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Management Data Series Number 126
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ACKNOWLEDGMENTS

We would like to thank Texas Parks and Wildlife Coastal Fisheries personnel who collected the data and Tom Heffernan, C. E. Bryan, Larry McEachron, Hal Osburn, Jerry Clark, Lynn Benefield, Ed Hegen and Al Green for reviewing the manuscript. Special thanks go to Deborah Fuller and Dr. Jay Geaghan at Louisiana State University for writing the regression program. Hal Osburn and David Trimm deserve thanks for their input on the final copy. This study was jointly funded by the Texas Parks and Wildlife Department and the U.S. Fish and Wildlife Service under DJ 15.605 (Project F-34-R), and the U.S. Department of Commerce; National Oceanic and Atmospheric Administration, National Marine Fisheries Service under PL 88-309 (Project 2-427-R).

ABSTRACT

Weight (W)-total length (TL) relationships were developed for alligator gar (*Lepisosteus spatula*), Atlantic croaker (*Micropogonias undulatus*), Atlantic sharpnose shark (*Rhizoprionodon terraenovae*), Atlantic stingray (*Dasyatis sabina*), gafftopsail catfish (*Bagre marinus*), gizzard shad (*Dorosoma cepedianum*), gulf flounder (*Paralichthys albigutta*), gulf menhaden (*Brevoortia patronus*), hardhead catfish (*Arius felis*), pinfish (*Lagodon rhomboides*), spot (*Leiostomus xanthurus*) and striped mullet (*Mugil cephalus*). Atlantic stingray TL was measured from wing tip to wing tip. Weight-standard length (SL) and TL-SL equations were developed for the above species, except that no TL-SL equations were developed for Atlantic stingray or Atlantic sharpnose shark.

Regression coefficients for equations in the form of $Y = a + bX$ were estimated for log transformed weight as a function of log transformed total length, log W as a function of log standard length and log TL as a function of log SL. Equations developed for species in this study were generally different from those reported in other studies.

INTRODUCTION

Information on the relationships between weights and lengths of fish are important tools in the study of fish biology and fisheries management. Analysis of weight-length data is used to describe the regression of weight (W) on length (L) so that knowledge of one variable allows for the prediction of the other (Parker 1971). These conversions allow for estimating landings by weight utilizing fish measured but not weighed.

A problem frequently encountered when studying weight-length relationships is comparing data when different methods of measurements were used. Lengths may be recorded as total length (TL), fork length (FL) or standard length (SL). Length measurements can be interchanged and compared if length-length regressions are calculated (Hein et al. 1980).

Weight-total length regressions have been developed for hardhead catfish (*Arius felis*) along the Mississippi and Louisiana coasts (Dawson 1965), pinfish (*Lagodon rhomboides*) from the Newport River estuary, North Carolina (Hoss 1974), spot (*Leiostomus xanthurus*) from Galveston Bay, Texas (Parker 1973) and the Mississippi-Louisiana coast (Dawson 1965). Weight-total length regressions were also developed for Atlantic croaker (*Micropogonias undulatus*) from Texas (Parker 1973, White and Chittenden 1977) and other areas of the Gulf of Mexico (Dawson 1965) as well as striped mullet (*Mugil cephalus*) from Peru (Cedillo and Ruiz 1980).

Weight-standard length regressions have been developed for hardhead catfish along the continental shelf from Florida to Texas (Sheridan et al. 1984), gulf menhaden (*Brevoortia patronus*) from upper Galveston Bay, Texas (Matlock and Strawn 1976) and pinfish from selected areas of the Texas coast (Cameron 1969, Marcello and Strawn 1972) and from southern Florida (Caldwell 1957). Weight-standard length regressions were developed for spot from Galveston Bay, Texas (Marcello and Strawn 1972, Matlock and Strawn 1976), along the continental shelf from Florida to Texas (Sheridan et al. 1984), from South Carolina (Dawson 1968 in Parker 1973) and from Virginia (McCambridge and Alden 1984). Marcello and Strawn (1972) and Matlock and Strawn (1976) developed W-SL regressions for Atlantic croaker from Texas while other areas of the Gulf of Mexico were dealt with by Sheridan et al. (1984). Weight-standard length regressions were developed for striped mullet from selected areas along the Texas coast (Hellier 1962, Matlock and Strawn 1976) and from Peru (Cedillo and Ruiz 1980). Thomas (1971) developed W-FL regressions for spot from New Jersey.

Total length-standard length regressions have been developed for gulf menhaden (Matlock and Strawn 1976) and Atlantic croaker (Matlock et al. 1975) from Galveston Bay, Texas. Standard length-total length regressions for pinfish in Texas were reported by Cameron (1969). Standard length-total length regressions for striped mullet from Peru were reported by Cedillo and Ruiz (1980).

