

## Overview of the Tortugas Sanctuary Studies

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The Shrimp Fishery Management Plan (FMP), prepared by the Gulf of Mexico Fishery Management Council (GMFMC), established the Tortugas shrimp sanctuary on May 15, 1981, which was implemented through cooperation of the State of Florida and the U.S. Department of Commerce. All trawling activity was permanently prohibited inside the sanctuary.

The purpose behind the sanctuary was to optimize the yield of pink shrimp (*Penaeus duorarum*) recruited to the nearby Tortugas fishery by protecting small shrimp until they reached a size larger than 69 tails/lb. This protective regulation was based on previous research that indicated small pink shrimp move through the sanctuary toward the deeper fishing grounds upon leaving the shallow nursery area. It was assumed, also based on earlier research, that the distribution of small shrimp is confined mainly to areas within the sanctuary and that larger shrimp occur mainly outside the sanctuary. Limiting the trawling to areas outside the sanctuary thus would minimize the need to discard small shrimp and reduce waste in the shrimp stock.

The National Marine Fisheries Service (NMFS) was requested to survey and monitor the shrimp population in the sanctuary and on the fishing

grounds, to determine movements of tagged shrimp, and to evaluate how well the objectives of the Tortugas shrimp sanctuary regulation were achieved since 1981. Field work and many of the scientific analyses were conducted by the staff at the Galveston Laboratory of the Southeast Fisheries Center of NMFS; additional analyses were conducted at the Miami Laboratory and the work was supported by other center personnel. Results of these studies were reported to the GMFMC in January 1984.

### Organization of the Research

Data for scientific analyses were collected from two sources. Two commercial shrimp trawlers were used to collect data on the populations of pink shrimp inside the sanctuary and on the Tortugas fishing grounds, and to tag and release shrimp at different locations in the study area. These data were used to describe size and abundance distributions, to give estimates of the size of the standing stock, and to describe movements of the shrimp over a 7-month time interval.

Interviews by port agents provided the second source of data. These interviews with shrimpers and processing plants' staff provided information

about the shrimpers' fishing locations, methods, catch, effort, and catch per unit effort (CPUE). They also yielded information on size and location of pink shrimp, as well as on the effect the sanctuary regulation had on fleet mobility. The four papers following this overview describe the results of the cooperative investigation in detail.

### Summary of Results

A survey in 1981–1982 was designed to give a detailed description of the distribution of pink shrimp less than 103 mm total length (69 tails/lb), particularly in relation to the position of the sanctuary boundary north of the Marquesas Keys. Twelve monthly samples indicated the average shrimp size varied significantly among stations and months. Large shrimp dominated more than one-half of the 22 sampling stations during September through December; all the December samples contained shrimp averaging more than 103 mm in length. This distribution was reversed during January through August, when one-half or more of the stations were dominated by smaller shrimp. The overall abundance, as measured by CPUE, was highest inside the sanctuary for each month and, except for October through December, small pink shrimp made up more than one-half of the samples (55–82%) from all 22 stations combined each month. When the abundances of small shrimp at stations inside the sanctuary were compared to those outside the sanctuary, it was clear that the sanctuary protected a high proportion, but not all, of the small shrimp.

As indicated by the presence of small pink shrimp, recruitment was continuous throughout the year, but there were seasonal peaks in recruitment. A single peak occurred in September 1981, which falls within the historic pattern. However, two peaks occurred in 1982—the first in January and a second broader peak beginning in June and continuing through August. Previous research had not indicated such an extended recruitment pattern throughout the summer.

The 1982–1983 survey was structured differently from the 1981–1982 survey in order to determine the distribution of small pink shrimp in deeper water over most of the trawling grounds and to estimate the standing stock of pink shrimp on the Tortugas grounds. Shrimp less than 103 mm long occurred at most stations in deeper water beyond the sanctuary, but they decreased in abundance with distance from the sanctuary. Overall, there was an increase in average shrimp size with

increasing depth. Small pink shrimp were more abundant inside the sanctuary than outside and they dominated the samples at more than one-half of the stations inside the sanctuary in September through December and February through May (samples were not taken in April and June). January and July were the only months of the 1982–1983 survey when large pink shrimp dominated the catch at most stations inside the sanctuary, whereas large shrimp had predominated during September–December in the 1981–1982 survey.

