Aspects of the Biology of Spotted Seatrout in Calcasieu Lake, Louisiana, with Management Implications

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Abstract: A life history study of spotted seatrout (*Cynoscion nebulosus*) was conducted in Calcasieu Lake, Louisiana, from January 1976 through December 1983. This species was found to be essentially non-migratory, as it appears to spend most of the year within Calcasieu Lake. Most spawning takes place during July and August. Fecundity values for various length classes captured in 4.1-, 4.4-, and 5.1-cm bar mesh monofilament gill nets demonstrated that spotted seatrout taken with the 4.1-cm bar mesh contributed greater spawning power than fish caught in both the 4.4-cm and 5.1-cm combined. Spotted seatrout captured in the 3 mesh sizes approximately corresponded with age classes III, IV, and V respectively. The minimum bar mesh of 4.4 cm is recommended to allow age class III to spawn with little risk of net capture. A portion of Calcasieu Lake (West Cove) should be designated as a sportfishing area only.

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The spotted seatrout is one of the most sought after coastal finfishes throughout the northern Gulf of Mexico and South Atlantic coastal area (Guest and Gunter 1958). Its desirability as both a game and food fish have caused considerable difficulties among sport and commercial fishermen. Many sportfishermen claim commercial finfishermen are depleting spotted seatrout stocks, while the commercial faction claims an historical right to the fishery.

Conflicts between the 2 groups over this species have occurred in Louisiana, Texas, Mississippi, Alabama, and Florida. Both Texas and Alabama have closed commercial fishing for red drum (*Sciaenops ocellata*) and spotted seatrout by classifying these fish as "game" species.

From 1975 through 1977, summer daytime closure of all commercial finfishing was enacted by the 1975 Louisiana Legislature. This act was the result of a "gentlemen's agreement" between sport and commercial fishermen in southwest Louisiana, during which time the Louisiana Department of Wildlife

and Fisheries was to initiate a spotted seatrout study. The objectives of this study would be to present management recommendations for the spotted seatrout fishery.

The daytime restrictions in Calcasieu Lake did not prevent statewide coastal finfish conflicts. In 1977, the Louisiana Legislature enacted Act 653, H.B. 1117 which prohibited monofilament gill nets and established: (1) a 2.5-cm bar maximum for seines, (2) a 5.1-cm bar minimum for gill nets and (3) a 2.5-cm bar maximum for inside walls of trammel nets. The 5.1-cm minimum mesh requirement replaced the previous 3.8-cm legal bar mesh for gill nets; the new law therefore had the potential for drastically reducing the commercial catch of spotted seatrout.

Synopses of various Gulf States coastal finfish management practices were presented by Lorio and Perret (1980) and Perret et al. (1980). Ramsey and Wakeman (1983) presented management implications from electrophoretic analysis, age and growth, and estimates of natural and fishing mortality of spotted seatrout. Lorio et al. (1980) studied the impact of netting and sport fishing on spotted seatrout in Mississippi.

Objectives of this study were to determine the relative abundance of various spotted seatrout size classes and their relative spawning contributions through fecundity analysis and to analyze movement and migrational patterns. The study was funded by Dingell-Johnson Federal Aid Projects F-32-R and F-42-R.

Methods

Calcasieu Lake is a relatively shallow estuarine lake located mostly in Cameron Parish, Louisiana, with the northernmost tip in Calcasieu Parish, Louisiana. Much of the lake system averages <2.4 meters in depth at mean high water (Barrett 1970). The lake receives much of its freshwater inflow from the 6,578-km^2 Calcasieu River watershed (U.S. Dep. Agric. 1974) and its saline water from the Gulf of Mexico via Calcasieu Pass and the Calcasieu Ship Channel. Calcasieu Lake is 21,416 ha, based upon shoreline high water marks (Barrett 1970). Calcasieu Lake is transected by the 152-m wide, 12.2-m deep Calcasieu Ship Channel, constructed in 1927 and dredged to its present width and depth in 1965 (Port of Lake Charles, pers. commun.).

Both daytime and overnight gill net sets were made in 3 Calcasieu Lake zones (north, south, and West Cove) from January 1976 through December 1983. Prior to July 1978, 2 sets per zone were taken; thereafter, sets were reduced to 1 set per month. A 182.8-m monofilament gill net, 4.1-cm bar mesh, was used from January 1976 through June 1978. It was reduced to 91.4 m for the remainder of the study. Monofilament gill nets, each 91.4 m long, with 4.4- and 5.1-cm bar mesh were used from July 1981 through December 1983. In addition, a 91.4-m monofilament gill net, 1.9-cm bar mesh, was used January 1976 through June 1981. All nets were 2.4 m deep. Live

spotted seatrout taken in nets were measured to total length (TL), tagged, with the remainder measured to TL and standard length (SL) and weighed.

