Gulf Research Reports, Vol. 8, No. 1, 63–67, 1985

SHORT COMMUNICATIONS

YIELD-PER-RECRUIT OF SPOTTED SEATROUT[1]

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ABSTRACT A von Bertalanffy growth curve,

$$L = 65.47 \text{ cm } (1 - e^{-.2005(t + .4113 \text{ yr})}),$$

is derived from published data on spotted seatrout in the U.S. Gulf of Mexico and used in constructing a yield-per-recruit contour. Maximum yield-per-recruit is approached as F increases above 1 and age of first entry approaches 3.9 years (14.9 in., 1.1 lb). A linear regression is derived relating average size of capture to gill net mesh size (MS in inches),

$$L = 1.97 \text{ in.} + 8.63 \text{ MS},$$

and used along with legal sizes of first harvest to evaluate the impact of current laws in the Gulf states on yield-per-recruit of spotted seatrout.

INTRODUCTION

Spotted seatrout are one of the most important edible finfish in the northern Gulf of Mexico. Despite their preeminence, there is a perception that scientific "information [on seatrout] is general and, for the most part, inadequate" to meet management's needs (Lorio and Perret 1980). Current regulations on the size at harvest are not based upon a quantitative consideration of yield-per-recruit and spawner-recruit relationships. Rather, current laws are largely based upon expedient compromises between conflicting user groups (Perret et al. 1980; Merriner 1980).

In this note we present a yield-per-recruit analysis based entirely upon a synthesis of published data. While lacking the rigor of a study based upon its own data collection, this synthesis does offer a needed first look at the effect of current regulatory restrictions on the yield of this increasingly important resource.

RESULTS AND DISCUSSION

Construction of the yield-per-recruit contour

A von Bertalanffy growth curve,

$$L = 65.47 \text{ cm } (1 - e^{-.2005(t + .4113 \text{ yr})}),$$

was fitted to size-at-age data (total length in cm) reported for seatrout in U.S. Gulf of Mexico estuaries (Pearson 1929, Klima and Tabb 1959, Moffett 1961, Stewart 1961, Tatum 1980, and Colura et al. 1984) (Figure 1). Mean annual air

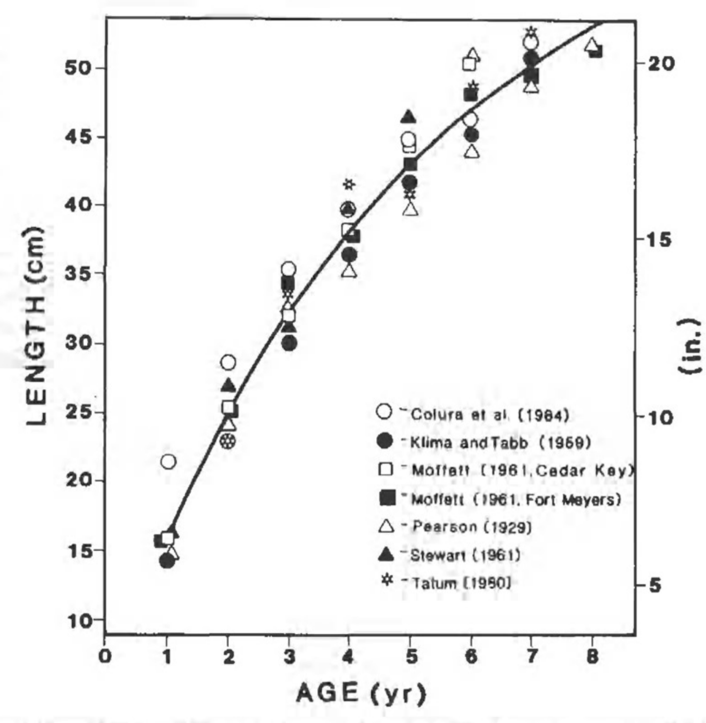

Figure 1. Growth rate of spotted seatrout in the northern Gulf of Mexico. Tatum's "Age I+ . . . Age VI+" data are plotted as age 2 through age 7 fish under the assumption that all of the annual growth had occurred when the length-age measurements were made.

[1]This is contribution No. CFI-84-5, Coastal Fisheries Institute, Center for Wetland Resources, Louisiana State University, Baton Rouge, Louisiana 70803-7503. It results from research supported by the Louisiana Fisheries Initiative.

Manuscript received October 23, 1984; accepted May 18, 1985.

temperature (1941–1970; NOAA 1981, 1983a, b) of the coastal weather station nearest to each study site was used as an index of mean annual water temperature (Table 1). The average of these means was used as an estimate of the overall mean water temperature for the entire data set.

