the South Carolina Shrimp Fishery

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NOTE

Special appreciation is due to the many shrimp fishermen and shrimp dealers throughout the state for their continued interest and cooperation in our management program. We also wish to thank all Crustacean Management personnel who are responsible for conducting the programs and projects described in this report.

contents

The Marine Resources Center at Fort Johnson.

INTRODUCTION

Shrimp support the most valuable seafood fishery in South Carolina as well as in the United States. The fishery in South Carolina has generally prospered during its long history without depletion of annual stocks, although it is felt that shrimp production has reached its maximum or near maximum level in recent years.

In view of the importance of shrimping, this report proposes to inform South Carolina fishermen and other interested individuals of the present status of the state's shrimp fishery and to familiarize them with the current shrimp management program being conducted by the Marine Resources Division. In addition, basic information concerning the biology and life history of commercial shrimp is presented.

Shrimp represent an annual crop, and their abundance is subject to considerable variations from year to year depending largely upon changes in environmental conditions such as salinity, water temperature, rainfall, river discharge and ocean currents. These conditions have a direct effect on shrimp populations by influencing spawning periods, growth rate, movement and migration. All of these factors, in turn, influence season opening dates and the areas in which fishing will be permitted. Biological, economic and social factors must also be taken into account in making management decisions. And because so many important and controversial decisions must be made, often on short notice, fishermen may not always be informed of all considerations made prior to taking a particular management action. All things considered, the shrimp resource is difficult to properly manage or to predict with reasonable accuracy in advance of fishing seasons. The difficulties encountered, however, are being overcome through an innovative and comprehensive management program presently in use by the Office of Conservation and Management Crustacean Management Section.

It is hoped that this report will provide a broad perspective of the current shrimp management program of the Division and thereby improve communication and rapport among all those vitally or casually concerned with the shrimp fishery. Our goal is to maintain a *productive, profitable* and *progressive* fishery and insure a *biologically stable* resource for this and future generations.

THE SOUTH CAROLINA SHRIMP FISHERY

Fishermen have harvested shrimp since at least 1817, although commercial catch statistics were not collected and published until 1880. Dip nets, haul seines, and cast nets were the principal gears used initally, but between 1912 and 1915 fishermen began to use otter trawls. The otter trawl became standard gear by 1917, and by the 1930's accounted for approximately 90 percent of the catch. The remaining catch was taken by cast nets and seines.

Early fishing craft were small, open skiffs powered with gasoline engines. During the 1920's and 1930's vessels were decked over, engines placed forward with a pilot house added, and the diesel engine introduced. Since then shrimp vessels in the South Atlantic have been strongly influenced by vessels designed to fish along the Florida coast and in the Gulf of Mexico. Presently, most vessels are double-rigged for towing two nets at once. Exceptions to this are smaller boats which usually fish in the bays and sounds of South Carolina. These boats are often equipped with power winches and rope towlines and are rigged for towing a single trawl from the stern.

Most commercial trawlers use a flat or two-seam balloon net to fish for brown shrimp, while four-seam semi-balloon nets are often preferred for white shrimp. White shrimp are generally caught during daylight, in contrast to brown and pink shrimp which are often caught at night.

Although the otter trawl is the main commercial gear, some shrimp are still taken by haul seines, cast nets, drop nets and channel nets. Channel nets are effective for harvesting white shrimp in South Carolina but are restricted to certain areas and seasons.

Recently, there have been scattered attempts to test the application of twin trawling techniques in the South Atlantic region. Some of these trials have been encouraging, and a few shrimpers are using these techniques on an experimental basis. The method of twin trawling involves towing two trawls on a single pair of doors or otter boards. Both trawls are joined together at the head rope and foot rope to a "neutral door" connected to a third bridle leg.

Reported advantages of this rig over the conventional double rig include:

- an increase in fishing efficiency (25% increase in some cases)
- greater ease in handling two 35' trawls than a single 70' trawl
- nets can be towed more slowly, allowing the vessel to make sharper turns with fewer incidents of tangling
- reduced fuel consumption.

Brown shrimp are most abundant from mid-June to mid-August. There is a spring fishery for white "roe" shrimp in May and June. Their offspring form the basis of the fall fishery which occurs primarily from September through December, after which the season generally closes. St. Helena, Port Royal and Calibogue

Sounds as well as Bull Bay are the most productive inshore shrimping grounds in South Carolina. Offshore waters within 6 miles of the beach are most productive from Bull Bay to Tybee Road.

Average commercial fishing trips last 1 or 2 days and take place in prime fishing grounds within 6 miles of shore. There is no significant offshore fishery in South Carolina as there is in the Gulf of Mexico.

Generally, trawlers fishing primarily in one area deal with only one or two shrimp wholesale dealers, who not only buy shrimp but also provide services such as heading and packing, ice, and occasionally fuel. Larger vessels may fish in several states dealing with several dealers during a season. Most dealers assume responsibility for shrimp purchased from vessels, but some may act as brokers as well.

Shrimp fishermen engage in a number of other fisheries during the off season. In South Carolina, vessels may fish with pots for black sea bass or trawl for blue crabs. Others may fish for a combination of bottom-dwelling fishes such as snapper, grouper, grunts, porgy, and black sea bass, utilizing fish traps, hook and line, and high rise trawls.

Recreational shrimp fishing is widespread and probably accounts for 10 to 15 percent of the total catch of shrimp in the State. However, because of the lack of recreational catch statistics, it is very difficult to document either the catch or the value of this fishery. Bait shrimping is done mainly with cast nets in South Carolina, although a limited amount of bait shrimp trawling under strict regulation takes place in Beaufort County.

Other Harvesting Methods

Several additional methods of catching shrimp are popular in South Carolina waters. Haul seines, cast nets, channel nets and drop nets are used for recreational or limited commercial purposes with a relatively small capital investment and operational experience.

Haul Seines

Haul seines were introduced in the late 1880's and became the most important gear in the commercial shrimping industry prior to the otter trawl. Originally, seines were made of ½ inch stretched mesh netting and were up to 120 feet long and 10 feet deep. Smaller seines could be handled by two men in a rowboat. Gradually, the net mesh was made larger and the seines were increased in size, some of them reaching 1,800 feet in length with 14 foot depths at the center, graduated to about 7 feet at each end. Seines of this size required crews of 20 or more men to handle them. The haul seine today is rectangular in shape and constructed of nylon webbing, having a stretched mesh of ½ to 1½ inches. This net varies in length and depth, with a lead weight line running along the bottom and a cork or float line running along the top. Many of the seines have bags and pockets into which shrimp are herded. The seine nets now used in South Carolina are limited to 40 feet in length with a mesh size of one-half inch (stretch) or greater. The nets can not block more than one half of a creek.

Most seining operations are carried out in shallow waters near the shoreline where the net can be hauled out and the catch sorted. During the peak of commercial seining, nets were designed to fish waters as deep as 20 feet or more, but at present they are rarely used in water more than six feet deep. Most of the seine fishermen consist of bait shrimp dealers and sportsmen.

Cast Nets

Cast nets are circular, usually having a spread of 6-20 feet and mesh sizes ranging from ¼ inch square mesh to ¾ inch square mesh. Most modern cast nets are constructed of nylon webbing. The net is thrown or cast in such a manner that it falls flat on the water when fully open. After the weighted edges of the nets have settled to the bottom, the cord is drawn, pulling the tuck lines into the center forming a bag to hold the shrimp.

