

State of California  
The Resources Agency  
DEPARTMENT OF FISH AND GAME

Conversions Between Total, Fork, and Standard Lengths for 41  
Species in 15 Families of Fish from California Using  
Preserved and Fresh Specimens

by

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and  
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MARINE RESOURCES

Administrative Report No. 88-9

1988

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ABSTRACT

Tables of regression values for converting between total, fork, and standard lengths are provided for 41 species of fish from 15 families using preserved and fresh specimens of fish. A table is also included for converting between body length and total length for Pacific herring, Clupea harengus pallasii.

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1/ Marine Resources Administrative Report No 88-9.

2/ Marine Resources Division, 19160 So. Harbor Drive, Fort Bragg, CA 95437

## ACKNOWLEDGMENTS

We wish to thank, John Mello, Paul Reilly, and Gail Roper for assisting in collecting and measuring specimens. I also wish to thank Eric Anderson and Tomio Iwamoto for providing generous access to the fish collection at California Academy of Sciences.

Recent analysis of Marine Recreational Fisheries Statistics Survey (MRFSS) data collected between 1979 and 1984 has revealed a systematic sampling error consisting of measuring fork lengths rather than the required total lengths for most species collected in San Francisco and adjacent counties (Karpov 1988a-e; Karpov and Kwiecien 1987a-b; Karpov and Kwiecien 1988a-h; Karpov et. al. 1987a-c; Karpov et. al. 1988). The measurement method used in MRFSS outlined by Holliday, et. al. (1984a-b, 1985, 1986 and 1987) is incorrectly described as fork lengths for all species with forked tails. The actual measurements used in California's MRFSS are total lengths except for species with rigid tuna-like caudal fins, where fork lengths are used (Karpov 1986; Karpov 1987a-j; Karpov 1988a-e; Karpov and Kwiecien 1987a-b; Karpov and Kwiecien 1988a-h; Karpov et al. 1987a-c; Karpov et al. 1988). To convert the San Francisco area fork lengths to total lengths, fork length to total length regressions had to be generated for 41 species currently not reported in the literature.

Measurements were made of fresh or preserved specimens. Fresh specimens were obtained from creel sampled catches or from directed field collections. These were collected from Halfmoon Bay through Cape Mendocino, California, during 1986-87. Preserved specimens were measured from California Academy of Sciences in San Francisco, California. These were primarily collected between Monterey and Sonoma counties. However, some of the specimens were collected as far south as Baja California, and as far north as British Columbia. Preserved fish had been collected from 1894 through 1982. Only specimens with intact fin membranes were used

in this study. All preserved fish examined were being maintained in an aqueous solution of 70% ethanol.

Measurements were taken on a meter board in millimeters. Samples were selected in an attempt to cover the size ranges encountered in the MRFSS analysis. Up to four different types of length measurements were recorded depending on species. The measurements selected were total length, fork length, standard length, and for some Pacific herring, body length. Total length was measured from the most anterior tip of the longest jaw to the most posterior part of the tail when the caudal rays are squeezed together. Fork length was measured from the anterior tip of the longest jaw to the median point of the caudal fin (Holt 1959). Standard length was measured from the anterior tip of the upper jaw to the posterior end of the vertebral column (Hubbs and Lagler 1970); and body length was measured from the tip of the snout to the end of the pigment underlying the last row of scales on the caudal peduncle (Spratt 1981).

Linear regressions were run on all permutations of length measurements using a microcomputer and the ABSTAT statistical package. Statistics reports were the same as those used by Echeverria and Lenarz (1984); these included for each species the y-intercept (a), slope (B), standard error of the estimate ( $S_{y*x}$ ), correlation coefficient (r), range in length, and the sample size used in the regression (n) (Tables 1-4).

Caution needs to be exercised by applying these regressions only to the size ranges covered. In addition, the assumption was

made that shrinkage due to preservation technique had a proportional affect on the various measurements taken and did not affect the regressions involved.