Use of the combined growth equation and overall mean temperature in Pauly's (1979) equation generated an instantaneous rate of natural mortality (M) of 0.45 on an annual basis. These rates of growth and mortality predict that maximum biomass of an unfished cohort is attained at 3.9 yr (14.9 in., 1.1 lb).

Tatum (1980) reports a total annual mortality of 50% (Z = 0.69, where Z is the instantaneous annual rate of total mortality) for spotted seatrout in Alabama. An instantaneous rate of annual fishing mortality (F) of 0.24 is estimated as the difference between Tatum's Z and our M (F = Z – M = 0.69 – 0.45 = 0.24).

For comparison, we reran the natural mortality analysis using the individual estimates of growth and temperature. The predicted individual estimates of M ranged from 0.22 to 0.65 with a mode of 0.36 (Table 1). Maximum biomass of an unfished cohort was predicted to occur over a range of 3.4 yr (14.2 in., 1.0 lb) to 8.4 yr (24.4 in., 5.0 lb) with modes of 4.9 yr and 15.9 in. (1.3 lb) (Table 1).

We are not able to correlate the variation between these individual estimates with location or timing of the studies. For example, estimates were comparable for central and south central Texas despite the wide temporal range of these reports, 1929 and 1984. In contrast, Moffett's study generated two widely differing sets of estimates for north central and south central Florida. We assume that the real variation in growth rates which should occur as one moves from the southern to the northern estuaries of the U.S. Gulf of Mexico is not represented by the variation observed in these estimates. We use our combined equation as the best estimate of growth throughout the rest of this paper.

Data on the average sizes of fishes (total length in inches) caught in differing size mesh (MS in inches) of monofilament and multifilament gill nets are plotted in Figure 2 (Trent and Pristas 1977, Matlock et al. 1978, Adkins et al. 1979, Lorio et al. 1980, Adkins and Bourgeois 1982, Arnoldi 1982). Analysis of covariance indicates no significant effect of mesh type (mono- or multifilament) on the relationships between sizes of fish and mesh,

$$L = 1.97 \text{ in.} + 8.63 \text{ MS}$$

($r^2 = 0.90$, H.S.). The minimum legal mesh sizes of gill nets in the various Gulf states (Table 2) were used in this weighted regression to estimate average size at entry.

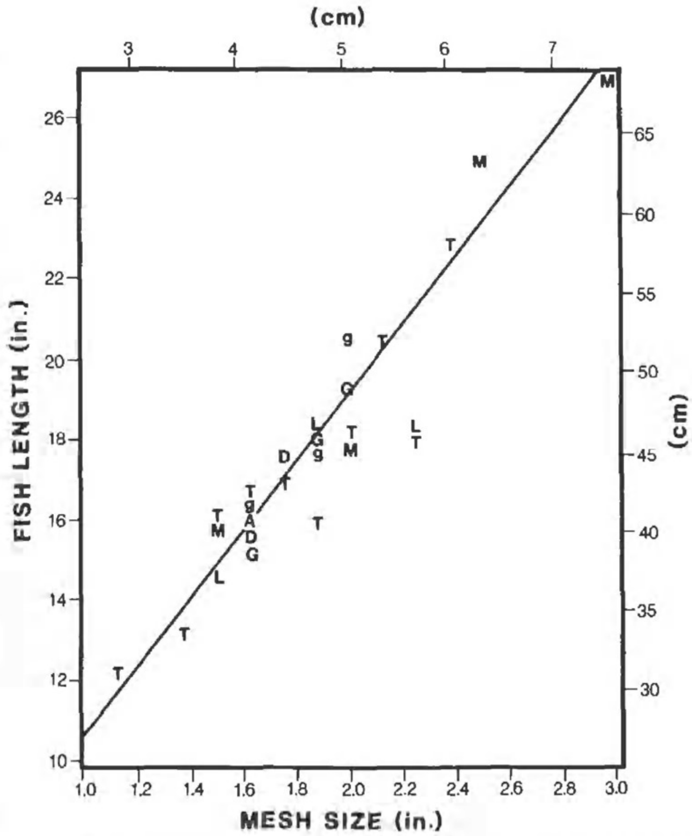

Figure 2. Relationship between mesh size of monofilament or multifilament gill nets and average length of spotted seatrout captured. Data from Matlock et al. 1978 (M); Trent and Pristas 1977 (T); Adkins et al. 1979 (A); Lorio et al. 1980 (L); Adkins and Bourgeois 1982 (G, monofilament; g, multifilament); and Arnoldi 1982 (D).

TABLE 1

Estimates of growth, mortality, and of age and size of maximum biomass predicted for an unfished cohort.