Cast nets are used primarily by sportsmen fishing for bait shrimp and for home consumption purposes and by commercial fishermen fishing for live bait shrimp. These nets are particularly effective in tidal creeks on ebb tides where "creek shrimp" congregate at the mouths of small tributaries and sloughs and along the shoreline adjacent to the channel.

Channel Nets

Channel nets are essentially shrimp trawls anchored at the surface of the water. Like the haul seine, channel nets have a cork or float line at the top and a lead or weight line at the bottom. Instead of otter boards to hold the net open, poles are secured to the lead and cork lines at each end of the net to hold it open, and extra floats are used to keep the net at the surface. Each end of the net is usually held in position by a large anchor. The net is fished by emptying the tail bag into a skiff. Channel nets are fished mostly in North Carolina and South Carolina in bays and sounds on ebb tides at night. The size of channel nets varies in the different states, with 80 feet being the maximum legal width in South Carolina with a mesh greater than 2 inch stretch.

The employment of channel nets in North Carolina is very productive for pink shrimp, which begin their seaward migration during the spring each year. A major portion of the commercial catch is accomplished through the use of this gear during early spring. The channel net has also carried over into South Carolina recently and is effectively employed in harvesting white shrimp. The legal season is open during the same period as the fall sound and bay legal trawling season. Most of the net sets are commerical operations and are located in the most productive bays, sounds and rivers chiefly in the Georgetown and Beaufort areas.

Drop Nets

Drop nets consist of a large hoop up to 3-4 feet in diameter to which a cone-shaped net is attached. The hoop or frame is attached to a main line by a bridle. The main line is tied to a bridge, boat or pier while the net is dropped into the water. Nets are baited with smoked herring, cut fish, canned dog food or local varieties of bait which attract shrimp. This method is strictly recreational and is used for catching bait shrimp and shrimp for home consumption.

Trends in the Fishery

Shrimping today ranks first among all commercial fishing activities in South Carolina in terms of employment, capital investment and harvest value. Commercial landings of brown shrimp, white shrimp and pink shrimp from 1960 through 1974 were in excess of 62 million pounds (heads-off) total. During 1975 alone, approximately 5.4 million pounds of shrimp (heads-off) were reported by dealers along the coast with the highest market value ever recorded. The total landings and value of the shrimp catch for 1976 were almost equal to the 1973 figures. Concurrently, however, the number of resident and non-resident licensed trawlers (including boats under 30 feet in length) has increased significantly from approximately 430 in fiscal year 1960-61 to more than 1,100 in 1976-77. There is little evidence this increased "fishing pressure" will decrease noticeably in future years. In analyzing shrimp landing values and the increasing number of licensed trawlers operating in the state from 1960 through 1975, several interesting trends are apparent. (Figs. 1 & 2)

- Although South Carolina shrimp landings have fluctuated considerably during the 16

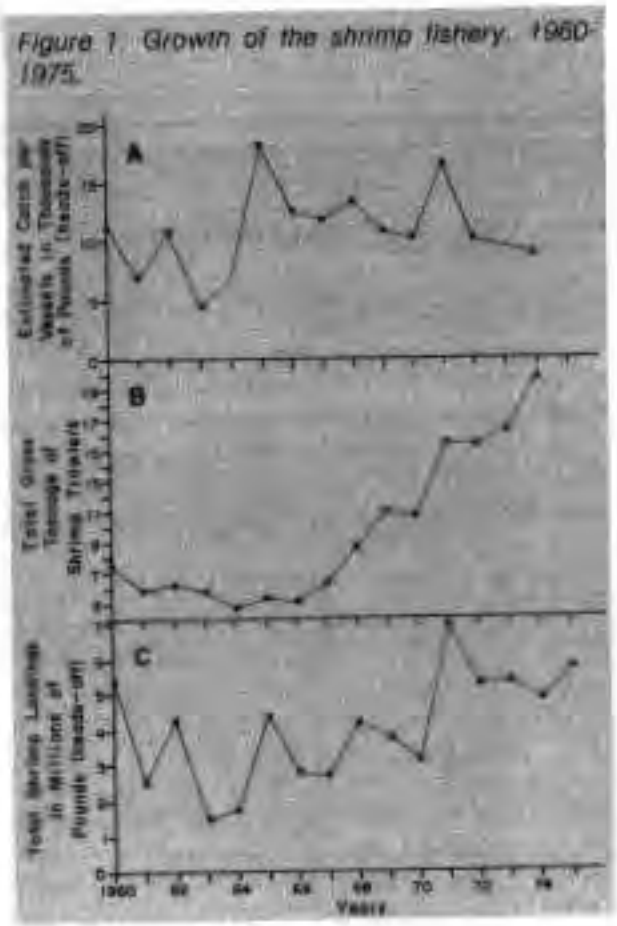


Figure 1. Growth of the shrimp fishery, 1960-1975.

Figure 2. Trends in the fishery, 1960-1977.

Number of Licensed Shrimp Trawlers, Commercial Shrimp Landings and Values in South Carolina (1960-1976)

Fiscal Year (July 1 - June 30)	Trawler Licenses			Year	Landings (heads-off)*	Total Value
	Resident	Non-Resident	Total			
1960-61	287	134	421	1960	5.1	$2,167
1961-62	281	89	370	1961	2.5	1,294
1962-63	305	156	461	1962	4.1	2,598
1963-64	289	97	386	1963	1.3	642
1964-65	221	111	332	1964	1.6	853
1965-66	251	116	367	1965	4.2	2,608
1966-67	271	97	368	1966	2.6	2,152
1967-68	294	196	490	1967	2.5	1,655
1968-69	321	166	487	1968	4.0	3,664
1969-70	365	251	616	1969	3.7	3,425
1970-71	368	211	579	1970	3.1	2,879
1971-72	491	356	847	1971	6.8	6,386
1972-73	573	305	878	1972	5.1	5,547
1973-74	667	389	1,056	1973	5.2	8,967
1974-75	624	336	960	1974	4.7	4,589
1975-76	689	302	991	1975	5.4	10,511
1976-77	838	291	1,129	1976	5.5	10,805

*In millions of pounds.

year period from 1960-76, there has been no dramatic increase in the annual shrimp catch per vessel since 1960. The average annual shrimp catch for the 1960-70 period was approximately 3.2 million pounds (heads-off). For the 1971-75 period, the average annual catch was approximately 5.4 million pounds (heads-off). But in view of the larger number of trawlers in 1971-75, per vessel catch was not dramatically increased.

- The number of licensed shrimp trawlers has increased significantly since 1970. The average number of shrimp trawlers licensed annually during the 1971-75 period was 946. During the 1960-70 period the average number of trawlers licensed each year was 428.
- There has been a significant increase in the number of larger double-rigged trawlers in recent years. During 1976-77, for example, 570 of the 1,129 licensed trawlers were double rigs. This is higher than the average annual total number of all vessels licensed during the 1960-70 period.

The present stability of the South Carolina shrimp fishery appears strong in regard to annual production and availability of the resource, although quantities of shrimp stocks fluctuate and will continue to do so in the future. Still, fishermen who harvest shrimp and management biologists who study them must look seriously to the future to continue wise resource management. In this effort, the Marine Resources Division, Office of Conservation and Management is directing considerable attention to what is now termed *Crustacean Management*.

Figure 3. Relation of white shrimp to pinks and browns landed in S.C.

