GONADAL DEVELOPMENT, GROWTH AND CONDITION OF SAND SEATROUT FROM LOUISIANA

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Abstract: Numerous young of the year sand seatrout (*Cynoscion arenarius*) trawled from West Hackberry nearshore sites along the Louisiana coast indicated spawning peaks occurred during spring and late summer. Sexual maturity is reached at about 1 year of age and 150 mm SL for males and females. Growth of zero-year class sand seatrout during summer to fall and fall to winter was approximately 40 mm SL. Standard length of sand seatrout collected during the study ranged from 26 to 268 mm. Small young of the year were abundant during summer and winter at the nearshore site and during winter at the Weeks Island offshore site. Numerous individuals older than 6 months were present only during summer and fall at the nearshore site. Peak condition of spring fish at the nearshore site indicated preparation for spawning and favorable environmental conditions.

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Several workers have published information concerning growth and condition of commercially important fishes in the Gulf of Mexico (Dawson 1965, Parker 1971); however, such information is not available for many recreationally important species of the Gulf. One species in this category, the sand seatrout is very abundant in estuaries and shallow waters of the northern Gulf of Mexico (Gunter 1938, 1945). Sand seatrout are also a major component of the commercial fishery landing and shrimp bycatch in the Gulf (Roithmayer 1965). Although sand seatrout do not grow as large as spotted seatrout (*Cynoscion nebulosus*), they are a popular sportfish. The sand seatrout catch in Galveston Bay (212,000 kg) from September 1974 through August 1975 (Moffett et al. 1979) was exceeded only by the spotted seatrout catch (1,017,000 kg).

Hoese and Moore (1977) reported sand seatrout are confined to the Gulf of Mexico, but are possibly genetically identical to the recreationally important weakfish (*Cynoscion regalis*) of the Atlantic coast. Electrophoretic studies by Weinstein and Yerger (1976) suggest sand seatrout are a subspecies of weakfish. However, osteological studies (Moshin 1973) indicate sand seatrout are a valid species.

Sand seatrout and weakfish exhibit contrasting life history traits. Merriner (1976) stated that peak spawning activity in weakfish occurs in May and June on the North Carolina coast and to a lesser extent in July and August. He also reported male and female weakfish probably attain sexual maturity as 1-year-old fish throughout their geographic range. Young-of-the-year weakfish in South Carolina waters grew 35 mm from July to September (Shealy et al. 1974). Young-

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of-the-year from coastal waters of Virginia grew 55 mm from August to November and 1-year-old fish grew 55 mm from May to October (Massmann et al. 1958). Wilk (1979) reported that the oldest aged weakfish was 9 years old and weighed 5.05 kg. He also stated that weakfish have a long life span and may not spawn until their 2nd year.

Sand seatrout spawn in the Gulf of Mexico (Gunter 1945, Simmons 1951, 1957, Miller 1965) from March through September (Shlossman 1980) with peak activity during spring (Mar-May) and late summer (Aug-Sep). Shlossman (1980) reported sand seatrout spawn at 1 year of age and do not live much longer. Using scales to age sand seatrout from the Gulf of Mexico, off Texas, he observed growth of 10, 35, 15, and 30 mm/month from December to February, March to April, June to July and September to October, respectively. He also reported that bay populations exhibited a slower growth rate than Gulf populations. Perret and Caillouet's (1974) sand seatrout data from Vermilion Bay, Louisiana suggest a 30 to 40-mm total length (TL) increase between June and October. Landry (1977) reported on weekly sand seatrout collections from Galveston Bay, Texas and his data indicated a 25 to 30-mm SL increase during 12 May to 11 July for individuals spawned during spring. Moffett et al. (1979) calculated the log weight - log standard length relationship for sand seatrout from the upper Texas coast and determined regression slope coefficients to be 3.11 and 3.13 for males and females, respectively.

