Current Status of Biological Investigations of Florida's Mackerel Fisheries*

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Abstract

Spanish and king mackerel, significant constituents of sports and commercial fisheries of the southeastern United States, have long been prominent among Florida's fisheries. With the advent of more sophisticated fishing and processing methods, the stature of mackerel fishing in Florida has increased from that of a principally seasonal to a potentially continuing natural resource.

Proper management of such a resource depends upon an adequate understanding of its magnitude, scope, replenishment, accessibility and exploitation. Knowledge required for such an understanding is being accumulated from a study initiated in 1968 concerning several aspects of population dynamics including the age and growth, reproduction, migration, larval development and juvenile ecology of both species in Florida waters. This paper presents the current progress of these studies and offers an opportunity for speculation into additional areas of investigation.

MACKEREL OF THE GENUS *Scomberomorus* range throughout the coastal waters of the world, principally in the tropical and subtropical oceans. They abound in the western Atlantic from Florida to Chesapeake Bay and occasionally are taken north of Cape Cod. Since the mid-1800's the Spanish mackerel, *S. maculatus,* has supported a commercial fishery in the United States which has produced an average of 8 million pounds annually, valued at over three-quarters of a million dollars (Lyles, 1969). In 1967 there were over 6 million pounds of king mackerel, *S. cavalla,* valued at over $800,000 landed in Florida (Johnson, 1968).

Klima (1959) summarized the seasonal range of Spanish mackerel along the Atlantic seaboard. Generally, they are abundant in Florida from October through February or March, appearing off the Carolinas by April, off Chesapeake Bay by May, and off Narragansett Bay by July. They remain in the north until September.

Klima also compared commercial landings of Spanish mackerel from three areas along Florida's west coast and noted that over 90% of the annual total were taken from Tampa Bay south to Key West during November through March. He showed that only 10% of the annual commercial production came from the Gulf waters along Florida's panhandle during April through October. Gunter (1945) reported that Spanish mackerel were also abundant along the Texas coast from April through September, peaking in August. However, he estimated that perhaps less than 1% of the available supply was being exploited commercially.

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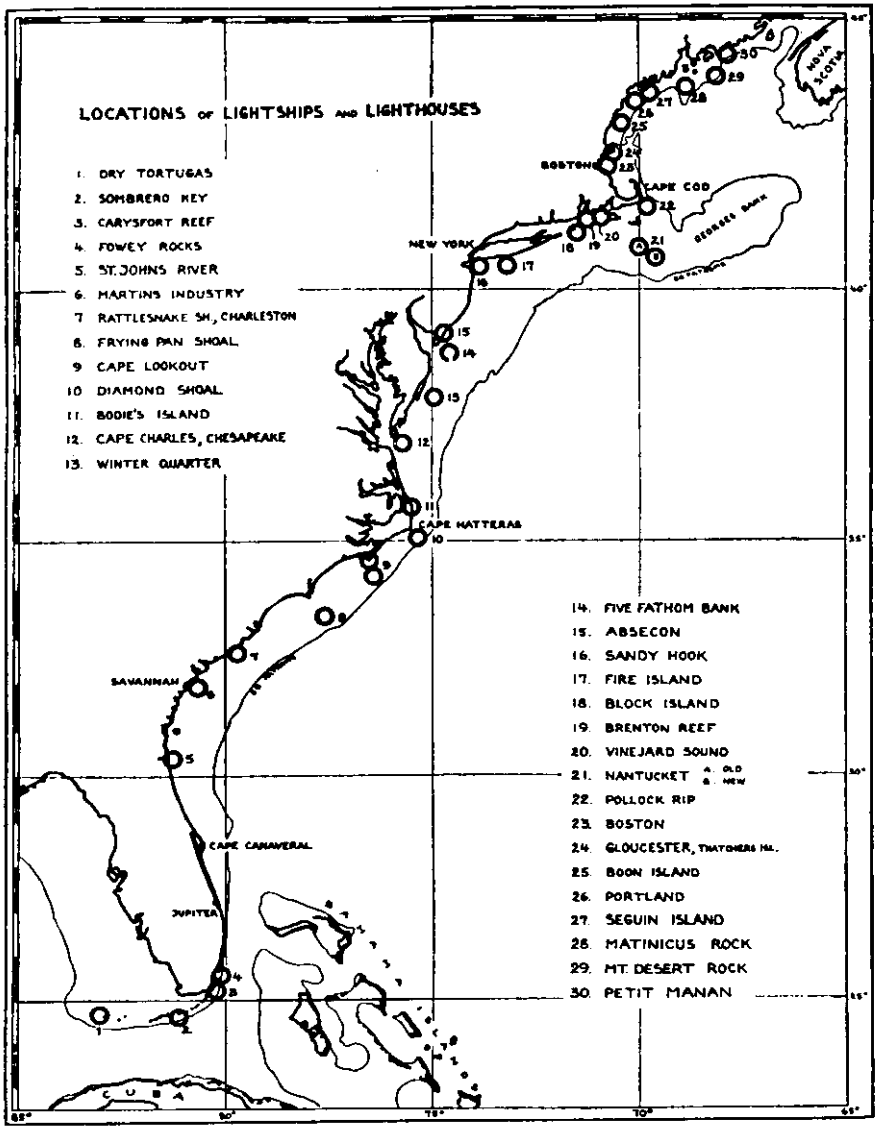