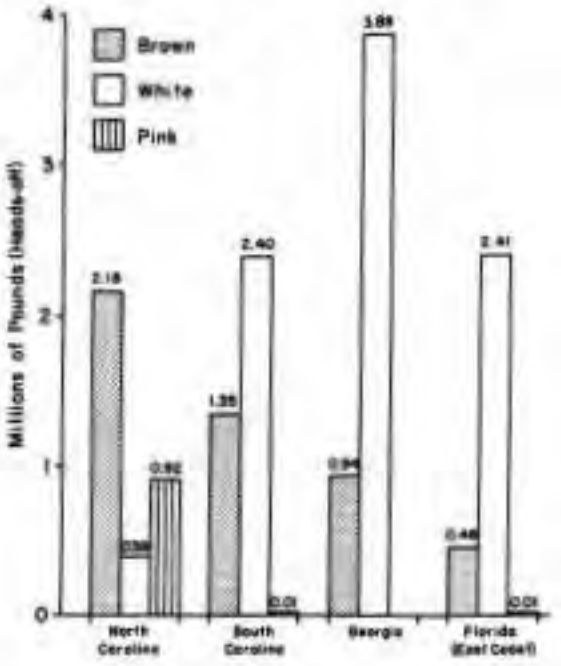
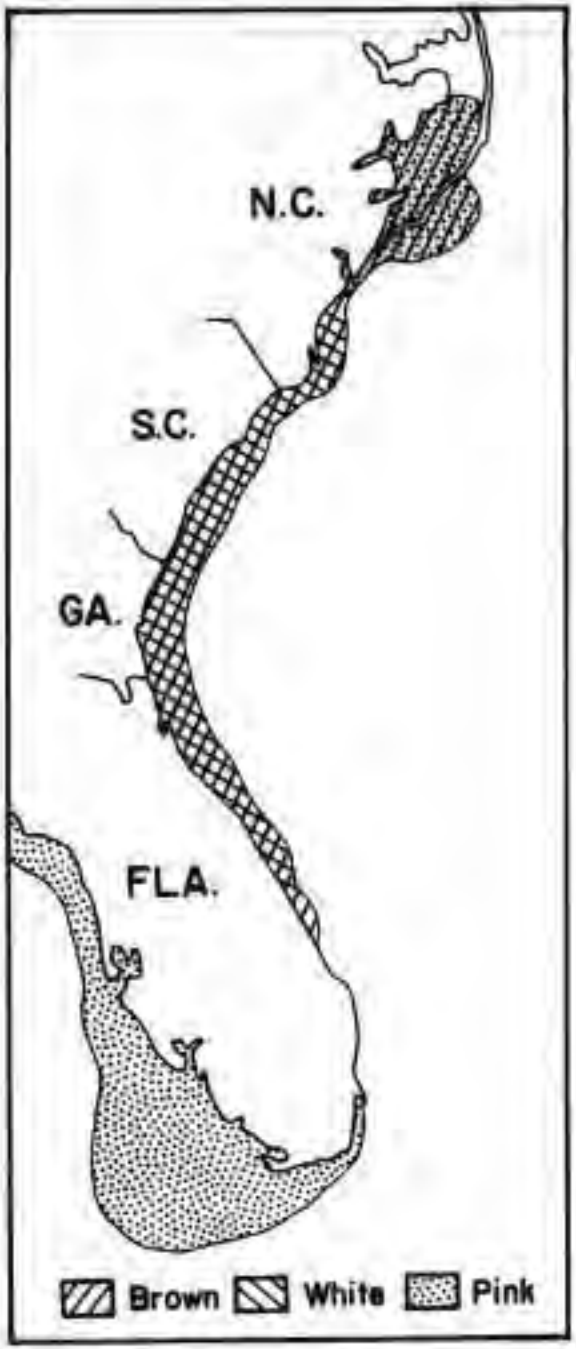


Figure 4. Map showing locations of white, pink, and brown shrimp populations.



The Crustacean Management Program is designed to derive maximum yield and economic benefit from the shrimp fishery while protecting the resource as well. In order to do this, Marine Resources Division biologists need to study particular portions of the life cycles of white, brown, and pink shrimp. Some of the generally accepted information on these shrimp is presented in the next chapter. (Figs. 4&5)

THE LIFE CYCLE OF SHRIMP

Three shallow-water species of Penaeid shrimp support almost entirely the commercial shrimp fishery of South Carolina. These include the brown shrimp, *Penaeus aztecus aztecus*, the white shrimp, *Penaeus setiferus*, and the pink shrimp, *Penaeus duorarum duorarum*. Brown and white shrimp are by far the most important, while pink shrimp represent only a small percentage of the total shrimp catch annually. In recent years, commercial shrimp production for South Carolina by weight has been approximately 70 per cent for white shrimp, 30 per cent for browns and less than 1 per cent for pinks. (Fig. 3)

Brief Description of Life Cycle

All three shrimp species have very similar life cycles. Each species passes through essentially the same developmental stages, but the times of year during which a particular stage occurs, as well as spawning locations, differ considerably. Brown shrimp spawn primarily during the winter (probably from November through February) with their young first reaching marketable size in early summer. In contrast, white shrimp spawn during the spring and summer from April through July with their young reaching marketable size in late August and September. Pink shrimp, though not commercially abundant in South Carolina,

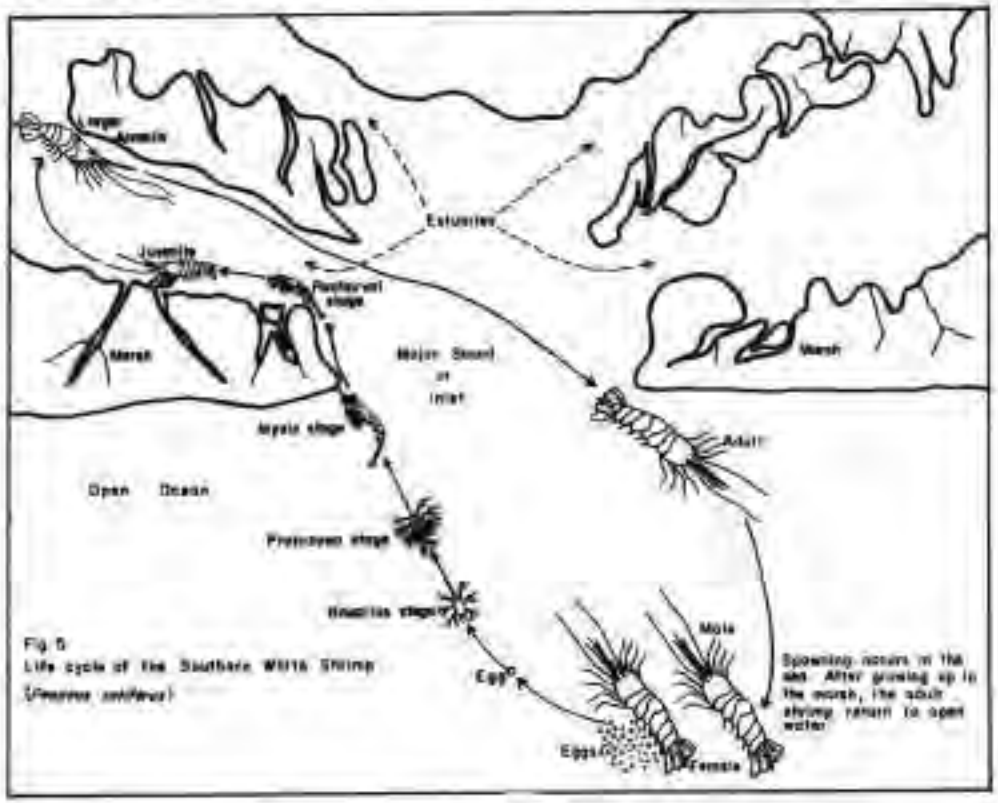


Fig. 5
Life cycle of the Southern White Shrimp
(*Penaeus setiferus*)

spawn at about the same time as do white shrimp.