Recruitment declined from the August peak in the 1981–1982 survey and reached a low in December 1982. A spring peak occurred in March 1983, but there was no summer peak as there had been in the 1982 season.

Pink shrimp population estimates differed each month but generally were highest per unit of area inside the sanctuary. Although the area inside the sanctuary accounted for only 6% of the total survey area, the shrimp population in the sanctuary averaged 36% of the total population in the survey area. Conservative estimates of the total pink shrimp population on the Tortugas grounds ranged from  $52.7 (\pm 12.8) \times 10^6$  shrimp in March 1983 to  $11.8 (\pm 5.3) \times 10^6$  shrimp in July 1983.

A mark–recapture study of pink shrimp in 1982–1983 was designed to determine pink shrimp movements into and out of the sanctuary, as well as to survey the overall movement of shrimp on the Tortugas grounds west to Rebecca Channel and in a small area south of the Marquesas Keys. Results from four monthly releases inside the sanctuary indicated that most of the shrimp that left the sanctuary moved into deeper waters to the north. However, some pink shrimp released inside the sanctuary appeared to remain there—some for as long as 60 d. A smaller proportion of the shrimp released inside the sanctuary moved to the west outside the sanctuary and a very small percentage moved toward the area south of the Marquesas Keys.

Pink shrimp released north of the sanctuary showed a tendency to move to the west and southwest, while a few moved in random directions or even remained in the general release area. Only three recaptures from the northern release sites were reported south of the Marquesas Keys. Pink shrimp released near Rebecca Shoal appeared to disperse in random directions but an overall movement was indicated to the northeast. Very few shrimp were recaptured from the releases south of the Marquesas Keys (south side), but most of those recaptures were close to the release sites.

However, there were a few shrimp that appeared to move north from the south-side release sites.

Commercial production of pink shrimp on the Tortugas grounds in 1981 amounted to 10.2 million lb, but dropped to approximately 7 million lb in 1982. Average landings from 1960 to 1979 were 9.8 million lb annually, clearly indicating that 1981 catches were far superior to those in 1982 and slightly above the historical average. Commercial landings were relatively stable during the 23-year period (1960–1982) and deviated very little from the mean (9.7 million lb), with a standard deviation of approximately 1.8 million lb and a coefficient of variation (SD/mean) of 18%.

Commercial fishing on the Tortugas grounds increases in September each year with the anticipated recruitment of small juvenile pink shrimp onto the grounds during September through November. The fishery is maintained by this fall recruitment and, in some years, recruitment is again enhanced during the spring months of April and May. For 1981, landings were enhanced by substantial spring recruitment in March, April, and May but little recruitment occurred in September through November 1981 or in spring or fall 1982. This resulted in a very poor pink shrimp fishery in 1982.

Fishing effort during the 23-year period averaged approximately 16,000 d/year and did not fluctuate greatly. Fishing effort during the closed period was 12,800 and 14,700 d in 1981 and 1982, respectively.

The relative abundance of pink shrimp on the Tortugas grounds, as measured by the annual CPUE, was remarkably stable from 1960 through 1982, averaging 619 lb/d (SD,  $\pm 79$  lb). The highest CPUE was 797 lb/d in 1980 and the lowest was 479 lb/d in 1982. Size distributions of pink shrimp landed in 1981 and 1982 were significantly different from each other, and distributions in these years also were significantly different from those of the 1960–1964 and 1975–1979 periods.

The quantity of pink shrimp landed and the CPUE differed dramatically between the two closure years, probably due to a major change in recruitment. No differences in catch, CPUE, or size composition were detected due to the closure. Compliance with the prohibition of all trawling within the sanctuary was not good, as indicated by the large number of violations cited. Because of this it was difficult, if not impossible, to determine any impacts of the closure on the pink shrimp population. The theoretical gain in yield of 1 million lb by closure of the sanctuary to fishing could

not be demonstrated because of the lack of compliance by the fishermen.

