Management of Spotted Seatrout in Mississippi: Effects of Changing the Minimum Size Limit

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ABSTRACT

Spotted seatrout, *Cynoscion nebulosus*, is the most targeted sport fish in Mississippi coastal waters. The growing popularity of spotted seatrout angling on the Mississippi Gulf coast and the subsequent increases in fishing pressure require managers to maintain appropriate size and bag limits if this important fishery is to be sustained. Although the number of anglers on the Mississippi coast has increased each year since 1994, data from fishery-independent monitoring and from the Marine Recreational Fishery Statistics Survey (MRFSS) show that population size, age structure, and length frequency distribution of spotted seatrout in Mississippi all display a positive, upward shift. Because catch-per-unit-effort (CPUE) data show that daily bag limits probably have little impact on this particular fishery, it is suggested that the minimum size limit is the determining factor in managing the fishery. A comparison of two groups of data illustrate the importance of applying appropriate management restrictions to a fishery in order to sustain a viable population. These groups of data are from the 1990s when the fishery was under what was essentially a 12-inch minimum size limit and later under a 14-inch minimum size limit.

KEY WORDS: *Cynoscion nebulosus*, fishery management, minimum size limit

INTRODUCTION

Spotted seatrout (*Cynoscion nebulosus*), a member of the family Sciaenidae (drums), is a relatively abundant finfish occurring in the Gulf of Mexico (Gulf) from the west coast of Florida to Texas (Tabb 1966, Mercer 1984). Spotted seatrout is an important recreational fishery species in the Gulf, and in Mississippi it is the most highly sought coastal sport fish (Deegan 1990). The growing popularity of angling for spotted seatrout in Mississippi and the subsequent increases in fishing pressure along the Mississippi Gulf coast necessitate fishery managers to continually assess this population to insure it remains at a sustainable level.

Tagging studies in Mississippi have shown that spotted seatrout is generally a non-migratory species (Hendon et al. in review). Fish tagged during this study seldom traveled distances greater than ten nautical miles and movement to the adjacent states of Louisiana and Alabama was rare (< 1% of recaptured fish). Similar tagging studies in Louisiana (Adkins et al. 1979), Florida (Iverson and Tabb

1962) and Texas (Bowling 1996) also report limited geographic movement for this species. Because of this limited movement, effective management of this fishery can be best accomplished on an individual state level.

Throughout the 1990s, Mississippi regulated its spotted seatrout fishery through minimum size limits (MSL) and daily bag limits (DBL). From 1992 through 1995, a 14 inch total length (TL) MSL and a 25 fish DBL were in effect, but a provision which allowed for five fish between 12 and 14 inches TL to be retained was also included. In late 1995, the allowance for the retention of five fish between 12- and 14-inches TL was removed, and the DBL was lowered to ten fish. Shortly thereafter, in March 1996, the DBL was increased to 15 fish with the MSL of 14-inches TL kept in place. These limits have remained through 2001. The purpose of this paper is to evaluate the general effectiveness of two management strategies applied to Mississippi's spotted seatrout fishery during the 1990s and to determine the effects of the two established MSLs on population dynamics of this species in Mississippi coastal waters.

MATERIALS AND METHODS

Abundance and length data for spotted seatrout surveyed/collected in Mississippi from 1992 to 1999 were obtained from the Marine Recreational Fishery Statistics Survey (MRFSS) and from the Gulf Coast Research Laboratory's research project "Studies of Spotted Seatrout in Mississippi Coastal Waters", hereafter referred to as GCRL. All hydrology and age data were obtained from the GCRL project, as described in Warren et al. (2001). These hydrology and biological data were compiled from collections taken as part of a fishery-independent monitoring program, in which spotted seatrout were collected on a monthly basis from ten established stations along the Mississippi coast with a 750-foot long by 6-foot deep gill net (Warren et al. 2001). Each net consisted of five 150-foot panels of 2.0 to 4.0 inches stretched mesh (0.5 inch increments). The MRFSS data are fishery-dependent and were obtained from dock-side interviews with anglers and surveys of their catch.