Tagging was also accomplished by hook-and-line and beach seining with a 91.4-m, 1.9-cm bar monofilament gill net. Spotted seatrout were tagged in the frontal base of the dorsal fin between the neural spine and the dorsal fin pterygiophores with Floy FD68-B anchor tags, measured (TL), and released.

Spotted seatrout fecundity was determined from 115 ovaries collected from 1976 through 1980. Ovaries from fish caught either by net or hook-and-line were frozen in water after collection. For lab analysis, eggs were estimated volumetrically in methodology described by Lagler (1956). After the eggs were separated from ovarian connective tissue, they were strained and allowed to blot dry. Asymmetrical and very small (<100 mm diameter) occytes were not counted. An aliquot of 0.2 ml was displaced in a 10-ml graduated cylinder; the eggs were then counted. The remainder of the egg mass was then placed in a 100-ml graduated cylinder and the displacement noted.

Although age-and-growth of spotted seatrout was not studied in this project, synopses from Lorio and Perret (1980) from various Gulf of Mexico locations were used in Table 1 for comparative purposes. Standard lengths were converted to total lengths in the formula described by Moffett (1961) as TL = 1.22 SL. This formula is useful for comparative purposes but is probably somewhat inaccurate for certain length classes (Overstreet 1983).

Results

Fish Tagging

A total of 4,569 spotted seatrout were tagged and released from January 1976 through December 1983 with 61 tag returns reported. Average elapsed time from time of tagging to time of recapture was 58.6 days, with a range of

Table 1. Ranges and standard deviations of total lengths of spotted seatrout in 8 year classes collected at various Gulf of Mexico and Atlantic coastal areas.[a]

Age group	Range in total length (mm)	SD (mm)
I	140–201	16
II	232–302	16
III	309–378	22
IV	378–468	24
V	449–558	30
VI	510–650	37
VII	526–684	51
VIII	534–761	78

[a] After Lorio and Perret (1980).

1 to 433 days, and average movement was 13.5 km, with a range of 0 to 177 km. Of the reported returns, 54 returns were reported from Lake Charles, Calcasieu Lake, and the Calcasieu Lake Ship Channel; and 7 returns were reported from the Gulf of Mexico.

Twenty-two of the 61 tag returns were from 175 spotted seatrout tagged October through December 1977 in the north-central portion of Calcasieu Lake. Even though all returns from these tagged fish were reported from Calcasieu Lake, there were indications of a gulfward migration and subsequent return to Calcasieu Lake in the winter of 1977–78. Tag returns from spotted seatrout tagged in fall 1977 showed 2 stages of movement. Initial tag returns from October through December 1977 showed definite southward movement. Following a lull in tag returns from early December through mid-January, 13 tag returns were reported from 20 January to 1 February 1978 in the south central portion of Calcasieu Lake. Tag returns after January indicated a continued northerly movement by spotted seatrout to areas where they had been tagged about 4 months prior. Tag returns from spotted seatrout tagged from January 1978 through June 1981 were far fewer in number and therefore less conclusive, although they do show signs of gulfward movement and return. Two spotted seatrout tagged in Calcasieu Lake were recaptured at Southwest Pass of Vermilion Bay and near Marsh Island, a distance of 161 and 177 km, respectively. Four spotted seatrout tagged in West Cove in October 1980 were returned 26 and 27 November 1981 in areas east and south of where they were tagged. These returns further indicate a fall gulfward migration.

A similar gulfward movement may occur during early summer, where a major segment of the population may remain for extended periods. One fish tagged in West Cove in May 1976 was later recaptured by a beach seine at Johnsons Bayou along the Gulf of Mexico beach in July 1976, a distance of approximately 400 km. Additionally, 2 fish tagged in early June 1979 at the south end of Calcasieu Lake were returned later at locations either closer to or in the nearshore Gulf of Mexico. Spotted seatrout tag returns from fish tagged at Holly Beach on the Gulf and at the lower jetties of the Calcasieu Ship Channel during the summer months generally showed little or no movement during summer.

Adult Relative Abundance

The 91.4-m, 1.9-cm bar mesh net captured numerous young-of-the-year spotted seatrout, mostly from 153 to 228 mm TL (Table 2). A majority of these fish (61.4%) were taken from February through May each year, and probably represent the faster-growing individuals of the previous year's spawn.

Catches from the other monofilament gill nets, with 4.1-, 4.4-, and 5.1-cm bar mesh were compared to estimate relative abundance and size distribution of spotted seatrout. Mean total lengths of captured spotted seatrout in each of the above nets were 398.8, 416.8, and 460.0 mm, respectively (Table 3). Mean weights for these fish were 721.2, 839.1, and 1,052.3 g. On a basis of

Table 2. Length frequences of spotted seatrout caught in various bar mesh monofilament gill nets.