TABLE 1. Results of Linear Regressions of Standard Length Versus Fork Length for All Species Sampled.

Species by family	n	r	Standard Length (mm)		Fork length as a function of standard length			Standard length as a function of fork length				
			Min.	Max.	a	B	$S_y^2x$	a	B	$S_y^2x$		
Clupeidae												
** <u>Clupea harengus pallasii</u>	65	0.997	114	203	0.005	1.098	2.371	1.125	0.905	2.153		
* <u>Sardinops sagax</u>	9	0.998	110	200	2.215	1.059	2.221	-1.521	0.941	2.093		
Engraulididae												
* <u>Engraulis mordax</u>	30	0.999	57	151	2.594	1.075	1.564	-2.145	0.928	1.453		
Salmonidae												
* <u>Salmo clarkii</u>	14	0.999	147	280	11.346	1.074	2.153	-10.170	0.930	2.003		
* <u>S. gairdnerii</u>	30	1.000	107	800	0.769	1.119	5.922	-0.424	0.893	5.289		
Osmeridae												
*** <u>Hypomesus pretiosus</u>	20	0.999	55	184	2.647	1.064	1.405	-2.215	0.938	1.319		
* <u>Spirinchus starksi</u>	10	0.994	82	117	-3.514	1.138	1.483	4.335	0.867	1.295		
* <u>S. thaleichthys</u>	10	0.995	48	90	3.329	1.037	1.317	-2.503	0.955	1.264		
Gadidae												
* <u>Gadus macrocephalus</u>	8	0.995	198	324	27.438	1.016	4.804	-24.396	0.976	4.708		
* <u>Theragra chalcogramma</u>	6	0.981	113	175	-2.484	1.134	5.863	7.319	0.849	5.074		
Atherinidae												
* <u>Atherinops affinis</u>	30	0.999	82	190	7.185	1.058	1.368	-6.545	0.944	1.292		
*** <u>Atherinopsis californiensis</u>	30	1.000	50	280	2.444	1.086	2.469	-2.062	0.920	2.272		
Scorpaenidae												
** <u>Sebastolobus altivelis</u>	46	0.996	170	260	12.024	1.172	2.304	-8.519	0.847	1.958		
Hexagrammidae												
* <u>Hexagrammos decagrammus</u>	17	0.999	130	345	3.076	1.146	3.251	-2.379	0.871	2.835		
* <u>H. superciliosus</u>	9	0.997	174	297	-1.100	1.180	3.892	2.295	0.842	3.287		
** <u>Ophiodon elongatus</u>	25	1.000	381	852	-6.085	1.135	4.782	5.937	0.880	4.211		
Anoploplatidae												
** <u>Anoplopoma fimbria</u>	25	0.993	450	567	9.571	1.075	4.039	-1.955	0.918	3.732		
Cottidae												
* <u>Leptocottus armatus</u>	10	0.999	56	178	1.549	1.166	2.718	-1.116	0.856	2.330		
Serranidae												
* <u>Paralebrax nebulifer</u>	13	0.997	73	392	8.988	1.154	8.827	-6.523	0.861	7.622		
*** <u>Roccus saxatilis</u>	35	0.999	53	206	5.942	1.136	1.695	-5.075	0.879	1.491		

TABLE 1. (Continued)