Fig. 1.—Chart showing locations of lightships and lighthouses. Small circle and dot between stations 5 and 6 indicate location of Brunswick Lightship, abandoned in January 1929.

Deuel and Clark (1968) report that 79% of the 9,534 Spanish mackerel and 79% of the 8,391 king mackerel caught by anglers in 1965 were taken from the south Atlantic, while only 0.3 and 3.0% were from the middle Atlantic; 14 and 12% from the eastern Gulf of Mexico and only 7 and 6% from the western Gulf.

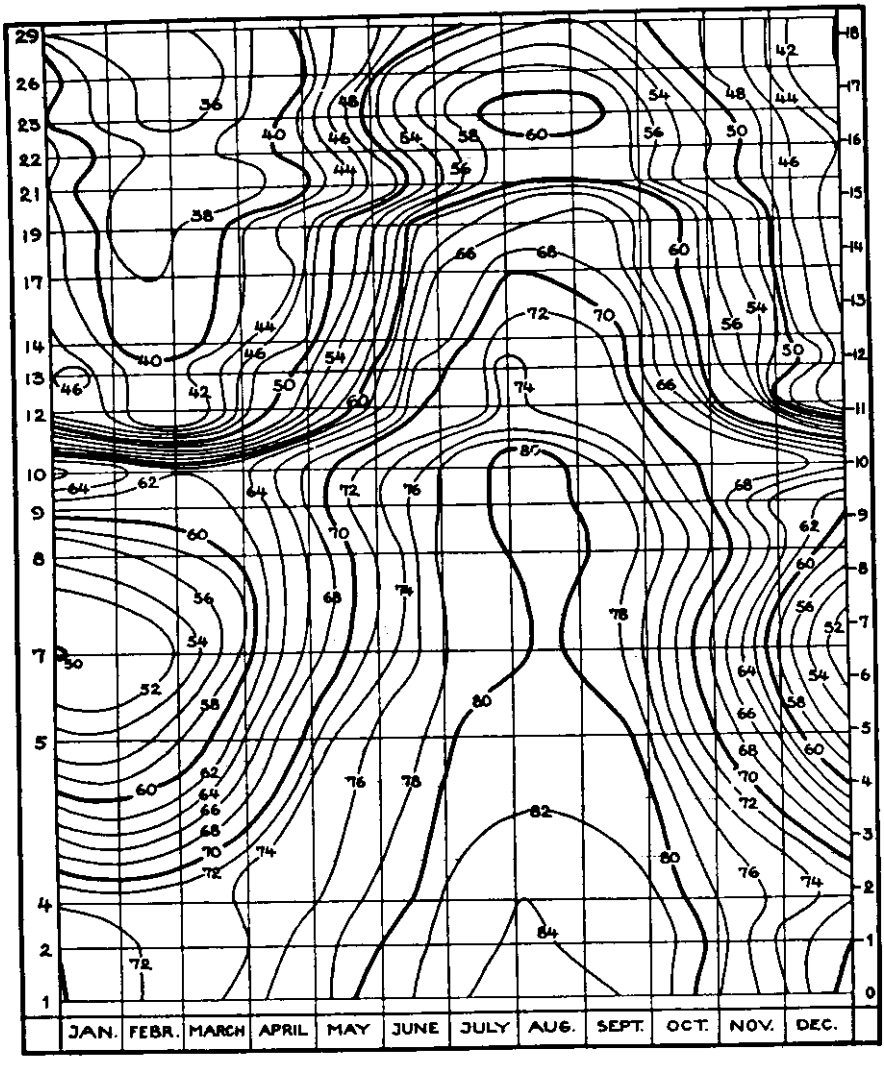

Fig. 13.—Average annual temperature cycle in shallow water from Dry Tortugas to Mt. Desert Rock. Isotherms for every 2 degrees Fahrenheit drawn according to the temperature records obtained during the period 1928–30. Lightships and lighthouses numbered (on the left) as in figure 1, on page 6. Coastwise distances from Dry Tortugas in hundreds of miles on the right.

Gunter regarded temperature as the chief factor initiating and affecting migrations and other seasonal cyclic actions in fishes along the Texas coast. The interrelationships between the various coastal regions with respect to temperature were examined by Parr (1933) who compared data gathered during 1928-1930 with data recorded during 1881-1885 by Rathbun (1887). This

data defined the annual temperature cycle of the entire shallow-water zone within the 10-fathom contour between Cape Cod, Massachusetts and Cape Canaveral, Florida (Fig. 1). It was found that migrations of coastal fishes are regulated by temperature. Klima (1959), citing work done by Munro (1943), gives the distribution of the genus *Scomberomorus* within the 68°F isotherm throughout the world. Fig. 2. (Fig. 13 from Parr, 1933) indicates that the temperature cycle along the Atlantic coast would allow fish to range as far north as Fire Island in August.

Rivas (1968) has shown for the Gulf of Mexico an encroachment of the 68°F isotherm in March to a line drawn from the area of the DeSoto Canyon to near Marco Island, Florida. In April, the 70°F isotherm stretches from the Chandeleur Islands to Cape San Blas and it is then that Spanish mackerel first appear in the northern Gulf.