Total length (mm)	1.9 cm	4.1 cm	4.4 cm	5.1 cm
127–152				
153–177	91			
178–203	186			
204–228	62			
229–253	23			
254–278	21			
279–304	11	1		
305–329	12	9		
330–355	12	150		
356–380	17	346	60	5
381–405	20	296	136	18
406–431	15	191	95	25
432–456	5	69	54	35
457–482	3	43	15	39
483–507	4	22	16	18
508–532		13	7	11
533–558	1	3	8	8
559–584		3	1	2
585–609	1		1	2
610–634	2		1	1
635–660	2			1
Total	488	1,146	394	165

catch-per-hour per 91.4 m of net, the 4.1-, 4.4-, and 5.1-cm nets averaged 0.84, 0.34, and 0.18 fish/hour spotted seatrout, respectively (Table 3).

Fecundity

Egg count estimate data from 115 spotted seatrout ovaries collected from 1976 to 1980 were pooled by years against total length and fish weight. The linear regression for fecundity versus total length was $F = -1{,}814.32 + 6.46$ TL ($r^2 = 0.70$). When fecundity was plotted against fish weight, the linear regression was $F = -31.81 + 1.14$ FW ($r^2 = 0.75$). Egg counts for mean total

Table 3. Relative abundance and fecundity of Calcasieu Lake spotted seatrout.

	Mesh size (cm)		
	4.1	4.4	5.1
Catch/hr. 91.4-m net	0.84	0.34	0.18
Mean total length (mm)	398.8 (34.5)[a]	416.8 (39.8)	460.0 (51.9)
Estimated year class of modal lengths[b]	Upper III Lower IV	IV	Upper IV Lower V
Approx. *N* eggs/ mean length female	760,900	877,100	1,156,000
Percent relative spawning contribution	55.8	26.0	18.2

[a] Standard deviation in parentheses.
[b] After Lorio and Perret (1980).

length spotted seatrout in the 4.1-, 4.4-, and 5.1-cm bar nets were estimated to be 760.9, 877.1, and 1,156 thousand eggs, respectively. Number of eggs per gram of fish weight was 1,090 (SE = 0.45) with a 99% confidence limit of ±110 eggs/g.

Discussion

Movement and Migration

In Calcasieu Lake, spotted seatrout appear to move gulfward in the fall and lakeward after mid-winter in each year. There are also gulfward movements in summer, probably in conjunction with spawning. Movements appear to be temperature related in fall, winter, and mid-summer; spawning-related in spring and summer; and also forage-related throughout the year. Spotted seatrout have been noted to be essentially non-migratory (Moffett 1961, Iverson and Tabb 1962, Ingle et al. 1962) based on Florida tagging studies. Other authors have noted seasonal migrations: spotted seatrout migrate to deeper, more thermally stable waters of bay channels, potholes, and nearshore oceanic habitats during both extremely cold or hot weather (Moody 1950, Tabb 1958, Breuer 1962, Fontenot and Rogillio 1970, Swingle 1971, Mahood 1974).

There is little evidence of mixture among estuarine "sub-populations" of spotted seatrout in this region since only 2 of 61 tag returns could be considered as having migrated to another estuarine area with its own sub-population of spotted seatrout. This finding is in agreement with data from Florida (Iverson and Tabb 1962). Therefore, despite the seasonal mass migrations to and from the lower ship channel and the Gulf of Mexico, the spotted seatrout in this area should be considered to be 1 population. However, there may be enough exchange among estuarine areas to sustain the homogeneity of the gene pool along the coast as reported by Ramsey and Wakeman (1983).

This "quasi-resident" spotted seatrout population may be susceptible to unlimited commercial fishing with nets having a bar mesh <4.4 cm, especially with any concurrent increase in sport fishing pressure and decrease in recruitment. Most of the population appears en masse in Calcasieu Lake in spring and fall, thus allowing for potential overfishing. If a proportion of the population remained in the Gulf of Mexico year round, allowing for recruitment of a relatively unfished population, then management recommendations in Calcasieu Lake would need be less stringent. The commercial and sport fishing pressure in the Gulf of Mexico is light compared to the inshore fishery.

Fecundity

In Calcasieu Lake, sexual development in spotted seatrout generally begins in March, peaks from May through August, and terminates in late September. Spawning is heaviest in July and August. Fecundity of Calcasieu Lake spotted seatrout exceeded values reported by Tabb (1961) in Florida, Pearson (1929), and Miles (1950) in Texas, and Sundararaj and Suttkus (1962) in

Louisiana, but were considerably less than those reported by Overstreet (1983) in Mississippi.