Area of study	Author	L_∞ cm	k annual	t_0 years	Temp. °C	M annual	Age years	Length in.	Wt. lb
Corpus Cristi, Texas	Pearson 1929	71.4	.148	−0.640	22.2	.36	4.9	15.6	1.3
Matagorda, Texas	Colura et al. 1984	72.6	.152	−1.288	21.4	.36	4.0	15.9	1.3
Coastal Alabama	Tatum 1980	57.2	.362	0.616	19.8	.65	3.4	14.2	1.0
Apalachicola, Florida	Klima and Tabb 1959	78.4	.140	−0.456	20.3	.32	5.6	17.5	1.8
Cedar Key, Florida	Moffett 1961	114.4	.085	−0.814	22.0	.22	8.4	24.4	5.0
Fort Meyers, Florida	Moffett 1961	62.6	.214	−0.343	23.3	.49	3.6	14.1	0.9
Flamingo, Florida	Stewart 1961	85.2	.138	−0.579	25.0	.35	5.2	18.4	2.1
Combined	All of the above	65.5	.200	−0.411	22.0	.45	3.9	14.9	1.1

TABLE 2

Current size and gill net restrictions on the harvest of spotted seatrout in the northern Gulf of Mexico.

	Florida	Alabama	Mississippi	Louisiana	Texas
Size limit					
Recreational	12 in. (but no size limit in Gulf and Franklin counties).	12 in.	None	None	14 in.
Commercial	12 in. (but no size limit in Gulf and Franklin counties).	Currently prohibited. Formerly 12 in.	12 in.	12 in.	Currently prohibited. Formerly 12 in.
Gill net mesh size (minimum)	Varies by local statutes or general statutes of local application or by rules of the Marine Fisheries Commission that are approved by the Governor and Cabinet.	Currently prohibited. Formerly 1.25 in. in Mobile County and 1.5 in. in Baldwin County.	1.5 in.	1.75 in.	Currently prohibited. Formerly 1.5 in.