During the proper season, sexually mature or "roe" females of each species release their eggs offshore and the young shrimp, after hatching, pass rapidly through various and complex developmental stages. During this development they move through the mouths of sounds, bays, inlets and rivers into saltmarsh creeks along the entire South Carolina coast. Within the tidal creeks of the shallow estuarine nursery grounds, these shrimp reach a juvenile and then sub-adult stage a few months later. Here, within this extremely productive zone, food is plentiful, growth is rapid and limited sanctuary from predators is available. As growth continues, a gradual seaward migration takes place. In time, many of these shrimp will enter the commercial fishery offshore.

Spawning

White shrimp spawn close to beaches along the South Carolina coast. This normally occurs within one to five miles from shore, in waters

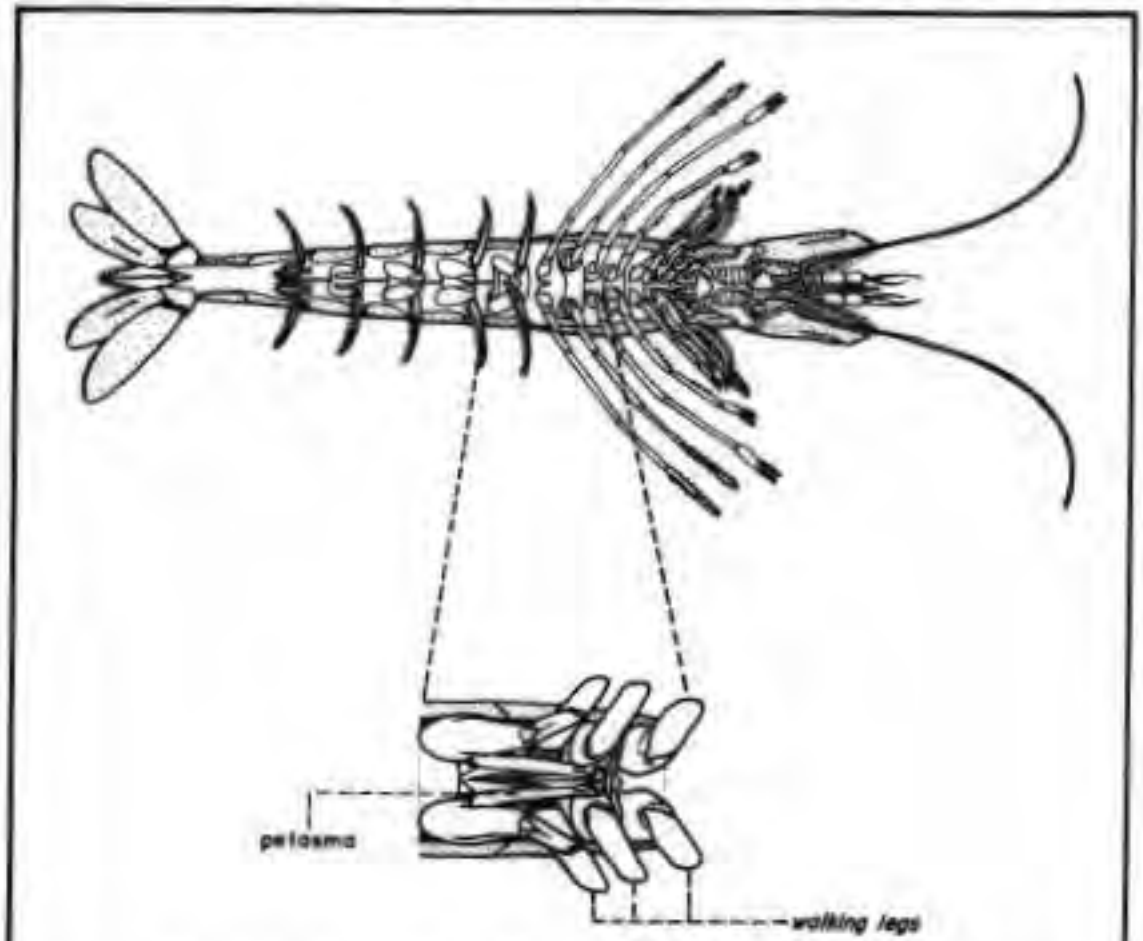


Fig. 6 Ventral view of male shrimp showing petasma

ranging from ten to thirty feet in depth. In comparison, brown shrimp are thought to spawn much farther offshore, although the exact spawning locations are still not known. In the past, a few large brown shrimp in spawning condition have been found off the South Carolina coast during November and December and concentrations of large brown shrimp have been located off the northeast coast of Florida during the winter months in depths of about 30 fathoms.

The male shrimp produces an inconspicuous pod-like structure called a spermatophore. This small white structure, which is about ¼ inch in diameter, contains sperm which fertilizes the female's eggs. The act of copulation or mating, to the best of our knowledge, has never been observed. It is thought that mating occurs for most shrimp species just after the female molts (sheds) and before the exoskeleton (outer shell) hardens. (Fig. 7)

The female shrimp bears a specialized structure located between the 3rd and 4th pair of walking legs called the thelycum, which has small tufts of bristles. These hair-like structures aid in the attachment of the spermatophore, which is covered with an adhesive or sticky substance. The spermatophore does not adhere very well to the female. It is uncommon to see a female roe white shrimp with an attached spermatophore, although spermatophores are frequently found loose in shrimp catches during the spawning season. The male also has a specialized external structure called the petasma, which joins the first pair of swimming legs. Some biologists believe that the petasma is an accessory structure which aids the walking legs in manipulating the spermatophore.