METHODS

Sand seatrout were collected at a nearshore (West Hackberry, Lat. 29° 40.0'N, Long. 93°28.0'W) and an offshore site (Weeks Island, Lat. 29°05.7'N, Long. 91°47.6'W) off Louisiana during Summer (18 - 22 Jun 1978), Fall (26 Sep -1 Oct 1978), Winter (14 - 17 Jan 1979) and Spring (16 - 20 Apr 1979). Collecting procedures employed a 12.2-m semiballoon trawl constructed of 47.6-mm stretched mesh throughout the body and 38.1-mm stretched mesh in the codend. Trawls were towed at night to minimize avoidance.

Sand seatrout were measured to the nearest millimeter of standard length and wet weighed to the nearest 0.01 g. Sex and gonadal development for most sand seatrout were determined by visual inspection of dissected fish according to the generalized classification scheme of Nikolsky (1963). Gonads of dissected fish were wet weighed to the nearest 0.01 g. Linear regression was used for groups of 10 individuals or more to relate log gonad weight to log body weight for seatrout which possessed a measurable gonad weight (0.01 g) but had not spawned. Seasonal length frequency distributions for respective gonadal stages were plotted for both sexes. Size classes were differentiated by assuming the peak of successive modes of a length-frequency distribution as the representative length of a size class (Lagler and Applegate 1943). Seasonal absolute population growth rates were determined for individual year classes by comparing differences in position of modal length size classes (Ricker 1975). Instantaneous rate of weight increase (G) was also calculated from the position of modal length classes with Ricker's formula: $G = \log L_2 - \log L_1$. Condition was determined by the allometric condition factor (w/l^b) while length-weight relationships were calculated by the geometric mean functional regression described by Ricker (1975). Analysis of variance and Duncan's multiple range tests were performed on length-weight regression coefficient means for each site and season which were calculated from length-weight regression coefficient (b) values for each station, and used as a measure of robustness.

RESULTS

Gonadal Development and Spawning

Sand seatrout from the West Hackberry nearshore site exhibited all gonad stages (Table 1) except reproduction (stage 5) and spent (stage 6). Individuals with immature gonads (stage 1) were abundant during summer and winter. Ripening (stage 3) individuals were prominent during fall. Sexually mature individuals (stage 4) were taken during fall and spring. Females and males exhibiting ripening gonads during summer and fall were larger than 120 and 100 mm SL, respectively (Fig. 1). Females were more abundant than males during all seasons except fall.

Table 1. Seasonal occurrence of gonad stage in sand seatrout from West Hackberry and Weeks Island.

Location and	Summer			Fall			Winter			Spring		
Gonad Stage	U[a]	F[b]	M[c]	U	F	M	U	F	M	U	F	M
West Hackberry												
1 Immature	175	154	101	4		3	109	56	11	6	5	
2 Quiescent		29	22		5	12		11	6		5	4
3 Ripening		9	19		35	58		4			2	2
4 Ripeness					1				1			1
5 Reproduction												
6 Spent												
Total examined	175	192	142	4	41	73	109	71	18	6	12	7
Weeks Island												
1 Immature							199	65	8			
2 Quiescent								3				
3 Ripening		1										
4 Ripeness			1		1							
5 Reproduction			1									5
6 Spent												
Total examined		1	2		1		199	68	8			5

[a] U = Undetermined sex.
[b] F = Female.
[c] M = Male.

All gonad stages of sand seatrout except spent (stage 6) were collected from the Weeks Island offshore site (Table 1). Sexually immature individuals dominated winter collections. Quiescent females from winter collections were larger than 100 mm SL. Sexually mature (stage 4) male and female seatrout from summer and fall collections were larger than 150 mm SL. Reproducing males collected during spring and summer were larger than 160 mm SL. Regression equations developed with data from both sites indicated that, for individuals of the same weight, female gonads were heavier than male gonads (Table 2).

Table 2. Regression equations for log gonad weight (LGW) against log body weight (LBW) for female and male sand seatrout trawled from West Hackberry and Weeks Island sites.

