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VARIATION IN SPOTTED GAR (*LEPISOSTEUS OCULATUS*) MASS-LENGTH RELATIONSHIPS IN TEXAS RESERVOIRS

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Abstract.—Total length and mass were measured on 883 spotted gar, *Lepisosteus oculatus*, collected between 1984 and 1996 from 49 Texas reservoirs. Spotted gar mass was positively related to length ($r^2 = 0.92$, $P < 0.0001$). Mass-length relationships differed significantly ($P < 0.0001$) among reservoirs, explaining an additional 2% of the variation in spotted gar mass.

Gars, family Lepisosteidae, historically have been regarded as nuisance species (Scarnecchia 1992) and have been little studied even though recreational and commercial fisheries exist for several species (Scarnecchia 1992; García de León et al. 2001). Indeed, the most studied aspect of gar biology is their diet, motivated by concerns that gars compete with and prey on recreationally important fishes. However, this view of gars ignores their potential ecological importance in aquatic systems (Scarnecchia 1992), particularly those in which gars are top predators (Hunt 1953).

The spotted gar, *Lepisosteus oculatus*, is distributed from Lake Erie, southeast through the Ohio and Missouri river drainages of the Mississippi River, and then westward through the coastal drainages of Texas (Hubbs et al. 1991). Despite its wide distribution, little is known of its biology (Redmond 1964; Parker & McKee 1983). This paper describes variation in mass-length relationships of spotted gar from 49 Texas reservoirs (Fig. 1).

METHODS

Total length (mm) and mass (g) were measured on 883 spotted gar collected between 1984 and 1996 by Texas Parks and Wildlife Department personnel during routine sampling. Texas Parks and Wildlife Department does not specifically target gars for annual monitoring; instead, they are incidentally captured while monitoring other species. Thus, spotted gar were captured in all months of the year by a combination of electrofishing, gill nets and trap nets, which varied among years and reservoirs. Length and mass measurements were $\log_{10}$-transformed and linear regression was used to explore mass-length relationships.
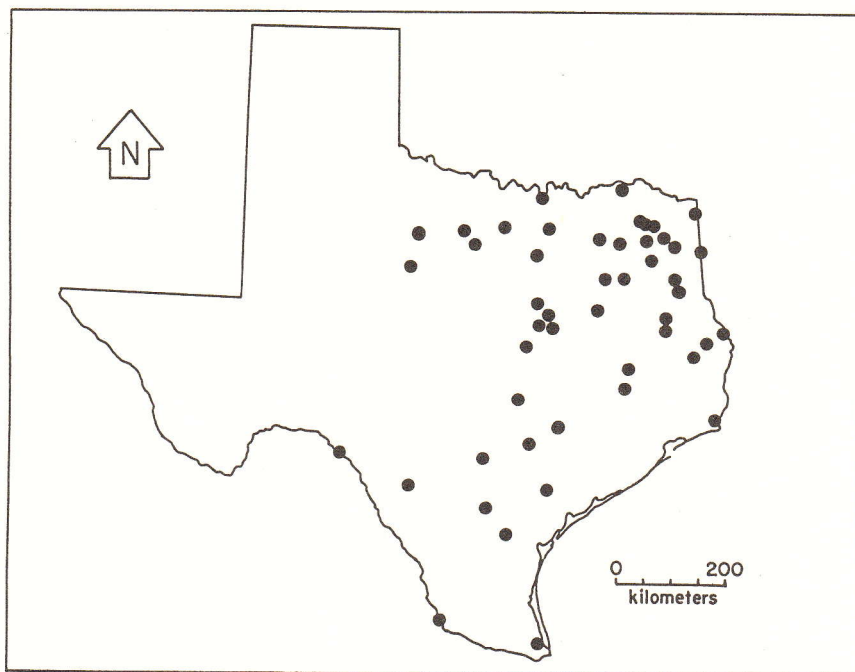
Figure 1. Map of Texas with locations of the 49 reservoirs where spotted gar were collected
    between 1984 and 1996.

Analysis of covariance was used to assess among-reservoir variation in
spotted gar mass with length as a covariate. Growing-season length for
each reservoir was obtained from Kingston & Harris (1983) and used as
a surrogate for climate-related effects (e.g., Wilde & Muoneke 2001).
The effect of growing season length on mass-length relationships was
assessed using multiple regression. All analyses were performed using
SAS software (SAS Institute, Inc. 1999).

RESULTS AND DISCUSSION

Spotted gar mass was positively related to total length ($\log_{10}$mass $=$
-6.272 + 3.319 x $\log_{10}$length, $n = 883$, $r^2 = 0.92$, $P < 0.0001$; Fig.
2). There was significant ($P < 0.0001$) among-reservoir variation in
spotted gar mass-length relationships, which explained an additional 2%
($R^2 = 0.94$) of the variation in spotted gar mass. The spotted gar mass-
length relationship also was significantly ($P < 0.0001$) related to the
length of the growing season; however, growing season length explained
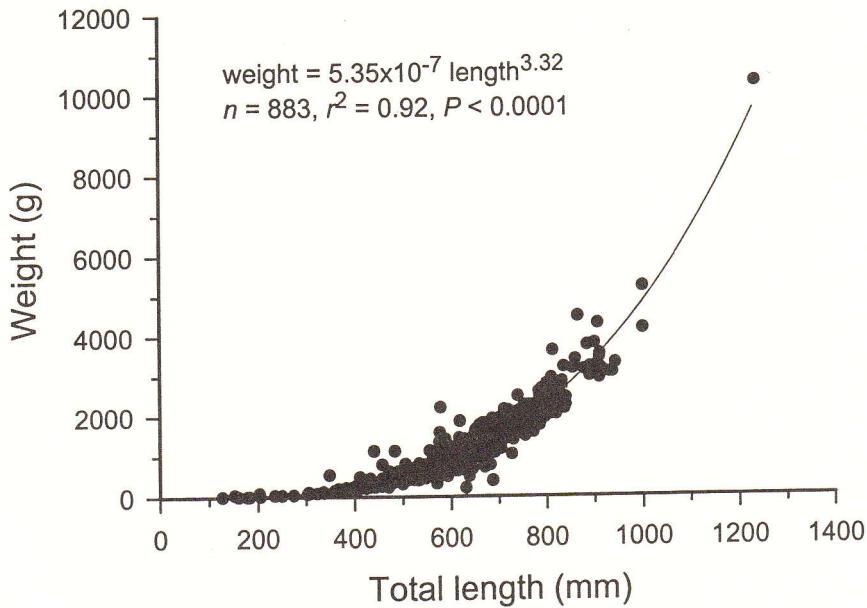only 0.2% of the variation in spotted gar mass.