Overstreet (1983) included all oocytes >30 mm in diameter, while the other authors counted only large, yolky eggs. Overstreet (1983) used volumetric ratios, which he claimed were more accurate because of lesser influence from tunica albuginea and "excess" ovarian tissue fluid. Very small oocytes are not included in this study because it is questionable whether these would be eligible during the latter part of the spawning season.

Adult Size Composition and Spawning Potential

The 4.1-, 4.4-, and 5.1-cm bar monofilament gill nets probably captured a representative cross-section of the Calcasieu Lake adult spotted seatrout population except for fish <330 mm TL, which probably comprise the entire age group II and part of age group III. Most age II fish are non-sexually mature; however, essentially 100% of all age III fish are mature.

Relative abundance presented as a catch-per-hour index shows modal lengths of 356 to 405 mm ($x = 398.8$ mm, SE = 34.5 mm) and a catch index of 0.84 fish/hour for the 4.1-cm bar net. Spotted seatrout in this net represent the upper age group III and lower age group IV categories. These size classes represent 55.8% of the spawning potential of all fish susceptible to the three mesh sizes, even though individually the fecundity is less for smaller individuals (Table 3).

Relative catch was recorded as 0.34 fish/hour in the 4.4-cm bar net (Table 3). These spotted seatrout had modal lengths of 381 to 431 mm TL ($x = 416.8$ mm, SE = 39.8 mm) indicating that most were age group IV. The size class captured by this gear represent 26.0% of the total spawning potential of all fish captured. The spawning contribution by age group IV, even with greater individual fecundity, was much less than that of age group III due to lower relative numbers of the total spawning population. This was also true for age V fish.

Spotted seatrout susceptible to the 5.1-cm bar monofilament gill net had a modal length of 432 to 482 mm TL ($x = 460.0$ mm, SE = 51.9 mm). Relative catch was recorded as 0.18 fish/hour. These fish comprised the larger age group IV and smaller age group V individuals. These size classes represent 18.2% of the total spawning potential of all fish captured. Individual fecundities for females of these size classes may exceed 1 million (Table 3).

Management Recommendations

When several user-groups utilize a common resource, i.e., spotted seatrout, management recommendations will not completely satisfy all groups. Without sufficient recreational and commercial catch data, it is impossible to allocate the resource with any degree of certainty. The ratio of recreational/commercial catch as reported by Adkins et al. (1979) in Vermilion Bay and

other similar ratios generated by the National Marine Fisheries Service may not have any validity in Calcasieu Lake. Likewise, fish population estimates as presented by Ramsey and Wakeman (1983), where such factors as annual recruitment and the recreational/commercial catch ratio are assumed to be constant are prone to have large error margins. In Calcasieu Lake, more than one-half of the tag returns from 1976 to 1983 were from commercial fishermen. It was also noted that recruitment also fluctuates significantly from year to year.

The saltwater finfish laws prior to 1977 allowed 3.8-cm minimum bar mesh nets, monofilament or nylon, to be fished in Louisiana. Most of the age group III spotted seatrout were susceptible to this gear. This situation is objectionable from a fisheries management perspective, as spotted seatrout reach their full spawning potential at age group III. Unlimited fishing with this gear, which targets almost all spawning-age fish, could significantly reduce the catch available to all fishermen, especially after several years of poor recruitment.

The 5.1-cm minimum bar mesh, which is presently the legal mesh size, allows commercial fishermen less than 18% of the total number of available adult spotted seatrout. With the light weekday recreational fishing noted throughout much of the project, this law constitutes an underutilization of the resource, as many spotted seatrout succumb to natural mortality by the time they are susceptible to this gear. In a long-lived species, an increase of gear size would simply postpone fishing effort until these fish again became susceptible to capture (Gulland 1974). This postponement would not occur in the spotted seatrout fishery.

This author recommends that commercial fishermen be allowed to use 4.4-cm bar monofilament gill nets throughout Calcasieu Lake, except that West Cove should be designated a sportfishing area only. This gear would allow all of age group III to avoid net capture and would still allow a significant commercial and recreational harvest. Even though the closure of an area is biologically unjustifiable, it would allow sportfishermen an area where no commercial netting is allowed, for numerous recreational fishermen object to even the presence of net fishermen. A closed area is not a management panacea, but it is easy to enforce and is easily understood by fishermen (Gulland 1974). Allowing commercial fishermen the use of monofilament gear would be a trade-off for closure of West Cove. Monofilament gear is an anathema to many recreational fishermen. Adkins and Bourgeois (1982) noted that monofilament nets outfished multifilament nets of similar mesh sizes; however, mesh size irregardless of material was a more important factor in fishing efficiency.

There were insufficient data in this project to base recommendations on a yield-per-recruit analysis due to insufficient fishing mortality statistics through tagging and absence of creel census work. Future work should incorporate these data for management recommendations. This study was understaffed to conduct a creel census survey.

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