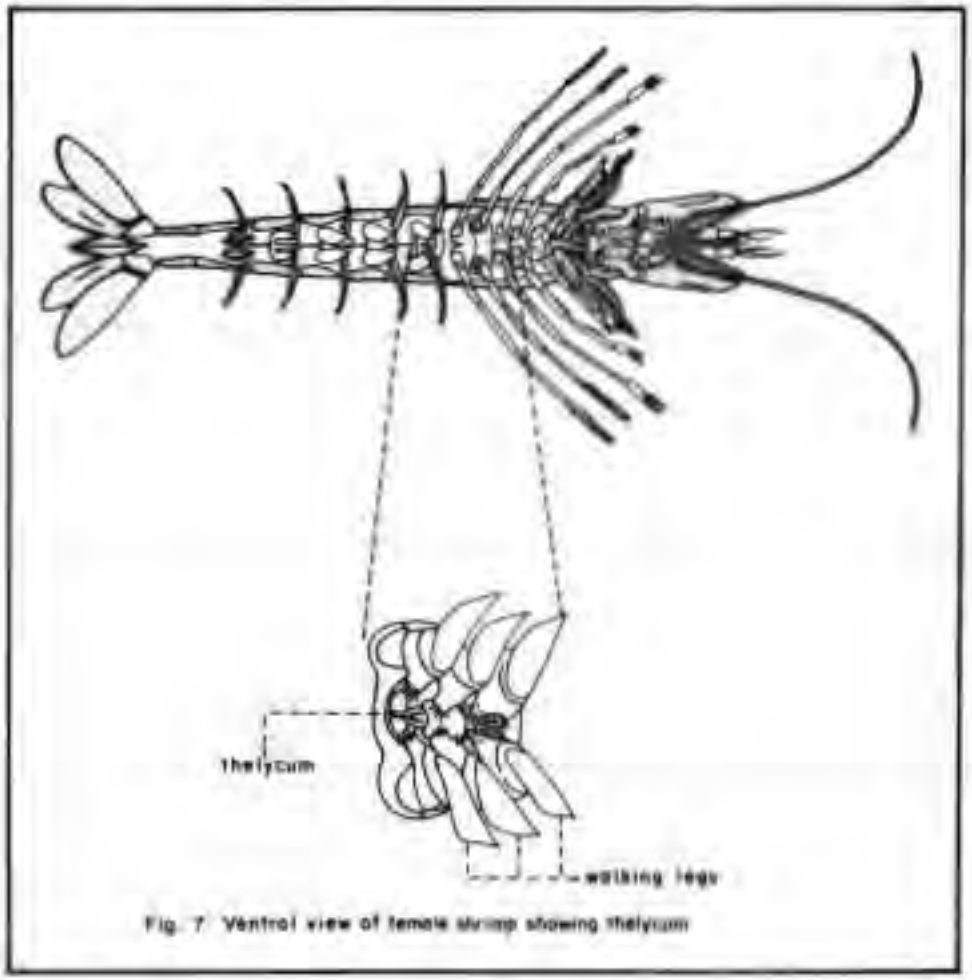


Fig. 7 Ventral view of female shrimp showing thelycum

Larval or Early Development

As eggs are released by the female, they are fertilized by sperm from the attached spermatophore of the male. Consequently, fertilization occurs externally or outside the female's body (Figure 7). Only one sperm is required to fertilize each egg, which is spherical and about 1/75 of an inch in diameter. A single female normally produces from 500,000 to a million eggs and may spawn several times during a season. Some females may even live to spawn the following year. The fertilized eggs are demersal, which means that they sink to the ocean bottom once released. The shrimp embryo then goes through 12 pre-adult stages. Larval development alone requires about 2 to 3 weeks.

After 20 to 24 hours, the first larval stage emerges from the egg. It is termed the nauplius stage. At this stage, the animal is only about 1/85 of an inch long. During the next 24 to 36 hours, the animal goes through 5 molts to form what is called protozoea, which is about 1/28 of an inch long. The larval shrimp now goes through 33 protozoeal stages, then 2 mysis stages, and finally 2 postlarval stages, a process which takes about 2 weeks.

Postlarvae Move Into Estuaries

Postlarvae which appear for the first time as "miniature adults" move with limited swimming ability into the estuaries of the coastal zone as part of plankton. The term plankton generally refers to all plant and animal life that is not

capable of swimming against water currents. During the planktonic stages, larvae and postlarvae are heavily preyed upon by a wide variety of fish, jellyfish, and an assortment of other marine animals.

Shrimp start actively seeking the bottom as postlarvae and begin to grow into adults at a rate of about 1½ to 2 inches per month. As they increase in size, the growth rate gradually slows down. Shrimp normally require about 4 to 6 months to reach maximum adult size.

The upper reaches of sounds and bays, as well as many rivers and creeks, are frequently referred to as nursery grounds. It is here, in a favorable habitat, that young shrimp grow best. These areas are extremely rich in nutrients, much of which is produced by decomposing saltmarsh grasses (detritus), principally cordgrass called *Spartina*. Again, limited protection from predators is available. Shrimp feed upon detritus, small marine worms, tiny crabs and shrimp, and other small shellfish. Shrimp have also been observed to attack and eat very small fish and squid.

The Effects of Environmental Factors

Environmental factors probably play the most important role in determining the success or failure of the commercial shrimp harvest. Water temperaure, salinity, rainfall, river discharge and water currents all have significant effects upon shrimp populations during any given year. Temperature is the most significant factor, influencing growth and survival rates as well as migration. During the warmer months, growth is rapid but diminishes or even stops during the winter.

During past winters, extremely low water temperatures have resulted in mass mortalities of white shrimp such as in 1963-64 and 1976-77. Decreasing water temperatures in the fall and winter also stimulate the seasonal and local migration of shrimp. As cold weather approaches, larger adult white shrimp move offshore and southward along the coast and small shrimp move to deeper waters in protective estuaries or offshore. Brown and pink shrimp, however, often burrow into the bottom during cold periods.

Salinity is another major factor affecting the "lifestyle" of shrimp. For example, mass inshore-offshore movement may result from heavy rainfall which lowers salinity.

Feeding Habits, Habitats, and Locomotion

Newly hatched shrimp feed entirely on plankton until they reach the postlarval stage of development. This means that after hatching in the ocean, young shrimp begin consuming small free-floating algae and animals in the water column before they move into inshore-nursery grounds. As postlarvae, small shrimp then

become bottom feeders, with a diet of plant and animal detritus, algae, and very small bottom invertebrates. The feeding habits of postlarvae will remain basically the same as they grow into juveniles and mature adults. Adult shrimp may occasionally ingest larger organisms such as worms, small fish and shellfish and may also feed as scavengers when opportunities arise.

Each of the three shrimp species display differences in habitat preference during their development and especially as adults. Studies have indicated that brown shrimp and pink shrimp generally prefer higher salinity, inshore habitats characterized by live bottom mixed with mud, sand and shell. In comparison, white shrimp appear to prefer lower salinity brackish water areas with soft-mud bottoms rich in detritus and other nutrients. Habitat preference may also be linked to other behavioral characteristics which have been observed in each species. White shrimp are the most active of the three species, but they do not burrow into the bottom as do browns and pinks. White shrimp are also the least hardy, being more susceptible to environmental fluctuations such as low winter water temperatures and salinity differences.

All three shrimp species display essentially the same means of locomotion or ways of moving about. To seek protection from predators, they usually congregate in large schools. The shrimp usually crawl along the bottom with the "walking legs" during random short-distance movement. They also travel considerable distances in search of food or as they migrate from one location to another. This long distance locomotion involves the use of the abdominal "swimming legs" which can carry the shrimp many miles. A third type of locomotion involves strong flips of the tail to produce quick movement. This kind of movement propels the shrimp rapidly backwards through the water and at times out of the water.