Many of the W-L and L-L equations previously developed for species along the Texas coast represent samples from only selected areas. The development of regressions representative of the entire Texas coast would benefit both management and law enforcement.

The objectives of this paper were to develop:

1. Weight-total length and W-SL equations for alligator gar (Lepisosteus spatula), Atlantic croaker, Atlantic sharpnose shark (Rhizoprionodon terraenovae), Atlantic stingray (Dasyatis sabina), gafftopsail catfish (Bagre marinus), gizzard shad (Dorosoma cepedianum), gulf flounder (Paralichthys albigutta), gulf menhaden, hardhead catfish, pinfish, spot and striped mullet; and

2. Total length-standard length equations for the above fish except Atlantic stingray and Atlantic sharpnose shark.

MATERIALS AND METHODS

Fish were collected with bag seines, trammel nets, gill nets, rotenone and otter trawls in all Texas marine waters from 1975 through 1982. Specific collection methodologies are published for bag seines (Hegen 1983a), trammel nets (Hegen et al. 1983; Matlock 1981, 1982; Matlock et al. 1978), gill nets (Hegen 1983a, 1983b; Hegen et al. 1983; Matlock 1981, 1982; Matlock et al. 1978), rotenone (Matlock et al. 1982) and otter trawls (Benefield 1982). Fish were counted and identified to species. Weights (± 5 grams) and total and standard lengths (Atlantic stingray total length was measured from wing tip to wing tip) were determined to ± 1 mm (Matlock 1982) or to ± 5 mm (Matlock et al. 1978).

Least squares linear regressions were performed on the log transformed power function of $W = aL^b$ (LeCren 1951) and $TL = aSL^b$ resulting in the regression equations $\log W = \log a + b (\log L)$ and $\log TL = \log a + b (\log SL)$, respectively, where a = Y-intercept and b = the slope of the regression line (Sokal and Rohlf 1969). Weights were regressed on TL and SL for all species. Total length was regressed on SL for all fish except Atlantic stingray and Atlantic sharpnose shark. Outliers within each data set were trimmed before analyses by deleting measurements greater than ± 99.99% confidence interval (C.I.).

Coefficients of determination (r^2) were calculated for all equations. Ninety-nine percent confidence intervals were also calculated for both the Y-intercept (a) and the slope (b) of each weight-length and length-length regression. All analyses were done at Louisiana State University using Statistical Analysis Systems software (SAS Institute, Inc. 1982a, 1982b).

RESULTS

The W-TL regressions for all species explained from 93% to 99% of the variation of W as a function of TL (Table 1). The W-SL regressions for all species explained from 95% to 99% of the variation of W as a function of SL (Table 2). The TL-SL regressions explained from 98% to 100% of the variation of TL as a function of SL (Table 3).

DISCUSSION

The TL-SL regressions developed in this study differed from those reported by other authors. Regression equations developed for gulf menhaden (TL = 0.620 + 1.253 SL) and for Atlantic croaker (TL = 1.215 + 1.267 SL, TL = 9.705 + 1.175 SL and TL = 19.885 + 1.109 SL) by Matlock et al. (1975) indicated that b does not fall within the C.I.'s of b calculated for this study.

Direct comparisons of some published L-L relationships were not possible due to differences in measuring techniques which resulted in different regression equations. Pinfish (Cameron 1969) and striped mullet (Cedillo and Ruiz 1980) were calculated as SL-TL. Thomas (1971) calculated FL-TL for spot.

Differences between regression equation coefficients may occur for many reasons, including different sample sizes or differences in length ranges. Regression coefficients may also vary among samples collected from different geographical areas. Matlock and Strawn (1976) found that gulf menhaden from Alabama weighed more at a given length than those from upper Galveston Bay, Texas. This could be due to differences in sample size, length range, or it could reflect true morphological or ecological differences between the two populations. When possible, fisheries managers should use regression equations developed from fish collected in the area where management occurs.

Matlock et al. (1975) found that the TL-SL regression equation for Atlantic croaker changed with body length. Since the relative length of the caudal fin tended to decrease as body length increased, separate regression equations were developed for three different length ranges. In the current study only one TL-SL regression equation was developed for Atlantic croaker. This could result in the actual length being under- or overestimated.

There were no published reports of W-L or L-L differentiation between sexes for any of the species in this study. The possibility of sex differences can not be examined since little information is available for these species. The regressions calculated here are useful for estimating landings by weight when only lengths are known.

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Table 1. Weight (W)-total length (TL) relationships using Log W = log a + b (log TL) for 12 species caught in marine waters of Texas during 1975-1982.