Because management regulations are not the only variables affecting fish populations, fluctuations in hydrological conditions were evaluated for 1993 to 1999 to determine if any of these parameters may have influenced Mississippi's spotted seatrout population. Mean surface water temperature (°C), salinity ($^{o}/_{oo}$), and dissolved oxygen (mg/L) measurements were compared between 1993 through 1994 (12-inch MSL) and 1996 through 1999 (14-inch MSL) to determine if any significant differences existed which may have impacted Mississippi's spotted seatrout population. Comparisons were made with the Kruskal-Wallis non-parametric statistic, and tests were considered significant at the $p < 0.05$ level.

Data were divided into two groups based on periods when different management restrictions were implemented for the spotted seatrout recreational fishery in Mississippi (Table I). Abundance, length and age data will hereafter be referred to based on which group (12-MSL or 14-MSL) they fall within. Note that

in graphical representations of abundance data the white bars depict the year in which regulations were changed and were removed from the analyses.

Table I. Table of management strategies applied to the recreational spotted seatrout fishery in Mississippi from 1992 to present. MSL = minimum size limit; DBL = daily bag limit; Undersize = number of fish between 12- and 14-inches TL allowed to legally be retained by anglers.

Group	Date/Period	MSL	DBL	Undersize
12-MSL	May 1992 to Nov 1995	14-in TL	25	5
14-MSL	Dec 1995 to Feb 1996	14-in TL	10	0
14-MSL	Mar 1996 to present	14-in TL	15	0

RESULTS

Although Mississippi's recreational fishery for spotted seatrout is regulated by both a MSL and a DBL, harvest numbers from MRFSS indicate that the DBL had minimal influence on the overall management success of the fishery in recent years (Figure 1). From 1996 to 2000, 90% of the intercepted angler trips in Mississippi yielded a harvest of ten fish or fewer, and almost 73% yielded a harvest of five fish or fewer. Less than 6% of the angler trips during this time period reached (or exceeded) the DBL of 15 spotted seatrout. Based upon the high percentage of angler trips that yielded five or fewer fish, it is assumed for purposes of this manuscript that the possession allowance of five fish between 12- and 14-inches TL from 1992 to 1995 equated to operating under a 12-inch MSL for most Mississippi anglers during this time period. Under this assumption, we have labeled fish taken when the fishery was under this allowance of undersize fish as "12-MSL", while "14-MSL" are those fish collected under a 14-inch MSL with no undersize allowance.

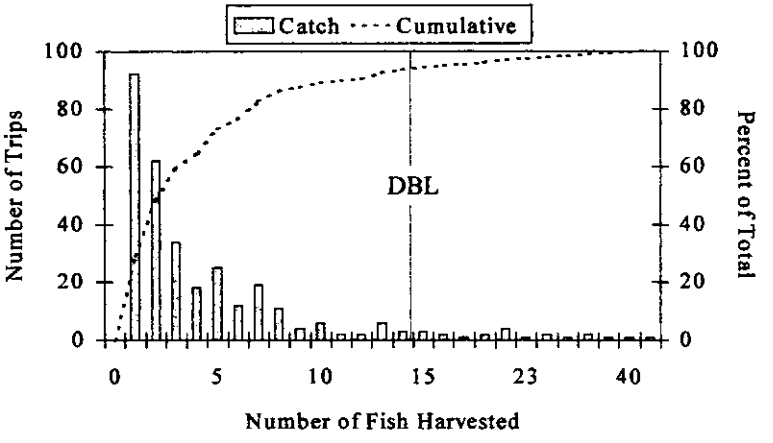

Figure 1. Number of angler trips that harvested increasing numbers of spotted seatrout in Mississippi (source: MRFSS).

Environmental Variations

Of the three hydrological conditions compared, both surface water salinity and dissolved oxygen differed between the two groups of data (Table 2), while tests of surface water temperature revealed no significant difference. Salinity was statistically higher for the 14-MSL period than for the 12-MSL, while dissolved oxygen was statistically higher for the 12-MSL period.

Table 2. Statistical values for comparisons of hydrological data of the Mississippi Sound for 12-MSL and 14-MSL, Kruskal-Wallis test considered significant at $p < 0.05$.

