 1758)	B	19	0.984	5.8	15.7	0.1143	1.1943	0.0105
		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
		T	35	0.997	11.1	20.9	0.2619	1.1904	0.0079
	Squalius cephalus (Linnaeus, 1758)	İ	25	0.985	15.9	29.3	1.9804	1.0779	0.0237
		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
	Tinca tinca (Linnaeus, 1758)	T	13	0.999	14.5	26.8	-0.0208	1.1769	0.0085
	Vimba vimba (Linnaeus, 1758)	Ö	370	0.996	6	23.7	0.3966	1.2108	0.0027
		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	*Aphanius fasciatus* (Valenciennes, 1821)	K	11	0.980	3.2	4.6	0.4167	1.0433	0.0446
Engraulidae	*Engraulis encrasicolus* (Linnaeus, 1758)	İzm	88	0.996	9.9	14.9	0.6260	1.0887	0.0066
Esocidae	*Esox lucius* Linnaeus, 1758	T	39	0.939	28.9	54.1	2.8931	1.0489	0.0376
Gadidae	*Gadiculus argenteus argenteus* Guichenot, 1850	Sı	110	0.993	5.5	9.2	0.0601	1.1418	0.0069
Gasterosteidae	*Gasterosteus aculeatus* Linnaeus, 1758	İ	229	0.977	1.9	7	0.1627	1.1086	0.0090
Gobiidae	*Neogobius gymnotrachelus* (Kessler, 1857)	T	14	0.976	4.7	7.5	0.4556	1.1462	0.0384
	Neogobius melanostomus (Pallas, 1814)	B	15	0.943	6	8.9	1.6217	0.9406	0.0682
		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
		T	17	0.991	2.8	12.1	0.2364	1.1580	0.0211
	Knipowitschia caucasica (Berg, 1916)	B	11	0.974	1.8	2.9	0.1883	1.0851	0.0494
	Proterorhinus marmoratus (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
		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* + *b*SL		
					min	max	*a*	*b*	SE(*b*)
Phycidae	*Phycis blennoides* (Brünnich, 1768)	Sı	12	0.990	11	13.4	0.2913	1.1042	0.0285
Poeciliidae	*Gambusia holbrooki* 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	*Chromis chromis* (Linnaeus, 1758)	Ç	34	0.948	10.4	12.8	0.1946	1.3033	0.0302
Serranidae	*Serranus hepatus* (Linnaeus, 1758)	İzm	93	0.985	5.3	8.4	0.2975	1.1709	0.0109
Sparidae	*Boops boops* (Linnaeus, 1758)	E	27	0.971	14.3	23.6	-0.2633	1.1959	0.0279
Trachichthyidae	*Hoplostethus mediterraneus* Cuvier, 1829	Sı	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* + *b*SL		
					min	max	*a*	*b*	SE(*b*)
Atherinidae	*Atherina boyeri* 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	*Belone belone* (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
	Belone svetovidovi Collette & Parin, 1970	İzm	173	0.993	25.9	44.3	0.5109	1.0325	0.0064
Clupeidae	*Alosa tanaica* (Grimm, 1901)	K	21	0.998	8.7	22.1	0.3031	1.0142	0.0109
	Clupeonella cultriventris (Nordmann, 1840)	B	20	0.978	8.2	9.8	0.4921	1.0015	0.0344
	Sardina pilchardus (Walbaum, 1792)	K	11	0.998	8.3	13.8	0.1697	1.0304	0.0138
Cyprinidae	*Abramis brama* (Linnaeus, 1758)	T	28	0.992	7.1	36.3	0.5169	1.0635	0.0166
	Alburnoides bipunctatus (Bloch, 1782)	T	11	0.998	4.8	8.6	0.4049	1.0271	0.0153
	Alburnus chalcoides (Güldenstädt, 1772)	B	28	0.995	9.4	17.2	0.2513	1.0515	0.0138
		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
		T	57	0.999	6.6	20.6	0.1511	1.0577	0.0037