Species by family	n	r	Standard length (mm)		Fork length as a function of standard length			Standard length as a function of fork length		
			Min.	Max.	a	B	$S_{y*x}$	a	B	$S_{y*x}$
Scieaenidae										
*** <u>Genyonemus lineatus</u>	8	1.000	94	262	5.868	1.137	2.084	-5.019	0.879	1.832
* <u>Roncador stearnsii</u>	4	0.999	177	271	16.892	1.107	2.216	-14.958	0.902	2.001
Girellidae										
* <u>Girella nigricans</u>	14	0.998	62	376	5.823	1.172	7.944	-4.316	0.850	6.768
Embiotocidae										
*** <u>Amphistichus argenteus</u>	27	0.999	108	230	4.883	1.138	2.010	-4.004	0.877	1.765
*** <u>A. koelzi</u>	15	0.998	103	193	6.363	1.133	2.282	-5.139	0.880	2.010
*** <u>A. rhodoterus</u>	19	0.999	55	214	-0.770	1.172	2.036	0.828	0.852	1.736
* <u>Brachyistius frenatus</u>	12	0.997	73	132	-3.699	1.213	1.758	1.444	0.819	1.444
*** <u>Cymatogaster aggregata</u>	30	0.982	53	97	6.920	1.054	2.462	-3.929	0.914	2.293
*** <u>Damalichthys vacca</u>	21	0.999	78	280	7.401	1.103	2.948	-6.426	0.905	2.671
*** <u>Embiotoca jacksoni</u>	28	1.000	51	205	6.575	1.133	1.641	-5.700	0.882	1.447
*** <u>E. lateralis</u>	35	0.999	53	206	5.942	1.136	1.695	-5.075	0.879	1.491
* <u>Hyperprosopon anale</u>	6	0.996	70	136	3.932	1.125	3.031	-2.652	0.882	2.685
*** <u>H. argenteum</u>	24	0.999	70	217	4.870	1.124	2.862	-3.977	0.888	2.544
* <u>H. ellipticum</u>	18	0.998	107	181	8.321	1.110	1.563	-6.880	0.897	1.405
* <u>Hypsurus caryi</u>	16	1.000	56	192	6.781	1.094	1.418	-6.050	0.913	1.295
* <u>Micrometrus aurora</u>	13	0.998	35	132	4.830	1.120	2.415	-3.871	0.889	2.151
* <u>M. minimus</u>	10	0.999	45	105	6.305	1.111	0.780	-5.541	0.899	0.702
* <u>Phanerodon atripes</u>	7	0.905	192	216	40.290	0.878	4.179	-10.451	0.932	4.304
*** <u>P. furcatus</u>	21	0.998	77	215	9.240	1.075	2.032	-8.015	0.927	1.886
*** <u>Rhacochilus toxotes</u>	14	1.000	70	280	9.440	1.100	2.341	-8.513	0.909	2.129
Pleuronectidae										
** <u>Parophrys vetulus</u>	26	0.983	235	333	17.766	1.118	4.968	-5.940	0.864	4.368

\* Preserved specimens only.

\*\* Fresh specimens only.

\*\*\* Both fresh and preserved specimens.



TABLE 2. Results of Linear Regressions of Fork Length Versus Total Length for All Species Sampled.