Parameter	p-Value	12-MSL $\bar{x}_{rank}$	12-MSL Actual $\bar{x}$	14-MSL $\bar{x}_{rank}$	14-MSL Actual $\bar{x}$
Salinity (‰)	0.000	156.1	8.45	200.9	11.50
Temp (°C)	0.310	221.7	22.78	208.8	21.98
D. O. (mg/L)	0.005	236.8	7.53	201.4	6.97

Trends in Abundance

Both MRFSS and GCRL data show an increase in spotted seatrout abundance in Mississippi beginning in 1996, immediately after the 14-MSL was implemented. MRFSS harvest data illustrate a gradual upward shift in the numbers of spotted seatrout landed in Mississippi, from an eight-year low in 1994 to a peak in harvest in 1999 (Figure 2). Under the 12-MSL, abundances averaged 204,707 fish harvested per year, the lowest average harvest for any two years in the MRFSS data for the time period evaluated. Numbers harvested for the 14-MSL averaged 329,524 fish per year, representing more than a 60% increase in fish landed in Mississippi. Although low sample size prevents statistical comparison of these data, the trend of increasing abundance from the 12-MSL period to the 14-MSL period indicates that Mississippi's recreational spotted seatrout fishery benefitted from the increase in MSL.

The GCRL fishery-independent data mirror the trend of continuous increasing abundance of spotted seatrout following the 14-inch MSL, with the exception of 1999 which represents a slight decline relative to 1998 (Figure 3). Average annual abundance for the 12-MSL period was 272 fish collected per year, nearly a third less than the average of 361 for the 14-MSL. For the years evaluated in this study, the MRFSS and GCRL data follow an almost identical trend for spotted seatrout abundance in Mississippi, albeit on a much different scale. As with the MRFSS numbers, these fishery-independent data illustrate a greater number of fish associated with the 14-MSL than with the 12-MSL, suggesting a larger population.

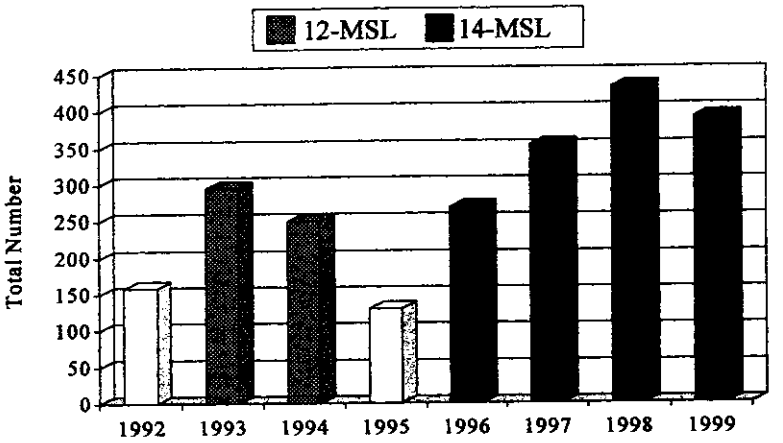

Figure 2. Annual harvest of spotted seatrout in Mississippi (source: MRFSS). White bars represent years not included in analyses because of MSL changes.

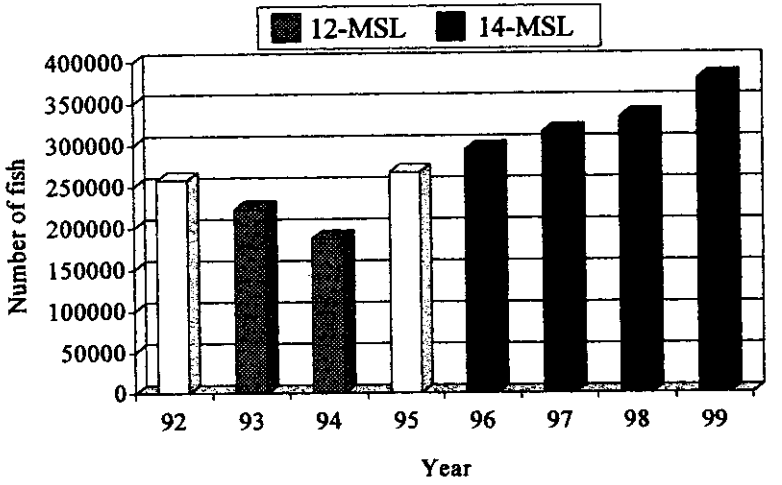

Figure 3. Annual abundance of spotted seatrout in Mississippi (source: GCRL).