To study Florida's mackerel populations, both species were intensively sampled throughout the state from January 1968 through January 1969. Sampling effort was concentrated on commercial landings where greater numbers were available each month. Whenever possible, our sample was drawn from the catch of a single vessel, or from those of a few vessels fishing in the same area. We also tried to distribute our sampling effort evenly within an area or between two or more coastal areas when fishing activity was widespread; changes in the weather usually facilitated this.

Length frequencies were obtained during the winter fishery in south Florida when large numbers of mackerel were landed. In addition, each month at least 60 individuals were sexed, weighed, measured to the nearest 0.5 cm and the otoliths (saggitae) removed for age and growth studies. Gonads were evaluated macroscopically; aperiodical samples of this tissue were preserved in Bouin's fluid for histological preparation. Stomachs were examined whenever possible.

Mackerel were randomly sampled during the summer and at least 60 pairs of otoliths were collected monthly from fish individually examined from charter boats or mixed in commercial catches of other species. Supplementary length frequencies were not obtained during summer months due to the small numbers of fish encountered during this "off season." Also, since landings were not centralized, it was necessary that we work independently in order to obtain adequate coverage of the summer landings.

Size classes were sampled in proportion to their abundance in the catches, without giving extra attention to the extremities of the distributions. Judicious subsampling, however, as proposed by Ketchen (1949), may have allowed us to reduce our efforts without loss of sample precision.

However, we have collected sufficient numbers of otoliths, 2,128 pairs from Spanish mackerel and 1,729 pairs from king mackerel, to assess accurately age and growth. Figure 3 shows that of the 630 king mackerel otoliths read to date, the opaque annulus apparently forms from April through July, thus agreeing with the estimates of Nomura and Rodriguez (1967) for Brazilian king mackerel.

Figure 4A gives field observations of the reproductive development of Spanish mackerel collected from the east coast during 1968. Fifty per cent of the females examined in April were developing while 38% appeared ripe. In May and June 79% were ripe while in July (at Cape Canaveral) 10% were spent and 13% appeared to be resting. Progressively more spent females were seen up to September, when only 4% were still ripe.

