OCCURRENCE OF YOUNG-OF-THE-YEAR KING, *SCOMBEROMORUS CAVALLA*, AND SPANISH, *S. MACULATUS*, MACKERELS IN COMMERCIAL-TYPE SHRIMP TRAWLS ALONG THE ATLANTIC COAST OF THE SOUTHEAST UNITED STATES[1]

King mackerel, *Scomberomorus cavalla*, and Spanish mackerel, *S. maculatus*, are migratory scombrids that support large recreational and commercial fisheries along the southeast coast of the United States (Manooch 1979). Recent evidence indicates that both species may be overexploited in portions of their range, prompting the South Atlantic Fishery Management Council to impose catch limits and landing quotas[2]. Many aspects of the biology and ecology of adult mackerels in this region have been studied (Manooch et al. 1978; Collette and Russo 1984), and the larval stages have also received attention (Fahay 1975; Collins and Stender 1987). However, little is known concerning the distribution and occurrence of juvenile (young-of-the-year) mackerels along the Atlantic coast of the southeastern United States, nor does it seem to be widely known that large numbers of these young fishes may be included in the bycatch of a major fishery. This report provides preliminary information on both of these topics.

Methods

During 1980–82 and 1985–86 the Marine Resources Monitoring and Assessment Program (MARMAP) at the South Carolina Marine Resources Research Institute conducted trawl surveys of the nearshore fish fauna in the South Atlantic Bight (Cape Hatteras, NC, to Cape Canaveral, FL). Before 1986, trawl gear consisted of two semiballoon shrimp trawls with an 18.3 m footrope, a 12.2 m headrope, 4.1 cm stretch mesh in the cod end, and 1.5 × 0.9 m doors towed at 2.5 knots (4.6 m/second). In 1986, paired "tongue" trawls with a 22.9 m footrope, 4.1 cm mesh, and 3.0 × 1.0 m doors were towed at approximately 2.5 knots. Sampling strategy and length of tow (20 minutes to 1 hour) varied between cruises. Station depths were 3–18 m in 1980–81 and 3–9 m in subsequent years. In each sample, all mackerels were identified to species and measured (fork length), and number and total weight were recorded for each species. We conducted two additional cruises in 1986 to test tongue trawl nets equipped with trawl efficiency devices (TED's). A National Marine Fisheries Service (NMFS) TED equipped with finfish deflector[3] was installed in one net, a Georgia TED[3] in a second net, and a third net acted as a control. The TED's were fished against each other and against the control for a total of 30 tows on the first cruise (July–August 1986) and 15 tows on the second (September–October 1986).

Tongue nets, also known as bib, falcon, cobra, or mongoose trawl nets, have become widely used by commercial shrimpers in some areas during recent years (Edwards 1987). The major difference between these and other common towed gears used in the penaeid shrimp fishery is a modified and elongated headrope that is held well above the footrope by attachment to the trawl warp with a third bridle. A large float, usually attached to the center of the headrope, produces a high, vertical mouth opening. The result is a net that fishes a larger portion of the water column than other common nets with similar footrope and door configurations.

Results

During years when semiballoon nets were used, catch per unit effort of mackerels was relatively low (king mackerel: 0.2–0.4 individuals/net-hour; Spanish mackerel: 0.3–2.2 individuals/net-hour). Tongue trawl nets on four 1986 cruises gave cruise-specific average catches of 2.5–8.7 individuals/net-hour for king mackerel and 12.4–115.2 individuals/net-hour for Spanish mackerel, using catches of control [unmodified] nets for TED cruises (Table 1). Both species were taken as late as 30 October, except for two king mackerel caught in December 1982. Approximately 79% of king and 91% of Spanish mackerel were caught in depths <9 m during the two years in which sample depths extended to 18 m.

Mackerels taken in shrimp trawls were almost entirely juvenile fishes. Rather than pool catches between cruises that often differed in time of year, geographic area, and sampling strategy, examples of length frequencies of Spanish and king

[1]Contribution No. 244 of the South Carolina Marine Resources Center.

[2]South Atlantic Fishery Management Council, Council Meeting Summary, 27-29 April 1987, Charleston, SC.

[3]Described and illustrated in the Federal Register, vol. 52, no. 124; Monday, June 29, 1987 - Rules and Regulations; p. 24244–24262.

TABLE 1.—Results of nearshore cruises using two types of shrimp trawls.