Trends in Numbers at Length

With the increase in the MSL, the modal length for fish sampled in the recreational fishery (MRFSS) shifted up from 13-inches under the 12-MSL to 14-inches under the 14-MSL (Figure 4). Not only did the modal size shift upward, but the average number of relatively large fish harvested (14- to 16-inch TL) more than doubled from the 12-MSL period ($\bar{x}_{(14\text{-}16)}$ = 18,304) to the 14-MSL period ($\bar{x}_{(14\text{-}16)}$ = 42,554). Mean numbers from the GCRL data did not display the upward shift in modal length that the MRFSS data exhibited (Figure 5), although numbers at length increased from the 12-MSL to the 14-MSL for each length interval (one inch). The lack of a modal shift in the GCRL data would be expected since fish collected in this program were not subject to the MSL restriction.

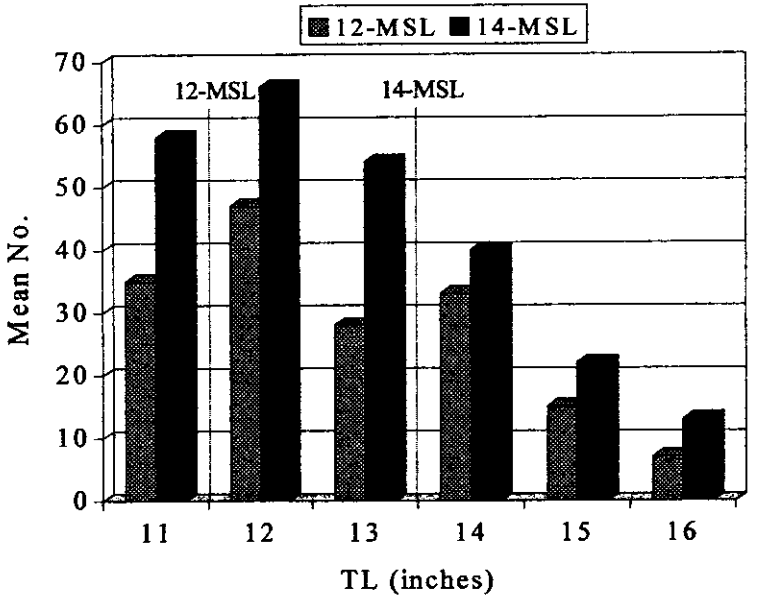

Figure 4. Mean numbers at length for spotted seatrout landed in Mississippi (source: MRFSS).

The purpose of the GCRL monitoring program was to attempt to provide an accurate sample of the state's adult/sub-adult spotted seatrout population. Fish are generally subject to capture by the independent sampling gear at approximately nine inches TL and longer. An increase in the numbers of fish in each size interval, with the exception of the MRFSS data for 12- and 13-inch fish under the 12-MSL, was observed after the establishment of the 14-MSL, and both groups of data illustrate higher abundances of larger fish in Mississippi's population of spotted seatrout.

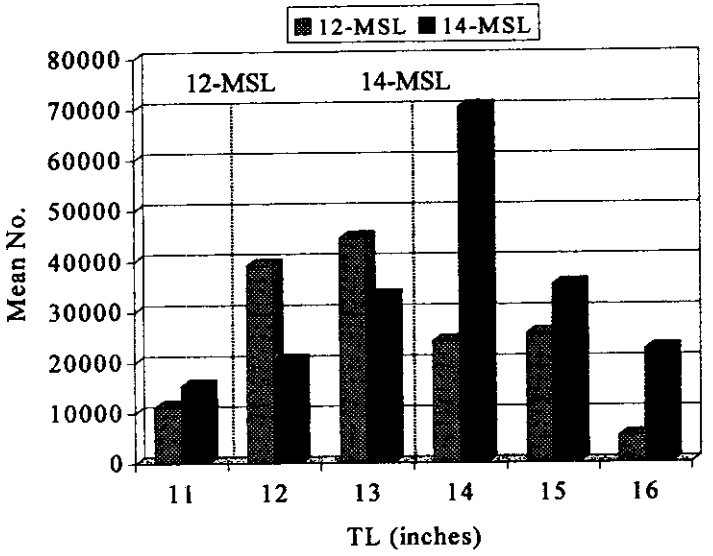

Figure 5. Mean numbers at length of spotted seatrout in Mississippi (source: GCRL).