Species	TL range (mm)	Number measured	Log a (99% confidence interval)	b (99% confidence interval)	r^2
Alligator gar	436-1,995	974	-6.16 (-6.10 to -6.22)	3.31 (3.29 to 3.33)	0.97
Atlantic croaker	20-487	12,844	-5.36 (-5.35 to -5.37)	3.20 (3.20 to 3.20)	0.99
Atlantic sharpnose shark	370-820	30	-7.15 (-6.70 to -7.63)	3.67 (3.51 to 3.83)	0.95
Atlantic stingray	87-734	4,302	-4.86 (-4.84 to -4.88)	3.21 (3.20 to 3.22)	0.97
Gafftopsail catfish	90-662	3,739	-5.43 (-5.41 to -5.45)	3.15 (3.14 to 3.16)	0.98
Gizzard shad	55-450	15,242	-5.49 (-5.47 to -5.51)	3.20 (3.19 to 3.21)	0.93
Gulf flounder	54-415	478	-5.39 (-5.34 to -5.44)	3.19 (3.17 to 3.21)	0.98
Gulf menhaden	22-390	12,791	-5.13 (-5.12 to -5.14)	3.08 (3.08 to 3.08)	0.99
Hardhead catfish	60-770	25,781	-5.56 (-5.55 to -5.57)	3.22 (3.22 to 3.22)	0.97
Pinfish	15-345	5,566	-4.66 (-4.65 to -4.67)	2.93 (2.92 to 2.94)	0.97
Spot	17-450	10,830	-4.98 (-4.97 to -4.99)	3.06 (3.06 to 3.06)	0.99
Striped mullet	20-865	28,439	-4.83 (-4.83 to -4.83)	2.93 (2.93 to 2.93)	0.99

Table 2. Weight (W)-standard length (SL) relationships using Log W = log a + b (log SL) for 11 species caught in marine waters of Texas during 1975-1982.

Species	SL range (mm)	Number measured	Log a (99% confidence interval)	b (99% confidence interval)	r^2
Alligator gar	420-1,550	325	-5.38 (-5.37 to -5.39)	3.10 (3.07 to 3.13)	0.97
Atlantic croaker	15-400	6,853	-4.76 (-4.75 to -4.77)	3.05 (3.05 to 3.05)	0.99
Atlantic sharpnose shark	311-510	9	-5.14 (-4.46 to -5.82)	3.11 (2.85 to 3.37)	0.95
Gafftopsail catfish	65-551	2,532	-4.91 (-4.89 to -4.93)	3.08 (3.07 to 3.09)	0.98
Gizzard shad	44-355	7,139	-5.01 (-4.99 to -5.03)	3.13 (3.12 to 3.14)	0.95
Gulf flounder	43-341	221	-5.00 (-4.94 to -5.06)	3.14 (3.11 to 3.17)	0.98
Gulf menhaden	18-310	8,857	-4.76 (-4.75 to -4.77)	3.07 (3.07 to 3.07)	0.98
Hardhead catfish	44-390	12,411	-4.99 (-4.98 to -5.00)	3.09 (3.09 to 3.09)	0.98
Pinfish	12-240	3,149	-4.49 (-4.48 to -4.50)	3.01 (3.00 to 3.02)	0.98
Spot	13-375	6,140	-4.68 (-4.67 to -4.69)	3.06 (3.06 to 3.06)	0.99
Striped mullet	17-500	11,552	-4.57 (-4.57 to -4.57)	2.96 (2.96 to 2.96)	0.99

Table 3. Total length (TL)-standard length (SL) relationships using Log TL = log a + b (log SL) for 10 species caught in marine waters of Texas during 1975-1982.

Species	SL range (mm)	Number measured	Log a (99% confidence interval)	b (99% confidence interval)	r^2
Alligator gar	290-1,550	317	0.15 (0.13 to 0.16)	0.97 (0.98 to 0.96)	0.99
Atlantic croaker	9-615	7,448	0.18 (0.18 to 0.18)	0.96 (0.96 to 0.96)	1.00
Gafftopsail catfish	65-575	2,456	0.16 (0.16 to 0.16)	0.97 (0.97 to 0.97)	1.00
Gizzard shad	24-360	7,052	0.15 (0.15 to 0.15)	0.98 (0.98 to 0.98)	0.98
Gulf flounder	43-380	243	0.15 (0.14 to 0.16)	0.97 (0.97 to 0.97)	1.00
Gulf menhaden	18-300	9,524	0.10 (0.10 to 0.10)	1.00 (1.00 to 1.00)	1.00
Hardhead catfish	44-508	11,771	0.18 (0.18 to 0.18)	0.96 (0.96 to 0.96)	0.99
Pinfish	10-215	3,713	0.06 (0.06 to 0.06)	1.00 (1.00 to 1.00)	1.00
Spot	9-375	7,098	0.08 (0.08 to 0.08)	1.01 (1.01 to 1.01)	1.00
Striped mullet	17-500	11,633	0.08 (0.08 to 0.08)	1.01 (1.01 to 1.01)	1.00