Species by family	n	r	Fork length_(mm)		Total length as a function of fork length			Fork length as a function of total length				
			Min.	Max.	a	B	S <sup>2</sup> x	a	B	S <sup>2</sup> x		
<b>Clupeidae</b>												
** <u>Clupea harengus pallasii</u>	65	0.996	126	221	1.702	1.109	2.799	-0.129	0.894	2.513		
* <u>Sardinops sagax</u>	9	0.999	117	216	-0.734	1.110	1.735	0.959	0.900	1.562		
<b>Engraulitidae</b>												
* <u>Engraulis mordax</u>	30	0.998	64	165	2.898	1.076	1.973	-2.292	0.926	1.831		
<b>Salmonidae</b>												
* <u>Salmo clarkii</u>	14	0.999	168	315	4.639	1.032	1.725	-4.233	0.968	1.670		
* <u>S. gairdnerii</u>	30	1.000	124	900	4.073	1.051	6.523	-3.547	0.950	6.200		
<b>Osmeridae</b>												
*** <u>Hypomesus pretiosus</u>	20	0.999	63	200	0.161	1.084	1.880	0.293	0.920	1.732		
* <u>Spirinchus starksi</u>	10	0.996	90	131	12.395	0.990	1.196	-11.487	1.002	1.204		
* <u>S. thaleichthys</u>	10	0.997	52	96	-3.494	1.150	1.199	3.476	0.864	1.040		
<b>Gadidae</b>												
* <u>Gadus macrocephalus</u>	8	0.999	228	350	-12.699	1.067	2.538	12.526	0.935	2.376		
* <u>Itheragra chalcogramma</u>	6	1.000	125	194	7.918	0.981	0.423	-8.035	1.019	0.431		
<b>Atherinidae</b>												
* <u>Atherinops affinis</u>	30	0.999	91	208	-0.228	1.092	1.272	0.399	0.914	1.164		
*** <u>Atherinopsis californiensis</u>	50	0.998	55	340	2.645	1.076	5.453	-1.509	0.925	5.057		
<b>Scorpaenidae</b>												
** <u>Sebastes altivelis</u>	46	0.999	212	317	1.759	1.007	1.332	-1.071	0.991	1.321		
<b>Hexagrammidae</b>												
* <u>Hexagrammos decagrammus</u>	17	1.000	155	404	-3.112	1.027	1.414	3.092	0.973	1.376		
* <u>H. superciliosus</u>	9	1.000	202	342	-2.541	1.016	0.937	2.590	0.984	0.922		
** <u>Ophiodon elongatus</u>	25	1.000	430	967	4.090	1.013	1.838	-3.942	0.987	1.814		
<b>Anoplopomatidae</b>												
** <u>Anoplopoma fimbria</u>	25	0.994	492	616	10.793	1.044	3.930	-3.807	0.947	3.742		
<b>Cottidae</b>												
* <u>Leptocottus armatus</u>	10	1.000	67	213	-0.083	1.013	0.584	0.093	0.987	0.576		
<b>Serranidae</b>												
* <u>Paralebrax nebulifer</u>	13	1.000	90	461	-2.030	1.046	3.035	2.097	0.956	2.901		
*** <u>Roccus saxatilis</u>	40	0.999	66	305	1.028	1.089	2.671	-0.695	0.917	2.451		

TABLE 2. (Continued)

Species by family	n	r	Fork length (mm)		Total length as a function of fork length			Fork length as a function of total length		
			Min.	Max.	a	B	$S_{Y^*X}$	a	B	$S_{Y^*X}$
Scieaenidae										
*** <u>Genyonemus lineatus</u>	26	0.998	115	345	0.338	1.030	4.560	0.698	0.966	4.417
* <u>Roncador stearnsii</u>	4	0.999	215	317	4.852	1.022	2.769	-4.239	0.977	2.707
Girellidae										
* <u>Girella nigricans</u>	14	1.000	77	456	-0.438	1.028	2.363	0.489	0.972	2.298
Embiotocidae										
*** <u>Amphistichus argenteus</u>	45	0.998	129	342	3.618	1.057	4.228	-2.520	0.943	3.994
*** <u>A. koelzi</u>	25	0.997	122	236	-4.142	1.121	3.267	4.771	0.887	2.906
*** <u>A. rhodoterus</u>	25	0.999	63	325	2.884	1.061	3.115	-2.465	0.941	2.933
* <u>Brachyistius frenatus</u>	12	0.995	84	155	5.754	1.030	2.074	-4.572	0.962	2.005
*** <u>Cymatogaster aggregata</u>	49	0.998	62	255	4.401	1.062	2.608	-3.740	0.939	2.452
*** <u>Damalichthys vacca</u>	40	0.996	92	360	2.311	1.139	7.346	0.008	0.871	6.423
*** <u>Embiotoca jacksoni</u>	50	0.998	64	275	0.456	1.087	4.032	0.317	0.916	3.702
*** <u>E. lateralis</u>	40	0.999	66	305	1.028	1.089	2.671	-0.695	0.917	2.451
* <u>Hyperprosopon anale</u>	6	0.999	83	155	3.478	1.035	1.650	-3.090	0.964	1.592
*** <u>H. argenteum</u>	37	0.998	85	265	0.036	1.088	3.501	0.581	0.916	3.213
* <u>H. ellipticum</u>	18	0.998	126	208	5.623	1.058	1.820	-4.466	0.941	1.716
* <u>Hypsurus caryi</u>	16	0.999	70	216	1.303	1.089	2.604	-0.735	0.916	2.389
* <u>Micrometrus aurora</u>	13	0.999	42	151	1.069	1.079	1.956	-0.711	0.924	1.810
* <u>M. minimus</u>	10	0.995	56	123	1.861	1.062	2.147	-0.744	0.933	2.013
* <u>Phanerodon atripes</u>	7	0.966	216	240	-108.930	1.612	4.253	78.295	0.579	2.548
*** <u>P. furcatus</u>	32	0.987	91	300	10.388	1.087	7.511	-3.946	0.897	6.822
*** <u>Rhacochilus toxotes</u>	19	1.000	85	337	-7.534	1.144	1.572	6.613	0.874	1.374
Pleuronectidae										
** <u>Parophrys vetulus</u>	26	0.985	276	390	-7.324	1.029	4.910	16.866	0.943	4.701