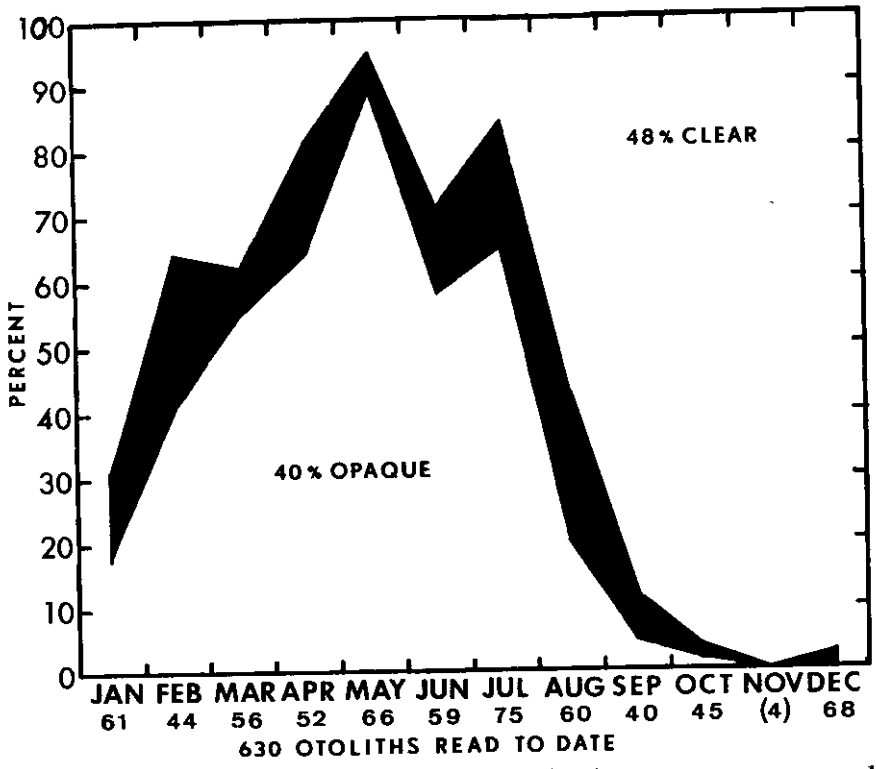

FIG. 3. Percentage of king mackerel otoliths showing opaque summer and clear winter margins throughout the year. Shaded area represents 12% which were indeterminable. (Preliminary analysis of first year's east coast collection only.)

Figure 4B shows field observations of the reproductive development of king mackerel collected from the east coast during 1968. Forty-seven per cent of the females examined in April were developing while 37% appeared ripe. In May, 13% were developing and 67% appeared ripe. From June through August 100% appeared ripe except for a few collected north of Cape Canaveral in July (20% were still developing). In September, 13% were spent and in October only 4% remained ripe. A similar pattern has been observed for both species along Florida's west coast.

Parr (1933) emphasizes that the nearness of Cape Hatteras' shoal topography to the marginal warm waters of the Gulf Stream should insure a high degree of horizontal and vertical mixing and so insure uniformly warm water. Similar conditions no doubt exist at Cape Canaveral.

Summer arrival of mackerel along the middle Atlantic coast may be associated with spawning. Earll (1880), for example, observed ripe adult Spanish mackerel off Virginia in June; Bigelow and Welsh (1925) thought Chesapeake Bay was a prolific nursery for Spanish mackerel and believed the spawning season continued 6 to 10 weeks from offshore of the Carolinas to off New York;