Cruise dates	Net type	Sampling[1] strategy	Sample area[2]	Total net-hour	No. Spanish	No. kings
July–Sept. 1980	semiballoon	SR+NR	NC, SC, GA, FL	114	250	40
Apr.–June 1981	semiballoon	SR	NC, SC, GA, FL	77	21	13
Sept. 1982–Jan. 1983	semiballoon	SR	NC, SC, GA, FL	73	27	27
Aug.–Sept. 1985	semiballoon	SR+NR	NC, SC, GA, FL	59	120	36
Aug.–Sept. 1986	tongue	NR	NC, SC, GA, FL	41	1,421	104
Oct. 1986	tongue	SR	NC, SC, GA	55	681	481
July–Aug. 1986	tongue	NR	SC	20	2,303	84
Sept.–Oct. 1986	tongue	NR	SC	20	327	80

[1]SR = stratified random sampling; NR = nonrandom sampling.
[2]At least some portions of the waters of these states were sampled.

mackerels taken in tongue nets on two cruises are presented in Figures 1 and 2, respectively. Comparisons of the catch rates of Spanish mackerel during the TED evaluations in July–August 1986 showed that significantly fewer were taken in the tongue net equipped with a NMFS TED than the control net (Mann-Whitney: $P < 0.001$) or the Georgia TED-net ($P < 0.05$) (Table 2). There were no significant differences in catches of king mackerel (Table 3), or in catches of either species between nets on the September–October cruise, perhaps due to the smaller sample sizes.

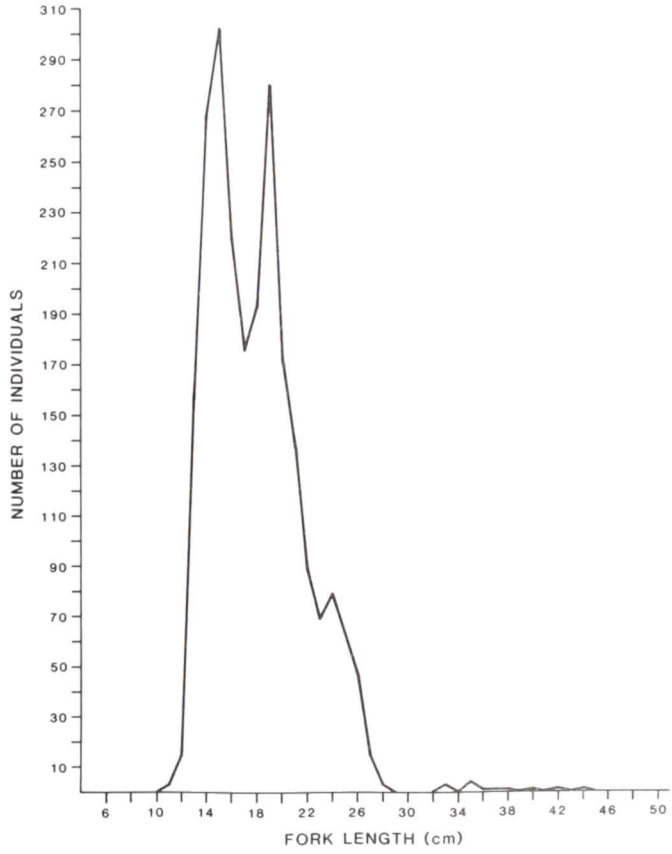

FIGURE 1.—Length-frequency distribution of Spanish mackerel taken in shrimp tongue trawl nets during July–August 1986 along the southern Atlantic coast of the United States (n = 2,303).

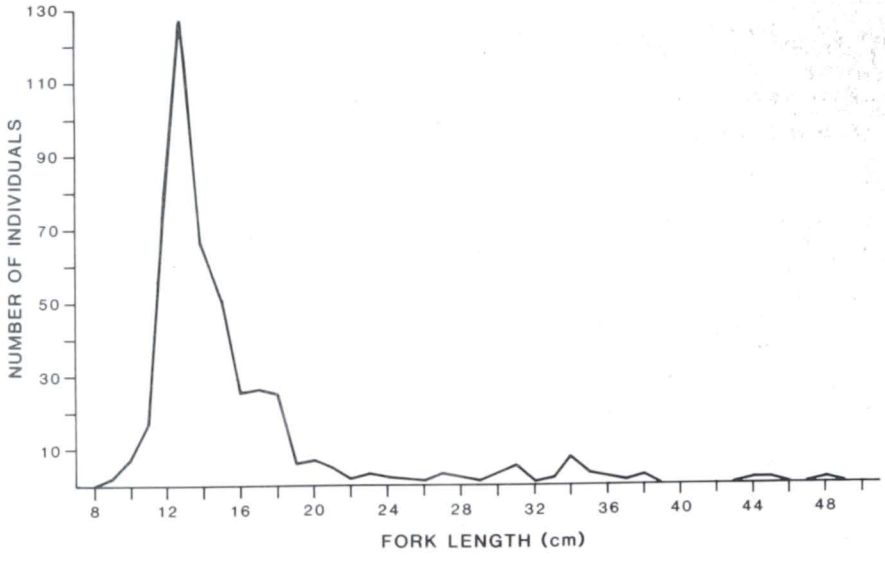

FIGURE 2.—Length-frequency distribution of king mackerel taken in shrimp tongue trawl nets during October 1986 along the southern Atlantic coast of the United States (n = 481).

TABLE 2.—Catches of Spanish mackerel during evaluations of tongue nets equipped with trawl efficiency devices (TED's). C = 22.9 m footrope length tongue net; NMFS = 22.9 m footrope length tongue net with a NMFS TED; GA = 22.9 m footrope length tongue net with a Georgia TED. Tow times = 1 hour.