### Council Considerations

The studies conducted on the Tortugas grounds highlighted the following points.

(1) Most small pink shrimp were found inside the western area of the sanctuary. A small proportion of shrimp larger than 103 mm in total length was in this western area.

(2) There was an overall increase in the average size of pink shrimp, but a decrease in abundance with increasing water depth.

(3) Some pink shrimp may reside inside the western sanctuary area for a period of up to 2 months.

(4) The highest density of pink shrimp was found inside the western sanctuary.

(5) Tagging studies showed pink shrimp released inside the sanctuary moved generally into deeper waters to the north and west and that pink shrimp in the sanctuary eventually recruited into the fishery.

(6) Examination of commercial catch statistics revealed 1981 was an above-average year for both catch and relative abundance and 1982 was a poor year for both. Impacts of the closure could not be discerned from catch statistics. Probable reasons for the inability to detect a closure impact on the pink shrimp catch were the significantly different recruitments between 1981 and 1982 and a lack of compliance with the law that prohibited trawling inside the sanctuary area.

These findings clearly indicate that the western area of the sanctuary does contain a large percentage of the small pink shrimp and, therefore, that the goal of obtaining an increase in yield of 1 million lb by restricting trawling in this area is realistic.

All of the studies conducted in 1981–1983 supported the conclusions of previous researchers about the distribution and movement of pink shrimp on the Tortugas grounds. The recent studies further expanded previous research findings by determining that pink shrimp in the sanctuary are recruited to the major portion of the fishery and are not lost to the fishery.

The Gulf of Mexico Regional Fishery Management Council, responding to the results of studies by NMFS, requested that a portion of the sanctuary be opened to shrimp fishing. Specifically, the council requested that the 40-square-nautical-mile area that was temporarily opened from April 1983 through August 1984 remain permanently open,

and that the rest of the western area outside the Florida territorial waters (21 square nautical miles) be opened on August 15, 1984. The council's rationale behind this request was that the combined area of 61 square nautical miles constitutes only 5.4% of the 1,128-square-nautical-mile sanctuary outside the territorial waters of Florida. The council further indicated that a large portion of this area is untrawlable and would remain a natural sanctuary, and made the following points.

(1) Changes in vessel characteristics, processing methods, and elimination of Florida's minimum-count law allows utilization of somewhat smaller pink shrimp than the fishery previously targeted.

(2) The Fishery Management Plan established a sanctuary "to protect small pink shrimp until they generally reached a size larger than 69 tails to the pound." No specific standard or percentage of available pink shrimp was mentioned to achieve the general size range.

(3) The NMFS study showed there were periods when the majority of the pink shrimp in samples from stations within the sanctuary were larger than the 69-count size.

(4) Testimony from fishermen and processors showed that all pink shrimp taken in this area could be utilized and that there were no discards of small shrimp.

(5) The NMFS studies showed there was a

consistently higher CPUE within the sanctuary, which provides for greater efficiency and higher catch rates at lower costs.

The council concluded that the proposed changes conform to the management plan's criteria in that the action results from "the identification of areas within the sanctuary containing an abundance of shrimp of harvestable size." The council reviewed letters that endorsed the proposed action from virtually every pink shrimp processor in the Key West area, and it concluded that there was no cause for concern that the present harvesting practices would cause recruitment overfishing, and that the requested management action would not affect the status of the stock.

The National Marine Fisheries Service, while considering the council's request to alter the geographic scope of the Tortugas sanctuary, reviewed the scientific analysis presented by the Southeast Fisheries Center and the public testimony presented at workshops held in Fort Myers and Key West, Florida. The NMFS concluded that the council's request was not consistent with the management plan's objective of protecting small pink shrimp from fishing and was not supported by the scientific evidence presented. As a result of these considerations a management decision was made to permanently close the Tortugas sanctuary in August 1984.