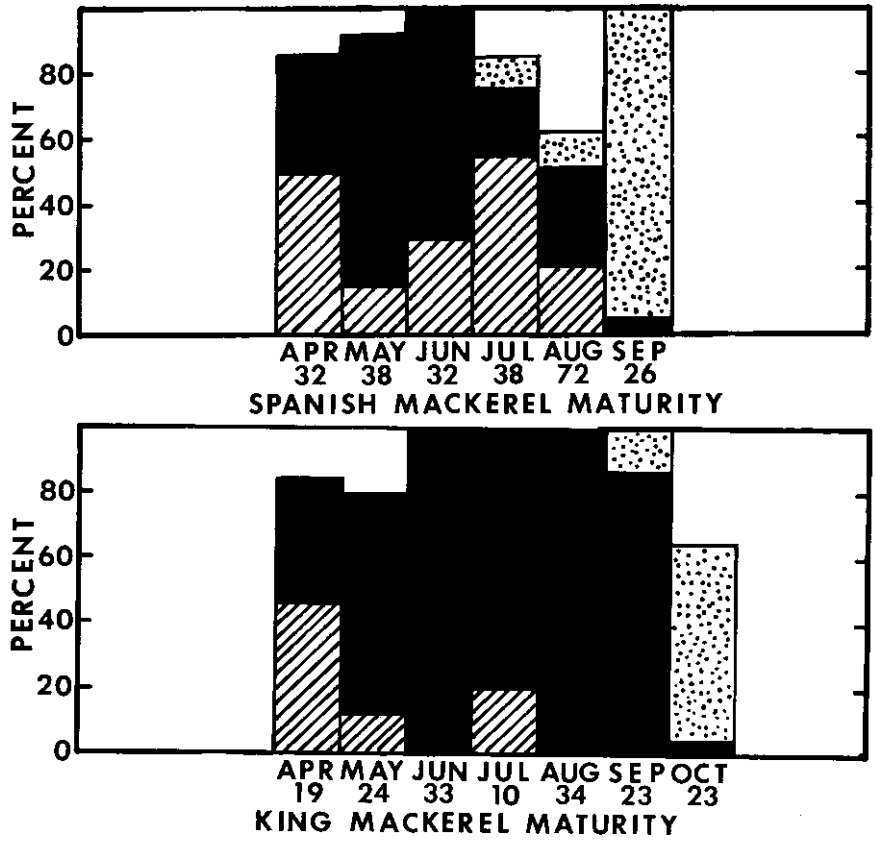

FIG. 4A. (Top) Field analysis of female Spanish mackerel ovaries showing percentage of developing (diagonal lines); ripe (solid area); and spent (stippled area) gonads observed during first year's east coast collections. FIG. 4B. (Bottom) Field analysis of female king mackerel ovaries showing percentage of developing (diagonal lines); ripe (solid area); and spent (stippled area) gonads observed during first year's east coast collection.

and Hildebrand and Cable (1938) believed that at least some Spanish mackerel spawned off Beaufort, North Carolina during late June or August. Butz and Mansueti (1962) noted a "spent or resting" female among three king mackerel taken during October in northern Chesapeake Bay.

Taylor (1951) cites Smith (1907) in reporting that Spanish mackerel eggs hatch within about 25 hours in water of 77 to 78°F. Tagatz and Dudley (1961) list two 18-20 mm FL Spanish mackerel from seine collections at Atlantic Beach, North Carolina in June (70.2 to 78.8°F). Figure 2 indicates that the 78°F isotherm does not usually extend north of Cape Hatteras and thus spawning is probably limited to those waters and any other more southerly coastal waters of similar temperature. Coast and Geodetic Survey Publication 31-1 (1968) gives the mean water temperature for Cape Canaveral

from 1946-1962 as 77.0, 77.4, 79.0 and 80.2°F for May, June, July and August.

The capture of juveniles (17 to 31 mm TL) of both species during September night-lighting off Destin and of larvae (3 to 7 mm TL) during September plankton tows off Cape Canaveral indicates two discrete spawning areas for these mackerel in Florida waters. A thorough study of the biology of these species, which would be applicable to proper management of their fisheries, should therefore be made with the consideration that more than one population may be involved in each case.

Our primary objective thus far has been to learn as much as we can about the biology of Florida's mackerel. It is our further responsibility to understand the dynamics of their populations, to assure that man does not adversely affect the maintenance of harvestable stocks.

We have seen some evidence which indicates the possible existence of separate populations of both species which contribute to Florida's winter mackerel fishery. This evidence is among data being gathered on the biology of the species and may now be further confirmed by the application of more direct methods, such as tagging and comparison of morphormetric characters. It is hoped that these techniques can be implemented after the accumulated biological data is analyzed.

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