	Alburnus tarichi (Güldenstädt, 1814)	V	62	0.953	17.4	22.5	0.7925	1.0422	0.0263
	Barbus escherichii Steindachner, 1897	Ö	12	0.999	4.4	20.9	0.0753	1.0757	0.0105
	Blicca bjoerkna (Linnaeus, 1758)	S	106	0.980	10.6	18.6	0.5498	1.0634	0.0129
	Carassius gibelio (Bloch, 1782)	İ	352	0.995	7.8	27.8	0.3617	1.1190	0.0032
		Ö	683	0.996	2.8	30.7	0.1107	1.1316	0.0022
	Cyprinus carpio Linnaeus, 1758	İ	12	0.999	12.7	44.4	0.1224	1.0805	0.0073
		Ö	49	0.999	11.5	79	0.6881	1.0613	0.0051
	Gobio gobio (Linnaeus, 1758)	B	12	0.977	6.3	10.6	0.4107	1.0433	0.0453
		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
	Petroleuciscus borysthenicus (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
		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
	Phoxinus phoxinus (Linnaeus, 1758)	T	14	0.973	5	8	-0.1369	1.1298	0.0414
	Rhodeus amarus (Bloch, 1782)	B	41	0.914	5.6	6.9	0.2578	1.0552	0.0426
		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
	Rutilus frisii (Nordmann, 1840)	T	16	0.999	13.1	34	0.3783	1.0448	0.0081
	Rutilus rutilus (Linnaeus, 1758)	B	217	0.997	7.3	19.6	0.0645	1.0834	0.0033
		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
	Scardinius erythrophthalmus (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
		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
	Squalius cephalus (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
		T	27	0.999	6.6	20	0.1916	1.0799	0.0064
	Tinca tinca (Linnaeus, 1758)	T	13	0.999	16.6	30.6	0.0197	1.1429	0.0093
	Vimba vimba (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
		T	25	0.998	7	22.4	0.4391	1.0443	0.0081
Engraulidae	*Engraulis encrasicolus* (Linnaeus, 1758)	İzm	88	0.996	10.4	15.6	0.1691	1.0344	0.0070
Esocidae	*Esox lucius* Linnaeus, 1758	T	39	0.982	30.8	57.3	1.5250	1.0217	0.0213
Pomacentridae	*Chromis chromis* (Linnaeus, 1758)	Ç	34	0.960	8.8	10.8	-0.2784	1.1448	0.0303
Sparidae	*Boops boops* (Linnaeus, 1758)	E	27	0.992	15.1	25	0.3185	1.0399	0.0169
Trachichthyidae	*Hoplostethus mediterraneus* Cuvier, 1829	Sı	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, Sı: 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* + *b*FL		
					min	max	*a*	*b*	SE(*b*)
Atherinidae	*Atherina boyeri* Risso, 1810	K	15	0.989	3.9	11.1	-0.0532	1.0742	0.0082
		Ö	240	0.974	7.7	12.9	0.4410	1.0255	0.0101
Belonidae	*Belone belone* (Linnaeus, 1761)	Ç	20	0.999	33.2	60.5	-0.3949	1.0495	0.0059
		İzm	56	0.998	24.7	46.6	-0.0546	1.0431	0.0062
	Belone svetovidovi Collette & Parin, 1970	İzm	173	0.999	27	46.3	-0.3489	1.0533	0.0028
Clupeidae	*Alosa tanaica* (Grimm, 1901)	K	21	0.998	9.6	24.6	-0.1650	1.1224	0.0086
	Clupeonella cultriventris (Nordmann, 1840)	B	20	0.943	8.9	10.7	-0.0035	1.0956	0.0497
	Sardina pilchardus (Walbaum, 1792)	K	11	0.999	9	15.3	-0.5069	1.1432	0.0085
Cyprinidae	*Abramis brama* (Linnaeus, 1758)	T	28	0.992	7.7	41.5	0.1137	1.1498	0.0156
	Alburnoides bipunctatus (Bloch, 1782)	T	11	0.997	5.2	9.4	-0.0311	1.0999	0.0163