Trends in Numbers at Age (GCRL Data)

As with length data, numbers at age of spotted seatrout also rose substantially with the implementation of the 14-MSL (Figure 6). In particular, mean abundance of age-1 fish rose from 132 fish under the 12-MSL to 230 fish under the 14-MSL (74% increase), while mean abundance of age-3 fish more than doubled from 15 to 34 fish, respectively. Total numbers of age-1 fish per year is used as an "annual index of recruitment" into the fishery, and these data also show the general trend of increasing abundance from the 12-MSL to the 14-MSL (Figure 7). These data are of particular interest to fishery managers as they provide an insight into the general "health" of the population, and the increases observed under the 14-MSL suggest a population of increasing numbers.

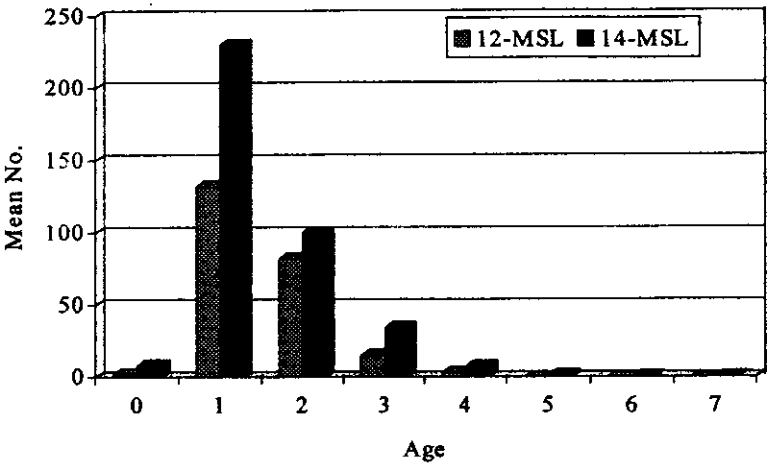

Figure 6. Age structure of spotted seatrout in Mississippi (source: GCRL).

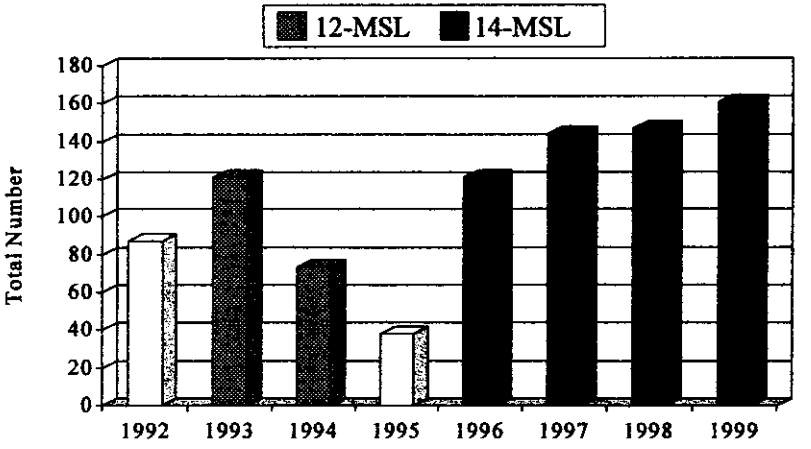

Figure 7. Annual abundance of age-1 spotted seatrout in Mississippi (source: GCRL).

DISCUSSION

Two management tools, the minimum size limit and daily bag limit, have been used by Mississippi fishery managers to regulate the state's important spotted seatrout fishery. Based on catch-per-unit-effort data, the DBL seems to have been of little significance in recent regulation of this fishery. Therefore, an assessment of effective management methods for Mississippi spotted seatrout was obtained by evaluating population dynamics when the fishery was under essentially a 12-inch MSL versus a 14-inch MSL.

In an attempt to remove environmental variation from this assessment, comparisons of surface water temperature, dissolved oxygen and salinity were made between the two management periods evaluated. Water temperature did not differ between the two groups of data, but differences in dissolved oxygen and salinity were detected. Dissolved oxygen levels were statistically higher for the 12-MSL period, and it is unlikely that the lower levels observed for the 14-MSL period would result in increasing numbers of fish. The salinity observed for the 14-MSL period averaged three parts per thousand higher than that for the 12-MSL, however mean salinity since 1993 remained fairly consistent until 1999 when average salinity in the Mississippi Sound increased almost five parts per thousand due to unusually dry summer conditions (Figure 8). Because numbers of spotted seatrout collected in the GCRL program showed a decline in 1999 during this period of higher salinity (Fig.ure 3), it can be surmised that the higher salinity for the 14-MSL period likely had little effect on increasing numbers of fish.