Figure 2. Mass-length relationship for 883 spotted gar collected from 49 Texas reservoirs between 1984 and 1996. The relationship has been back-transformed to a linear scale.

The observed among-reservoir variation in spotted gar mass-length relationships is probably ecologically and managerially important. However, the limited geographic scope of previous studies of spotted gar is inadequate for describing potential variation in spotted gar biology among reservoirs. Among Texas spotted gar populations for which at least 20 mass-length observations were available and for which the range in total length exceeded 300 mm, there was considerable variation in mass-length relationships (Table 1). Slopes of these mass-length relationships generally ranged from 2.87 to 3.87 with coefficients of determination (r^2) ranging from 0.84 to 0.98. The mass-length relationship for the spotted gar population in Lake Wright Patman appears to be an outlier in both slope (2.41) and coefficient of determination (0.49). Among-reservoir differences in slope often imply differences in condition, or relative "plumpness" (Le Cren 1951). Because reproductive development, fecundity and reproductive success often are positively correlated with condition in fishes (Willis 1987; Bevier 1988; Brown & Taylor 1992), among-reservoir differences in mass-length relationships observed in this study likely imply differences in population dynamics among spotted gar populations. Growing scarcity of some gar stocks

Table 1. Mass-length relationships for spotted gar populations from 15 Texas reservoirs. Relationships are expressed as $\log_{10}$mass = a + b x $\log_{10}$length, with mass measured in g and total length (TL) in mm. Sample size (*n*), root mean square error (RMSE), and coefficient of determination (r^2) are provided for linear regressions.

Reservoir	*n*	Intercept (a)	Slope (b)	RMSE	Min. TL	Max. TL	r^2
Lake Athens	26	-6.867	3.513	0.077	380	820	0.93
Lake Bob Sandlin	20	-5.032	2.873	0.135	274	910	0.89
Lake Coleto Creek	22	-5.418	3.018	0.033	470	720	0.95
Lake Fork	62	-6.952	3.551	0.060	423	937	0.96
Lake Pat Mayse	30	-6.696	3.429	0.064	478	792	0.87
Lake Monticello	21	-6.246	3.320	0.079	491	840	0.84
Lake Murvaul	26	-6.612	3.430	0.061	410	1000	0.97
Lake O' the Pines	46	-6.565	3.421	0.062	250	860	0.95
Lake Palestine	27	-6.030	3.227	0.045	302	943	0.98
Lake Tawakoni	31	-7.814	3.866	0.064	335	885	0.97
Lake Welsh	34	-6.356	3.366	0.046	555	819	0.93
Lake Whitney	54	-5.809	3.133	0.079	322	837	0.90
Lake Wright Patman	20	-3.737	2.411	0.152	440	800	0.49
Murphree Wildlife Management Area*	76	-6.855	3.554	0.090	366	728	0.90
Taylor Bayou	35	-6.489	3.407	0.085	335	680	0.86

*Data from several small impoundments and bayous were combined.

may necessitate active management in the future, which often relies on length-based regulations (e.g., size limits; Noble & Jones 1999). Therefore, understanding among-reservoir variation in mass-length relationships may be especially important for assessing populations and prescribing management activities.

About 6% of the variation in spotted gar mass was unexplained by length and reservoir effects. This suggests that other potentially important explanatory variables were not included in this analysis. For example, sexual dimorphism in spotted gar mass-length relationships was reported by Redmond (1964) and Tyler & Granger (1984); however, sex was not recorded for the individuals analyzed herein. Also, mass-length relationships of fish vary seasonally in response to changes in food availability and reproductive status (Pope & Willis 1996). Redmond (1964) documented seasonal variation in mass-length relationships of spotted gar in Missouri and observed that condition was greatest during March and July. Redmond speculated that greater than average condi-

tion in March was related to gonad development in preparation for spawning, whereas above average condition in July was related to abundance of fish in the diet of spotted gar.

Abiotic variables, such as temperature, have been shown to be important predictors of fish growth and production (Schlesinger & Regier 1982). In Texas, growth of largemouth bass *Micropterus salmoides* (cf. Miranda & Durocher 1986) and white bass *Morone chrysops* (cf. Wilde & Muoneke 2001) is correlated with latitude, longitude and growing season length, which are indirect measures of thermal opportunity for growth (e.g., Power & McKinley 1997). However, growing season length had little overall effect on spotted gar mass-length relationships, particularly when compared with among-reservoir effects. This suggests that local, within-reservoir variation in productivity and other biological characteristics has a greater effect on spotted gar mass-length relationships than do large-scale patterns in abiotic conditions.

ACKNOWLEDGMENTS

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