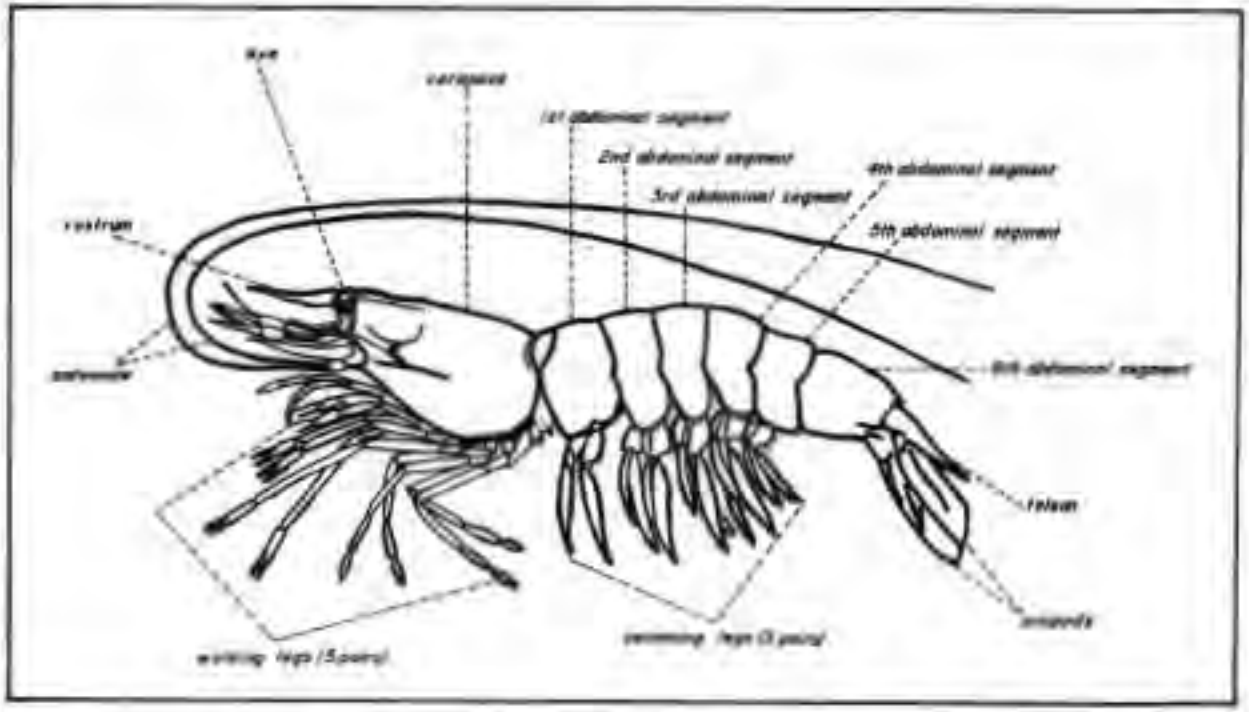
Shrimp Disease and Parasites

Many shrimp diseases are caused by minute parasites which actually feed on their host, the shrimp. A study completed in Florida yielded 15 different parasite species representing 4 major animal categories. Biologists found 5 types of protozoans (single cell animals), 4 types of larval trematodes (flatworms), 4 larval cestodes (tapeworms), 1 immature nematode (roundworms) and 1 fly larva.

Single cell protozoans are the most common parasites and inflict the greatest parasitic damage to the shrimp populations. These minute single-celled animals cause what is commonly called the "cotton" and "milk" condition. The parasites may attack the body muscles, the reproductive organs or the digestive tract of shrimp. These small animals are more properly called sporozoans, which means that they reproduce by spore formation. It is not known exactly how shrimp obtain this disease, but it is suspected that they eat small spore-infested creatures such as worms, smaller shrimp and other animals.

"Cotton shrimp" are not known to be harmful to man when eaten, but nor are they recommended for human consumption. These shrimp commonly lack the texture and natural coloration of normal shrimp and are fairly easy to recognize. Should a "cotton shrimp" be captured, it is best not to return the entire shrimp or shrimp head to the water. One shrimp may contain thousands of spores and possibly infect numerous other shrimp.

Figure 8.



THE SHRIMP MANAGEMENT PROGRAM

An Overview

The present shrimp management program in South Carolina is based largely upon biological knowledge and experience gained over the past twenty-five years. The primary objectives of this program are to:

- protect the resource
- maximize catch
- maximize gross economic yield.

The first of these objectives has been achieved by regulating the harvesting of shrimp (such as restricting trawling in nursery areas), and by regulating alteration of coastal estuaries and marshlands. Attempts have been made to attain the second and third objectives by regulating the size of shrimp harvested, primarily through the opening and closing of seasons at strategic times.

The South Carolina shrimp fishery has generally prospered during its long history without overfishing or depletion of the resource. Although it is felt that the existing management system has been satisfactory in maintaining shrimp production and in protecting the resource, there remain a number of problem areas. The present system is limited by biological information gaps, inadequate shrimp catch and effort statistics, and lack of sufficient social and economic information, as well as enforcement and legal problems. The lack of a regional management system for the four South Atlantic coastal states and limited jurisdiction on fishing beyond the offshore three mile territorial limit also hinder present management efforts.

In spite of these limitations, every effort is made under the present management system to regulate the fishery in such a way that the resource is protected while the fishermen receive maximum economic benefits. Management decisions such as whether to open or close the season in a particular area or areas are often difficult and must be based upon biological, social and economic considerations. These decisions are increasingly being based upon scientific information and are aimed at insuring a profitable shrimp fishery both now and in the future.

Up to date information on the abundance, size and other aspects of shrimp populations is essential to the management process. At present, the Office of Conservation and Management continually collects such information on the year round basis. This is done by monitoring shrimp throughout the coastal area with Marine Resources Division vessels, as well as by sampling commercial catches on board shrimp trawlers and at docks. In addition to these continuous monitoring operations, surveys aimed at providing information on movement into the estuary from offshore, migration, and the effect of environmental factors on shrimp are also being carried out.

Laws and regulations pertaining to the management of the shrimp fishery in South Carolina are generally designed to control seasons, fishing areas, and the general size of shrimp caught. The regulation of fishing areas is largely aimed at the protection of juvenile and young adult shrimp and inshore estuarine nursery areas. Inshore estuaries and marshlands are vital as nurseries for young shrimp. Protection of nursery areas from overfishing and degradation by man-made alterations and pollution is essential to the well-being of the fishery. Seasons are controlled primarily to provide for maximum economic benefits, although the protection of young shrimp and spawners for future harvesting is also considered. The size of shrimp that can be caught is controlled to a significant extent by regulations on gear and methods as well as by restrictions on seasons and fishing areas.

The Marine Resources Division of the South Carolina Wildlife and Marine Resources Department has the primary responsibility for the management and regulation of the shrimp fishery. Coastal fisheries laws for South Carolina are currently contained in Chapter 7, Title 28, South Carolina Code of Laws, as amended. The Division is authorized to put into effect rules and regulations for the control of fisheries consistent with existing State policies and statutes.

Most of the regulatory authority of the Division is specified by statute, including provisions for seasons, areas, gear restrictions, licenses and taxes, etc. The Division does have considerable flexibility in shrimp management, however, where control of the season in coastal waters is concerned. Any area where legal shrimp trawling is permitted may be opened or closed at any time.

The law enforcement unit of the South Carolina Wildlife and Marine Resources Department is the Division of Law Enforcement and Boating. The duties of the Division of Law Enforcement and Boating include the enforcement of game and freshwater fisheries laws, as well as boating and marine resources statutes and regulations. This Division has ten districts throughout the state with one, the Coastal Environmental Enforcement District, being primarily responsible for marine resources law enforcement.

White "Roe" Shrimp Investigations

Crustacean Management biologists extensively monitor legal offshore shrimp trawling areas (from the beaches to 3 nautical miles offshore) prior to evaluating the general state of the roe shrimp population. The primary objectives of this program are to determine (1) relative population size and (2) if spawning has occurred. These factors are very important in deciding when the shrimp season should be officially opened. Prior to 1974, for example, the offshore shrimp season remained closed until a large percentage of the white roe shrimp population had spawned. This was a conservative, common sense approach to management but is apparently not absolutely necessary.