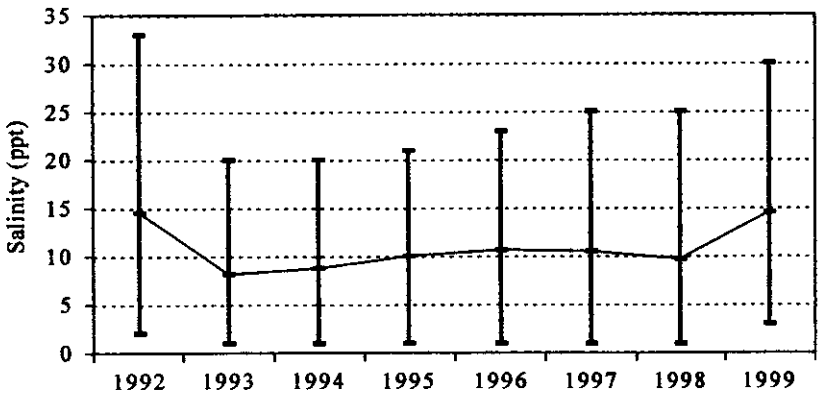

Figure 8. Mean annual salinity (°/$_{oo}$) of the Mississippi Sound (source: GCRL). Vertical bars represent range of values observed.

Data from both fishery-dependent and fishery-independent sources illustrate the importance of maintaining an appropriate MSL to effectively manage an exploited fishery. Increasing the MSL on spotted seatrout in Mississippi from essentially 12-inches to 14-inches resulted in not only more fish in the population but also larger fish in the population. Consequently, anglers harvested not only a greater number of spotted seatrout from 1996 to 1999 but also a greater number of larger fish. In addition, based on the number of age-1 fish collected annually, the increase in the MSL equated to an overall larger population and fishery, even in the midst of escalating fishing pressure (based on annual license sales) and increases in spotted seatrout landings along the Mississippi coast.

The observed population trends after the increase in the MSL can probably be attributed in part to the subsequent increase in spawning stock biomass in the population. GCRL data suggest that spawning characteristics of this species are probably the governing component in the increase in population size relative to the higher MSL. Management of a fishery should attempt to allow sufficient numbers of fish within a population to have the opportunity to spawn. For spotted seatrout in Mississippi, this suggests that at least a 14-inch MSL be maintained (Figure 9). Samples to date illustrate that 100% of fish at or above 14-inches TL had evidence of spawning based on post-ovulatory follicles (POF) or final oocyte maturation stage (FOM), while only 43% of 12-inch fish and 66% of 13-inch fish displayed such characteristics (Warren et al., 2001). By allowing more fish under 14-inches to spawn before recruitment into the fishery, the overall potential for egg production in the population is greatly increased, thus enhancing successive year classes. Batch fecundity is broadly defined as the number of eggs spawned per female during one spawning event. Batch fecundity generally increases with fish size, as is the case with spotted seatrout. GCRL data indicate that batch fecundity for female spotted seatrout in Mississippi waters averages around 66,000 eggs per spawning event for 12-inch fish and 99,000 eggs for 13-inch fish, while fish between 14- and 16-inches average well over 101,000 eggs per spawn (Warren et al. 2001). Because spotted seatrout spawn multiple times per year, a single female at any of these sizes is capable of releasing over half a million eggs in any given year.