Cruise	Comparison	No. of tows	Net type	No. of Spanish mackerel			Net type	No. of Spanish mackerel		
				Total	$\bar{x} \pm$ SD	Range		Total	$\bar{x} \pm$ SD	Range
July–Aug.	C-NMFS	10	C	1,104	110 ± 27	68–144	NMFS	519	52 ± 23	12–73
	C-GA	10	C	1,199	120 ± 65	40–276	GA	1,219	122 ± 74	44–300
	NMFS-GA	10	NMFS	880	88 ± 53	35–176	GA	1,650	165 ± 142	67–533
Sept.–Oct.	C-NMFS	5	C	104	21 ± 15	2–41	NMFS	53	11 ± 11	2–27
	C-GA	5	C	206	41 ± 38	1–103	GA	155	31 ± 28	0–76
	NMFS-GA	5	NMFS	108	22 ± 23	4–58	GA	149	30 ± 25	3–59

TABLE 3.—Catches of king mackerel during evaluations of tongue nets equipped with trawl efficiency devices (TED's). C = 22.9 m footrope length tongue net; NMFS = 22.9 m footrope length tongue net with a NMFS TED; GA = 22.9 m footrope length tongue net with a Georgia TED. Tow times = 1 hour.

Cruise	Comparison	No. of tows	Net type	No. of king mackerel			Net type	No. of king mackerel		
				Total	$\bar{x} \pm$ SD	Range		Total	$\bar{x} \pm$ SD	Range
July–Aug.	C-NMFS	10	C	41	4 ± 4	1–13	NMFS	46	5 ± 9	0–30
	C-GA	10	C	43	4 ± 5	0–15	GA	41	4 ± 4	0–13
	NMFS-GA	10	NMFS	23	2 ± 3	0–8	GA	26	3 ± 5	0–17
Sept.–Oct.	C-NMFS	5	C	26	5 ± 7	0–15	NMFS	14	3 ± 3	0–5
	C-GA	5	C	40	8 ± 8	4–22	GA	22	4 ± 5	1–14
	NMFS-GA	5	NMFS	24	5 ± 2	2–8	GA	20	4 ± 4	2–11

Discussion

Although it is possible that juvenile mackerels were more abundant in 1986 than in previous years, the increased catches of these fishes in tongue nets over semiballoon nets suggests that the former are much more efficient in capturing these fishes. Preliminary data from a gear comparison cruise in 1987 indicate that tongue nets do catch more pelagic fishes than semiballoon nets even after adjusting for differences in footrope lengths (G. Sedberry[4]). Unfortunately,

[4]G. Sedberry, Marine Resources Research Institute, South Carolina Wildlife and Marine Resources Department, P.O. Box

these tests were conducted during March–April when juvenile mackerels are rare in the coastal waters of South Carolina.

In 1986 we collected juvenile mackerels during July through October. Because of incomplete temporal sampling, we do not know if they were present earlier and later in the year in this region. Based on the occurrence of early larval stages, spawning of both mackerels in the South Atlantic Bight extends from May through at least September (Collins and Stender 1987). If growth rate estimates of ca. 3 mm/day for juveniles are correct (M. R. Collins, unpubl. data), king mackerel spawned in early May could be recruited into the bycatch of the shrimp fishery in June. Late-spawned fish from the previous year may also be present at this time. In South Carolina, the open season for commercial trawling for penaeid shrimps in state waters usually extends from June through December, which coincides with the presence of juvenile mackerels in the heavily fished nearshore waters. In addition, mackerels were much more abundant in tows made in depths <9 m, which includes the preferred shrimping areas, than in deeper waters. This may be due either to greater abundance in these depths or to greater catchability in response to the fact that the trawl nets fish a larger portion of the water column in shallower areas.

It is difficult to accurately estimate the bycatch of mackerels in the commercial shrimp fishery owing to lack of current, detailed information from throughout the region on number of vessels, effort expended, gears used, and areas fished. However, our catch rates suggest that the impact of tongue nets on mackerel stocks may be significant. As the current status of these stocks is such that strong restrictions have been imposed on both the recreational and commercial fisheries, it is unfortunate that the situation may be exacerbated by a potentially large bycatch of juvenile mackerels in the shrimp fishery. More information is needed on the ecology and behavior of young mackerels, and their vulnerability to various gears, in order to resolve this conflict.

Acknowledgments

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STOMACH CONTENTS OF COMMERCIALLY CAUGHT HUDSON RIVER STRIPED BASS, *MORONE SAXATILIS*, 1973–75

The Hudson River estuary is a detritus-driven ecosystem. Only a few of the 100 or more reported fish species function as tertiary piscivores more typical of a grazing food chain. Of these few species, which include the American eel, *Anguilla rostrata*, and the summer-transient juvenile

12559, Charleston, SC 29412, pers. commun. May 1987.