It is now thought that perhaps only a limited number of adult spawners is needed to produce all the eggs required for a successful spawn. The present offshore sampling program, together with the plankton survey which is described later in this report, is directed at investigating the relationship between the parent population of shrimp and the number of young produced. Trawling for roe shrimp before complete spawning occurs may not adversely effect the quantity of shrimp in the fall. In 1975, for example, the offshore season was officially opened shortly after the first evidence of spawning, with no obvious detrimental effect. In 1976, the shrimp season was also opened before any major spawning activity had occurred.

The offshore shrimp sampling program has been underway for two years, during which time several modifications have been made to further improve the quantity and quality of information collected. Sampling is carried out as consistently as possible in all areas surveyed, and the number of sampling stations has been increased. The interest and helpful cooperation of numerous trawler captains is of significant benefit to this survey, as it has been in the past.

Sampling normally begins in March in the McClellanville, Charleston and Beaufort areas with cruises made each week aboard the R/V CAROLINA PRIDE. Privately owned trawlers are also used in the areas off St. Helena Sound and Bull Bay when feasible. Crustacean Management personnel also continue to monitor catches throughout the state after the season is officially opened.

Sampling consists of 30 minute trawls made at designated locations along the entire coast. Shrimp catches are sorted and separated by species. Shrimp are then weighed, counted and measured. Heads-on and heads-off counts are also recorded. Fifty females, selected at random from each catch, are measured and the ovaries or "roe" inspected to determine the

Figure 9. Measuring shrimp caught during offshore sampling.

Figure 10. **Stages of Roe Development in White Shrimp**

Stage	*Appearance of Ovaries*	*Probable Occurence*
Undeveloped	Clear, small	Summer, Fall and Winter
Developing	Surface with pigmented spots, interior slightly milky in color	March and April
Yellow	Light yellow to almost organge	Late April through August
Ripe	Olive brown or green	May through August
Spent	White or cream colored, deflated	Late May through August

stage of roe development. The percentage of shrimp at each stage of roe development, including *undeveloped, developing, yellow, ripe* or *spent* are recorded.

The stage of roe development in female shrimp can be determined by the color of the eggs within the ovaries or egg sacs. Ovaries are found under the carapace at the base of the rostrum or spine and along the tail on either side of the digestive vein. As eggs mature they change progressively in color and size.

Maturing is actually a continuous process, but it can be divided into five phases or stages which are visually distinguishable from one another. In the first stage, or the *undeveloped stage*, ovaries are small, flattened and clear. This stage is present in younger shrimp during the fall and winter and in many large shrimp through February and March.

The next stage is termed the *developing stage*, which is difficult to distinguish from the first stage except that the ovaries are easier to detect and are characterized by small pigmented spots on the surface. Ovaries become cloudy and then an opaque creamy color before reaching the next stage.

The third stage or *yellow stage* occurs next when the color of ovaries ranges from light yellow to almost orange. This is when roe first

Figure 11. [below] *Roe Shrimp.*

becomes obvious to the casual observer. Shrimp apparently may remain at this stage of development for some time before entering the fourth or *ripe stage* which is characterized by deep olive-brown roe. This stage immediately precedes spawning. Once the eggs are released ovaries are said to be *spent* and look like deflated balloons. They are white or creamy in color and similar to ovaries found in the developing stage.

The offshore shrimp sampling program will be continued in order to monitor any changes in the white "roe" shrimp population each year. Yearly variations in catches will be compared to the results of the plankton survey, inshore trawling data and fall commercial landings to determine when and if any detrimental effects occur and to observe any trends from year to year or over many years. Hopefully, pieces of the puzzle surrounding roe shrimp can be fitted together in order to improve or at least predict future shrimp season harvests. Many of the pieces are in place. Now the effect of combinations of natural and man-made conditions such as rainfall, temperature, predation, pollution and others must be investigated to more fully understand their influences on the life history of commercial shrimp. (Fig. 12)

Postlarval Shrimp Survey

Small commercial shrimp of only ¼ to ½ inch in length enter estuaries, aided by currents along the entire South Carolina coast each year. These shrimp have successfully passed through half a dozen or more critical growth stages in the previous two to three weeks and have developed from microscopic, sperical eggs, through several larval stages, to postlarvae. At this point in their development, they enter the estuaries through sounds, bays, inlets and rivers. Postlarval brown, white and pink shrimp, along with innumerable other tiny planktonic animals and marsh grass fragments (detritus), are carried through these narrow passes in great numbers. Because of the funneling effect which characterizes most inlets, shrimp become concentrated and are fairly easily collected. Two such areas have been selected as sites for field research. They are Breach Inlet, located between Sullivans Island and the Isle of Palms, and the mouth of the South Santee River. Here, tiny postlarval shrimp which constitute the foundation of our commercial shrimp fishery each year are caught during an intensive plankton sampling program.

An entirely new approach to sampling commercially important postlarvae was initiated at Breach Inlet Bridge in 1974, and has continued through 1977 (Figure 14). The experimental site was selected on the basis of its representative location and history of consistency of producing postlarval brown, white and pink shrimp. Due to the sampling success at Breach Inlet, a second station located in the mouth of the South Santee River was established in 1975. The two sites provide a basis of comparative data on postlarval recruitment (movement into the estuaries) across separate parts of the state.

Plankton samples are collected by standard procedure using two nylon plankton nets. Each net is set very near the bottom for an equal time during daylight hours. A total of eight, one hour sets are made each sampling week. The two cone-shaped nets are equipped with flow meters, which record the quantity of water passing through each net. The nets are fished during the flood tide exclusively. The first set of samples is taken one hour after mean low water during the early stage of the flood tide. This schedule permits time between tows for washing and storing samples in formalin, switching nets between locations and recording hydrographic and meterological data. Once samples have

Figure 12. Summary of White Roe Shrimp Landings in South Carolina, 1960-1976.*

Year	Roe Shrimp Landed (Pounds, Heads-off)	Roe Shrimp % of Total Shrimp Catch	Value of Roe Shrimp (Dollars)	Roe Shrimp Value as % of Total Shrimp Value
1976	700,655	12.6	2,562,727	23.7
1975	813,954	10.8	1,399,951	13.0
1974	808,959	16.9	1,225,282	25.2
1973	553,940	10.4	1,040,633	11.7
1972	1,582,427	20.9	1,347,963	24.3
1971	143,083	2.1	201,962	3.2
1970	14,359	**	15,639	**
1969	943	**	1,132	**
1968	0	0	0	0
1967	56,047	2.2	55,787	3.3
1966	31,964	1.2	24,246	1.1
1965	183,127	4.3	151,557	6.8
1964	0	0	0	0
1963	0	0	0	0
1962	78,876	1.9	60,743	2.3
1961	52,055	2.2	27,443	2.1
1960	243,449	5.1	145,217	8.7

*Consider shrimp landings March - July.
**Less than 1%.

been collected they are returned to the laboratory for sorting and identification. This is often a tedious and time consuming phase of the program, because one sample may require from two to four hours to process.