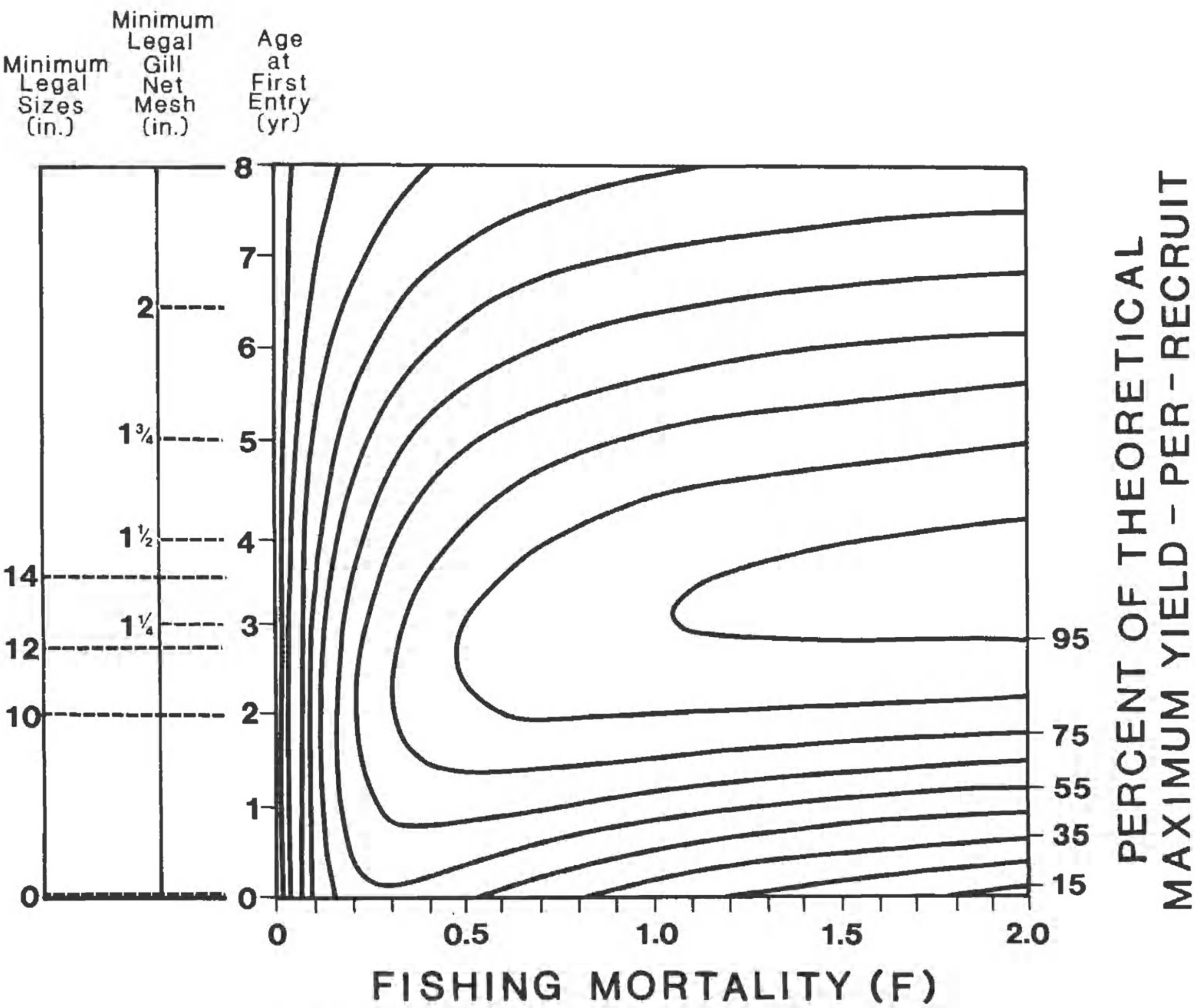

Figure 3. A yield-per-recruit contour for spotted seatrout in the northern Gulf of Mexico. Points indicate the entry levels associated with the current or recent Gulf state laws on minimum legal sizes of harvest and of gill net mesh (Table 2).

Effect on yield-per-recruit

A yield-per-recruit contour was computed with Ricker's (1975) expanded form of Beverton's expression using these estimates, Harrington et al.'s (1979) length-weight relationship, and 12 years as an estimate of the maximum attainable age (Figure 3). Sizes of first entry as denoted by legal size limits (Table 2) and average size at entry predicted for gill net mesh limits are denoted for the respective states on the plot.

The fisheries of most concern are in Florida's Gulf and Franklin counties and in Louisiana and Mississippi's recreational fisheries since these fisheries have no legal minimum limits on the size of first harvest. As such any growth-overfishing concerns are superseded by the open nature of these fisheries since they are fully exposed to the potential for spawner-recruit overfishing.

The situation in Louisiana's commercial harvest has been greatly improved by two pieces of recent legislation (Ford 1984). The first reduced Louisiana's gill net mesh from 2.0 in. to 1.75 in., moving the gill net fishery from fish averaging 19.2 in. (6.4 yr, 2.4 lb) to those averaging 17.1 in. (5.0 yr, 1.7 lb). The second increased the minimum legal commercial harvest from 10 in. (2.0 yr, .33 lb) to 12 in. (2.7 yr, .57 lb).

On the other hand, Alabama and, perhaps, Texas have recently moved away from maximum yield per recruit. In both states commercial harvest has been recently prohibited. Before the prohibition the existing regulations targeted the commercial harvest towards the size of fish which would maximize yield: 3–4 years old, 12–15 in., and 0.6–1.1 lb. Given our current estimate of fishing mortality for Alabama, this prohibition will reduce the overall yield for that state, unless it stimulates an increase in the recreational fishery. A similar pattern might be expected for Texas, although the situation is less clear as we have no direct estimate of fishing mortality for that state.

Since the spotted seatrout fishery has a large recreational component, management may be far more concerned with catch-per-angler-hour and spawner-recruit relationships than with yield-per-recruit. Our analysis suggests, however, that efforts to optimize catch-per-angler-hour and to maintain an adequate spawning biomass may be compatible with efforts to maximize yield-per-recruit. Yield appears to be maximized when spotted seatrout are harvested at 3.9 years. This age represents the second year of spawning activity. As such, management that provides for maximum yield-per-recruit, also reduces the danger of spawner-recruit overfishing (as compared to most current regulations), and enhances the recreational experience through the harvest of larger fish.

ACKNOWLEDGMENTS

We would like to thank the following reviewers for their suggestions: A. M. Bankston, V. Guillory, G. C. Matlock, M. D. Murphy, J. E. Roussel, B. Thompson, G. Waguespack and W. Wiseman.

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ADDENDUM (in proof)

Since this paper was written, Mississippi and Florida have begun consideration of new regulations that would change the size restrictions in their states. In Mississippi it is probable that state regulations will be changed to make it illegal to sell, offer for sale, or transport for sale in or from the state of Mississippi, spotted seatrout under 14 in. In Florida it is possible that state regulations will be changed to make 14 in. the minimum size limit for spotted seatrout for both commercial and recreational fisheries. The Florida regulation might or might not be applied statewide. If applied statewide in Florida's recreational and commercial fisheries and applied in Mississippi's commercial fisheries, the 14 in. minimum limit would target the harvest towards the size of fish that would maximize yield-per-recruit in these fisheries. On the other hand, if part of Florida remains exempt from this regulation that part, along with the recreational fisheries in Louisiana and Mississippi, will be fully exposed to the threat of spawner-recruit overfishing.