SEX	REGRESSION EQUATION	PR F	R^2
FEMALE	LGW = −20.162 + 2.299 LBW	0.0001	0.81
MALE	LGW = −15.058 + 1.745 LBW	0.0001	0.74

Growth and Size-Class Representation

Three size-class modes were observed in samples of sand seatrout taken from West Hackberry (Fig. 1). An 80-mm SL mode during the summer of 1978 consisted of individuals near 3 months of age which were spawned during 1978. Also present was a 140-mm SL mode consisting primarily of individuals approximately 1 year old. Individuals taken during fall at 110 - 193 mm SL may have been the same age group that comprised the 80 mm SL mode present during summer, and if so, exhibited a 90-mm SL increase from summer to fall (Instantaneous rate of weight increase G = 2.246). However, many 110 to 193-mm SL fall constituents exhibiting a modal length near 180 mm may have been remnants of the summer 125 - 185-mm SL assemblage whose length mode was 140 mm. This would represent a 40-mm SL increase (G = 0.751). Individuals larger than 200 mm SL during fall were part of the older size class sampled during summer.

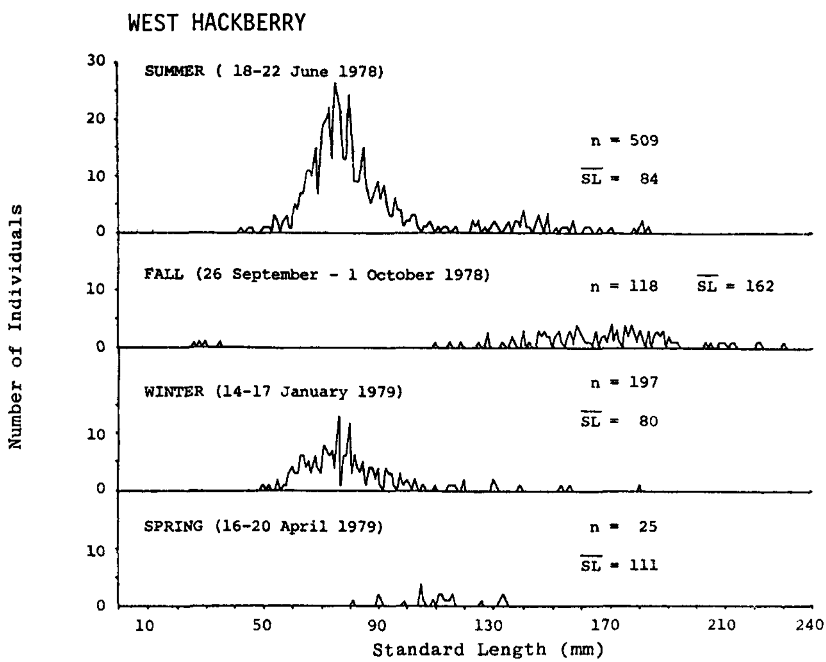

Fig. 1. Seasonal length frequencies, number of individuals measured (*n*) and mean standard length (SL) of sand seatrout trawled from West Hackberry.

Four small (<40 mm SL) individuals collected during fall were less than 2 months old. Winter constituents ranging from 50 to 120 mm SL (modal length near 80 mm) were spawned in late summer 1978 and exhibited growth near 40 mm through the fall (G = 2.072). The few 80 to 133 mm SL individuals collected during spring probably were associated with the 80-mm mode of winter.

The Weeks Island offshore site produced few (≤5) sand seatrout except during winter. Young-of-the-year in winter collections were spawned during late summer 1978 and exhibited a length mode near 70 mm SL (n = 203, SL = 69, SE = 10). Other larger individuals, ranging from 150-268 mm SL, also were present during summer (n = 3), fall (n = 1), and spring (n = 5), and represent individuals near 1 or 2 years old.