Future year class success for spotted seatrout is based on numbers surviving to maturity and successfully spawning. Spawning production is further mediated by spawning output by size. Nearly half (48%) of all fish sampled in the GCRL monitoring program measured between 11.0- and 13.9-inches TL. Batch fecundity is somewhat low for this size range when compared to those ≥ 14-inches, as less than two-thirds of fish ≤ 13.9-inches TL are capable of spawning (Brown-Peterson and Warren 2001). However, the lower output per fish in the 11- to 13-inch size range is offset by the higher numbers of fish within this range. The GCRL fishery-independent data provide an index of relative abundance for each length interval that is considered representative of Mississippi's spotted seatrout population. Assuming equal spawning frequency among the 12- to 16-inch size intervals, an index of mean egg production per spawning batch for each size interval can be estimated with the following equation:

$$\text{Index of } \bar{x} \text{ Egg Production Per Batch}_{\text{size interval x}} = [(\bar{x} \text{ eggs per batch}_{\text{size interval x}})^*(\bar{x} \text{ abundance}_{\text{size interval x}})] * [\% \text{ mature}_{\text{size interval x}}]$$

A proportional comparison of the products of this equation shows the almost equal contribution of the pooled 12- and 13-inch fish (46% of total eggs produced) and the pooled 14- to 16-inch fish (54%) to the overall egg production of the 12- to 16-inch spotted seatrout in Mississippi. This size range of fish constitutes over 70% of the mature fish in the population, based on GCRL population data. Under the 12-MSL, the 12- and 13-inch fish constituted the majority of the recreational catch in Mississippi (Figure 4), whereas they are prohibited from being removed from the population under the 14-MSL.

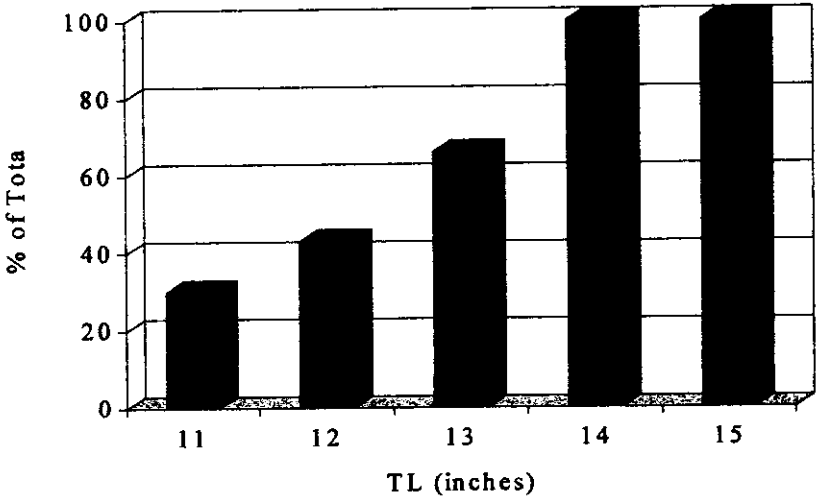

Figure 9. Percentage of Mississippi spotted seatrout with evidence of spawning (source: GCRL).

The 14-MSL has been in place for Mississippi's spotted seatrout fishery for almost five years. During this time, almost one-third of the fish sampled in the recreational fishery were not of legal minimum size (Figure 4). Increased enforcement of management regulations and enhanced compliance would further benefit the fishery by reducing the numbers of fish within these important size classes which are illegally removed from the population. While it is probably not realistic to totally eliminate the retention of undersize fish in a recreational fishery, effective management cannot be achieved without appropriate enforcement.

In 1997, regulations governing Mississippi's commercial fishery for spotted seatrout were revised to require that all gill and trammel (entangling) nets be constructed of a biodegradable material. Because nets made of such material were

not readily available, there was a gradual shift in the commercial fishery from entanglement nets as the primary harvest gear to hook and line, which theoretically allows undersize fish to be released alive. Although Mississippi's commercial fishery for spotted seatrout has historically constituted only around 8% of the statewide catch, gains in the state's spotted seatrout population size since 1997 may be attributable in part to the gradual decline in the use of entanglement gear.

In conclusion, proper management of a fishery should be based on sound, scientific information. When properly formulated, effective management measures such as minimum size limits can maintain and even improve an exploited fishery population, even in the face of increasing fishing pressure. Although the daily bag limit did not appear to be a major determinant in managing Mississippi's recreational spotted seatrout fishery over the past ten years, many fisheries rely on this tool, and it can be effective. For Mississippi's spotted seatrout fishery, increasing the minimum size limit from 12-inches TL to 14-inches resulted in a larger population, as evident by the increase in the total numbers of fish, the average size of fish and the numbers per size interval. The additional egg production resulting from the 12- and 13-inch fish which are now retained in the population is likely the primary reason for the increase in spotted seatrout numbers in Mississippi.

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