\* Preserved specimens only.

\*\* Fresh specimens only.

\*\*\* Both fresh and preserved specimens.

TABLE 3. Results of Linear Regressions of Total Length Versus Standard Length For All Species Sampled.

Species by family.	n	r	Total length (mm)		Standard length as a function of total length			Total length as a function of standard length		
			Min.	Max.	a	B	$S_{y^*x}$	a	B	$S_{y^*x}$
Clupeidae										
** <u>Clupea harengus pallasii</u>	65	0.997	140	250	0.249	0.813	1.900	0.776	1.223	2.330
* <u>Sardinops sagax</u>	9	0.998	131	238	-0.741	0.847	2.159	1.582	1.176	2.545
Engraulididae										
* <u>Engraulis mordax</u>	30	0.999	71	183	-4.467	0.861	1.405	5.471	1.159	1.630
Salmonidae										
* <u>Salmo clarkii</u>	14	0.999	180	332	-14.166	0.900	2.282	16.287	1.109	2.533
* <u>S. gairdnerii</u>	30	1.000	131	962	-3.782	0.849	4.288	4.659	1.178	5.051
Osmeridae										
*** <u>Hypomesus pretiosus</u>	20	0.999	68	218	-1.940	0.863	2.099	3.031	1.153	2.426
* <u>Spirinchus starksi</u>	10	0.998	101	141	-6.478	0.876	0.841	8.013	1.135	0.957
* <u>S. thaleichthys</u>	10	0.990	56	106	0.966	0.823	1.814	0.516	1.190	2.181
Gadidae										
* <u>Gadus macrocephalus</u>	8	0.998	232	365	-13.162	0.916	3.178	15.556	1.088	3.463
* <u>Theragra chalcogramma</u>	6	0.980	131	198	0.650	0.864	5.230	5.652	1.112	5.932
Atherinidae										
* <u>Atherinops affinis</u>	30	0.999	101	225	-6.217	0.863	1.491	7.565	1.156	1.725
*** <u>Atherinopsis californiensis</u>	30	0.999	60	368	-1.167	0.832	2.366	1.646	1.200	2.841
Scorpaenidae										
** <u>Sebastolobus altivelis</u>	46	0.996	215	320	-9.742	0.840	1.924	13.508	1.182	2.282
Hexagrammidae										
* <u>Hexagrammos decagrammus</u>	17	0.999	156	415	0.327	0.848	3.184	0.062	1.177	3.751
* <u>H. superciliosus</u>	9	0.996	203	344	4.620	0.828	3.702	-3.483	1.199	4.455
** <u>Ophiodon elongatus</u>	25	1.000	440	983	2.407	0.869	4.072	-2.146	1.150	4.687
Anoplopomatidae										
** <u>Anoplopoma fimbria</u>	25	0.991	424	660	-7.349	0.872	4.271	18.678	1.127	4.853
Cottidae										
* <u>Leptocottus armatus</u>	10	0.999	68	215	-1.056	0.846	2.151	1.462	1.181	2.541
Serranidae										
* <u>Paralabrax nebulifer</u>	13	0.997	92	476	-4.801	0.823	7.527	7.273	1.208	9.119
*** <u>Roccus saxatilis</u>	35	0.999	71	328	-3.927	0.794	2.206	5.354	1.256	2.775