Condition

An analysis of variance for seasonal length-weight regression coefficients (b) used as a measure of robustness was performed for each site separately because the interaction term was significant when both sites were combined, causing an inflated R^2 value. Sand seatrout were numerous only during winter at Weeks Island and data were not analyzed for this site. Duncan's multiple range tests indicated sand seatrout from West Hackberry were significantly more robust during spring than at other seasons. Robustness means for other seasons were not significantly different.

DISCUSSION

Shlossman (1980) stated that sand seatrout spawning peaks occurred during spring and late summer. Our data from West Hackberry also indicate 2 separate spawns. Individuals spawned during spring 1978 were captured in June at about 3 months old and exhibited a length mode near 80 mm SL. A 2nd group of individuals spawned during late summer 1978 exhibited a modal length near 80 mm SL and were present during January. These fish, approximately 4 or 5 months old, apparently experienced slow winter growth. Four individuals <40 mm SL collected during fall were <2 months old and associated with a later summer spawn.

Elevated temperatures and low dissolved oxygen levels during late summer were not favorable for spawning, and, as a result, the late summer spawn was not as productive as that of spring. Nevertheless, reproducing males exhibited an extended spawning period which coincided with spring and summer temperatures varying between 23 and 30 C. Sexual maturity occurred at about 1 year of age and 150 mm SL for males and females, which was similar to results of earlier studies (Moffett et al. 1979, Shlossman 1980).

It appeared that individuals spawned during spring 1978 and present at West Hackberry during summer had moved out of the study area by fall. If this migration did not occur, then individuals collected during fall exhibited extremely high growth rates. The literature on sand seatrout growth rates does not support this latter conclusion. Shlossman (1980) reported growth near 40 mm/month for summer while Perret and Caillouet's (1974) data for Vermilion Bay, Louisiana indicate only a 30 to 40-mm increase in total length from June to October. Landry's (1977) data for sand seatrout spawned in Galveston Bay, Texas during spring indicate a 25 to 30-mm increase in standard length from 12 May to 11 July.

Individuals spawned during spring 1978 and actually growing 90 mm from summer to fall (~ 90 days) would indicate a greater instantaneous rate of weight increase than that exhibited from fall to winter (~ 90 days) by 30-mm SL fish spawned during late summer 1978. In addition, seasonal temperature differences do not vary greatly in the northern Gulf of Mexico and high rates of growth during short periods would not be expected. Brown (1957) stated that food supply was probably the most potent factor affecting growth of fishes, and Gillespie (1971) reported peak abundance for zooplankton along the Louisiana coast during April, August and September. We conclude that sand seatrout spawned during spring 1978 which were found at West Hackberry during summer were not present during fall. Therefore, individuals with a length mode near 140 mm SL during summer at West Hackberry were near 180 mm during fall. This would indicate a growth rate which is characteristic of an organism near its maximum size. The greatest growth appears to occur during fall and spring, periods of favorable environmental conditions. Sand seatrout collected were not larger than 268 mm SL; most may not live past 2 years of age.

Sand seatrout which were spawned during spring and late summer 1978 were caught during summer and winter, respectively, at the West Hackberry nearshore site. Individuals spawned during late summer 1978 were also abundant during winter at the Weeks Island offshore site. Numerous individuals older than 6 months were present only during summer and fall at the nearshore site.

Robustness values of sand seatrout from the Galveston Bay System (Moffett et al. 1979) were slightly higher than overall values for West Hackberry and Weeks Island fish. Peak condition during spring at West Hackberry may indicate preparation for spawning and favorable environmental conditions.

Sand seatrout as well as weakfish exhibit spring and late summer spawns after obtaining sexual maturity at 1 year of age. Oldest sand seatrout from West Hackberry and Weeks Island sites were at least 1 year of age, except for 1 268-mm SL individual which may have been 2 years old. Shlossman (1980) reported annual mortality between 99.5 and 99.9% for sand seatrout. However, weakfish appear to have a greatly extended life (Wilk 1979).

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