	Alburnus chalcoides (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
	Alburnus tarichi (Güldenstädt, 1814)	V	62	0.955	19.1	24.6	-0.1416	1.1012	0.0243
	Barbus escherichii Steindachner, 1897	Ö	12	0.999	4.9	22.6	0.1154	1.0729	0.0083
	Blicca bjoerkna (Linnaeus, 1758)	S	106	0.972	12	21.2	0.5921	1.1019	0.0147
	Carassius gibelio (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
	Cyprinus carpio 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
	Gobio gobio (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
	Petroleuciscus borysthenicus (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
	Phoxinus phoxinus (Linnaeus, 1758)	T	14	0.996	5.2	8.4	0.0693	1.0478	0.0172
	Rhodeus amarus (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
	Rutilus frisii (Nordmann, 1840)	T	16	0.998	15	37.5	0.7608	1.0831	0.0107
	Rutilus rutilus (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
	Scardinius erythrophthalmus (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
	Squalius cephalus (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
	Tinca tinca (Linnaeus, 1758)	T	13	0.999	17	31.4	-0.0293	1.0292	0.0082
	Vimba vimba (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	*Engraulis encrasicolus* (Linnaeus, 1758)	İzm	88	0.996	11.4	16.8	0.4793	1.0502	0.0067
Esocidae	*Esox lucius* Linnaeus, 1758	T	39	0.985	32.5	60	0.6813	1.0423	0.0190
Pomacentridae	*Chromis chromis* (Linnaeus, 1758)	C	34	0.964	10.4	12.8	0.6452	1.1247	0.0294
Sparidae	*Boops boops* (Linnaeus, 1758)	E	27	0.972	16.5	28.1	-0.5485	1.1461	0.0287
Trachichthyidae	*Hoplostethus mediterraneus* Cuvier, 1829	Sı	458	0.984	8	18.3	-0.2236	1.2235	0.0049

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.

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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
Atherina boyeri	K – Ö	o	xx	xx
Belone belone	Ç – İzm	o	xx	xx
Alburnus chalcoides	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
Carassius gibelio	Ö – İ	xxx	x	xxx
Cobitis vardarensis	Ö – B		o	
	Ö – İ		o	
	Ö – T		o	
	B – İ		o	
	B – T		o	
	İ – T		o	
Cyprinus carpio	I – Ö	o	o	o
Gambusia holbrooki	Ö – B		xxx	
Gobio gobio	Ö – B	o	xx	o
	Ö – T	o	x	xx
	B – T	o	o	o
Neogobius melanostomus	S – Ö		o	
	S – T		o	
	S – B		xxx	
	Ö – T		o	
	Ö – B		xxx	
	B – T		x	
Petroleuciscus borysthenicus	K – Ö	o	xxx	xxx
	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
Proterorhinus marmoratus	B – T		o	
	B – İ		xx	
	T – İ		xxx	
Rhodeus amarus	Ö – B	o	xxx	xxx
	Ö – T	o	xxx	xxx
	B – T	o	xx	x
Rutilus rutilus	S – B	o	o	xxx
	S – İ	xxx	xxx	o
	İ – B	xxx	xxx	o
Scardinius erythrophthalmus	S – Ö	xxx	xxx	xxx
	S – B	o	o	o
	S – T	xxx	o	xxx
	Ö – B	xxx	xxx	xxx
	Ö – T	xxx	xxx	xxx
	B – T	xxx	o	xxx
Squalius cephalus	T – Ö	o	o	xxx
	T – İ	o	o	o
	Ö – İ	o	o	o
Vimba vimba	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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