TABLE 3. (Continued)

Species by family	n	r	Total Length (mm)		Standard length as a function of total length			Total length as a function of standard length		
			Min.	Max.	a	B	S <sub>y</sub> *x	a	B	S <sub>y</sub> *x
Scieaenidae										
*** <u>Gonyonemus lineatus</u>	8	0.999	118	317	-2.253	0.830	2.444	3.010	1.203	2.942
* <u>Roncador stearnsii</u>	4	0.998	223	327	-18.655	0.881	3.644	22.250	1.131	4.130
Girellidae										
* <u>Girella nigricans</u>	14	0.999	79	466	-3.967	0.827	6.340	5.472	1.206	7.655
Embiotocidae										
*** <u>Amphistichus argenteus</u>	27	0.999	140	275	-2.028	0.805	1.911	2.928	1.240	2.373
*** <u>A. koelzi</u>	15	0.998	142	245	-0.420	0.778	2.173	1.229	1.281	2.788
*** <u>A. rhodoterus</u>	19	0.998	72	266	0.308	0.791	3.143	0.321	1.259	3.966
* <u>Brachyistius frenatus</u>	12	0.998	93	167	-0.597	0.792	1.197	1.302	1.256	1.506
*** <u>Cymatogaster aggregata</u>	30	0.979	68	124	-1.353	0.785	2.471	5.274	1.221	3.082
*** <u>Damalichthys vacca</u>	21	0.999	102	356	-3.239	0.774	3.565	4.816	1.289	4.600
*** <u>Embiotoca jacksoni</u>	28	1.000	69	261	-4.067	0.799	1.588	5.241	1.251	1.988
*** <u>E. lateralis</u>	35	0.999	71	253	-3.927	0.794	2.206	5.354	1.256	2.775
* <u>Hyperprosopon anale</u>	6	0.998	90	166	-5.753	0.854	1.717	7.133	1.168	2.009
*** <u>H. argenteum</u>	24	0.998	89	278	-3.208	0.810	3.355	4.704	1.229	4.133
* <u>H. ellipticum</u>	18	0.995	138	222	-10.823	0.843	2.176	14.492	1.174	2.567
* <u>Hypsurus caryi</u>	16	0.998	74	235	-6.704	0.836	2.612	8.704	1.191	3.117
* <u>Micrometrus aurora</u>	13	0.997	45	162	-4.564	0.822	2.438	6.211	1.210	2.957
* <u>M. minimus</u>	10	0.998	61	132	-6.495	0.842	1.306	8.238	1.183	1.548
* <u>Phanerodon atripes</u>	7	0.891	241	278	59.814	0.550	4.591	-33.425	1.444	7.441
*** <u>P. furcatus</u>	21	0.989	102	289	-0.741	0.774	4.815	5.584	1.265	6.156
*** <u>Rhacochilus toxotes</u>	14	1.000	91	355	-2.027	0.790	2.368	2.674	1.264	2.995
Pleuronectidae										
** <u>Parophrys vetulus</u>	26	0.990	276	394	2.635	0.833	3.435	3.827	1.176	4.080

\* Preserved specimens only.

\*\* Fresh specimens only.

\*\*\* Both fresh and preserved specimens.

TABLE 4. Results of Linear Regressions of Body Length Versus Total Length for Pacific Herring.

Species by family	n	r	Body Length (mm)		Total length as a function of body length			Body length as a function of total length				
			Min.	Max.	a	B	$S_y^2x$	a	B	$S_y^2x$		
Clupeidae												
** <u>Clupea harengus pallasii</u>	65	0.997	118	209	0.702	1.182	2.382	0.361	0.841	2.009		

\*\* Fresh specimens only.

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