The on-going studies at Breach Inlet are demanding both in terms of time and personnel requirements. Still, it is felt that potential benfits to a progressive shrimp management program far outweigh the costs. Some of the objectives of this program are as follows:

- To define a possible relationship between the movement of postlarval shrimp into the state's nursery grounds and the quantity of mature shrimp which enter the commercial catch of shrimp trawlers offshore.
- To develop a dependable method of evaluating the spawning success of "roe" shrimp populations in the winter (brown

Figure 13

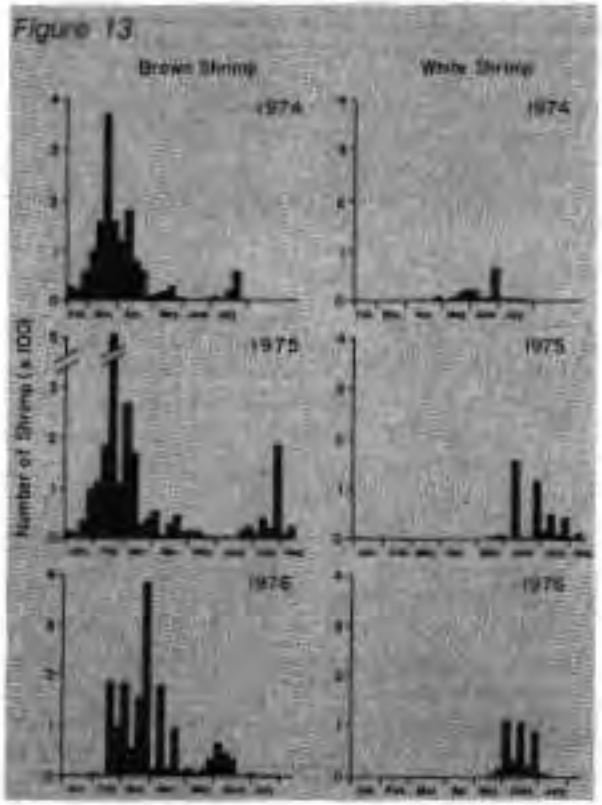


Figure 14. Postlarvae sampling, Breach Inlet.

Figure 15. Postlarval shrimp.

shrimp) and spring (white shrimp) each year.

- To expand our level of knowledge on the general and specific biology of commercially important postlarval shrimp with the hope of managing the South Carolina shrimp fishery more wisely. In these efforts, the commercial fishermen remain one of our primary concerns.

Managing The Sound and Bay Shrimp Fishery

South Carolina's legal inshore shrimp trawling grounds, including Winyah, North Santee and Bull Bay north of Charleston and St. Helena, Port Royal and Calibogue Sounds to the south (see Sections 28-861.1, S. C. Marine Fisheries Code of Laws) are sampled extensively by Crustacean Management personnel from July through December each year. Information obtained from experimental trawl collections aboard the R/V CAROLINA PRIDE and private trawlers is used in determining the overall quantity, size and condition of shrimp occupying these areas. These studies determine when each sound or bay should be opened to commercial shrimp trawling. Personnel also monitor any changes that might adversely affect normal shrimp production as the season progresses.

The same methods and procedures used in the offshore "roe" shrimp sampling program are employed in the sound and bay survey. Twin, twenty-foot flat-line otter trawls with 1 7/8 inch mesh webbing are towed for thirty minutes at predetermined locations in St. Helena, Port Royal and Calibogue Sounds, Bull Bay, North Santee Bay and Winyah Bay, which are typically shallow water areas, must be sampled from a smaller, more versatile 18 foot Division trawler. Shrimp are carefully sorted, examined, weighed and measured. Heads-on and heads-off counts are recorded. Hydrographic and meteorological data are also noted.

Many sound and bay sampling locations were selected on the basis of recommendations by local fisherman familiar with the general fishing area. With this approach, it was possible to take advantage of the valuable experience trawler captains have gained from many fishing years. Other recommendations included tidal stages, towing depth, towing direction, gear operations, etc. which were also considered. Clearly, our program has been enhanced with this type of cooperation from fishermen throughout South Carolina. (Figs. 16-20)

Several major criteria enter into a decision to officially open the sound and bay shrimp season. These include the quantity and size of available shrimp coupled with the current market price fishermen can expect for their catch. Unfortunately, these criteria can not be controlled and are, at any time, subject to sudden and occasionally drastic change. Consequently, no established date can be set for opening sound and bay areas each year, nor can they always open and close simultaneously. For example, the situation could arise when it would be in the best interest of fishermen and the resource to open St. Helena and Port Royal Sounds while Calibogue Sound remained closed.

The need for a continuing but flexible sound and bay shrimp sampling program becomes increasingly obvious as the fishery and especially fishing pressure expands. Each year brings new biological problems which challenge our efforts of wise resource management. This is not to mention the growing impact of economic and social factors to the fishery. As this management program continues, every effort will be made to further improve upon the methodology employed and the information gained. Clearly, much more information must be gathered concerning the life history and habits of shrimp before these and other problems can be resolved.

The following denote trawl stations for Crustacean Management Section.

Figure 16. Calibogue Sound

1 Off Daufuskie Island
2 Off Bull Island
3 Behind Marsh Island
4 Outside Marsh Island,
5 Beside Bram Point
Port Royal Sound
6 Off Dolphin Head and around Bobb Island to shrimping boundary
7 Chechesse River beside Coleton Neck to Foot Point
8 Colleton River mouth at shrimping boundary seaward into Chechesse River
9 Broad River beside lower end of Daws Island
10 Broad River beside upper end of Daws Island
11 Broad River beside Lemon Island from bridge seaward
12 lower Beaufort River behind Middle Marsh
Lower Beaufort River outside of Middle Marsh

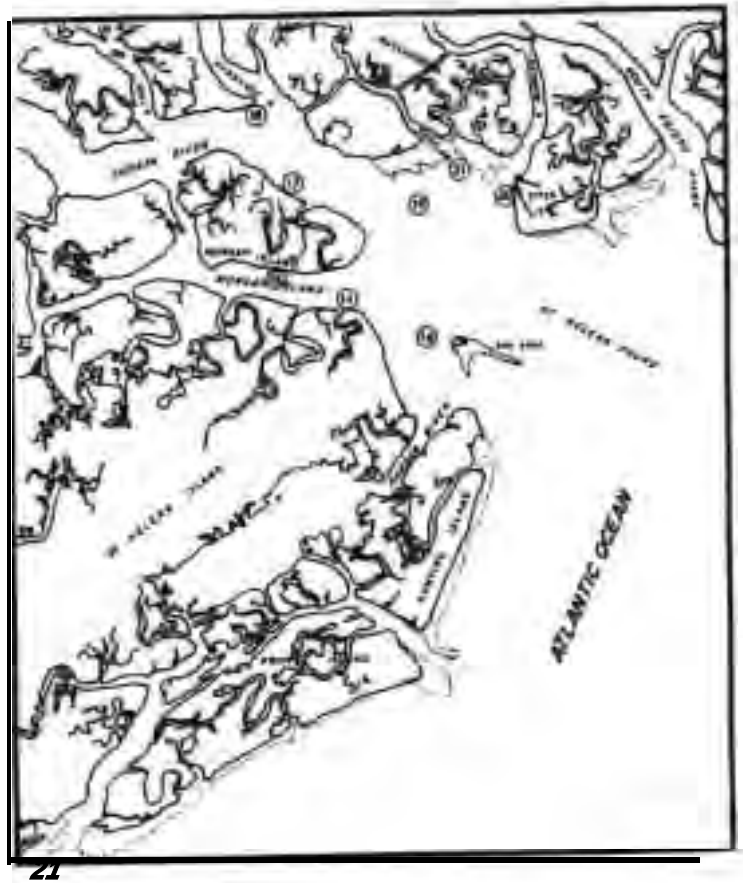


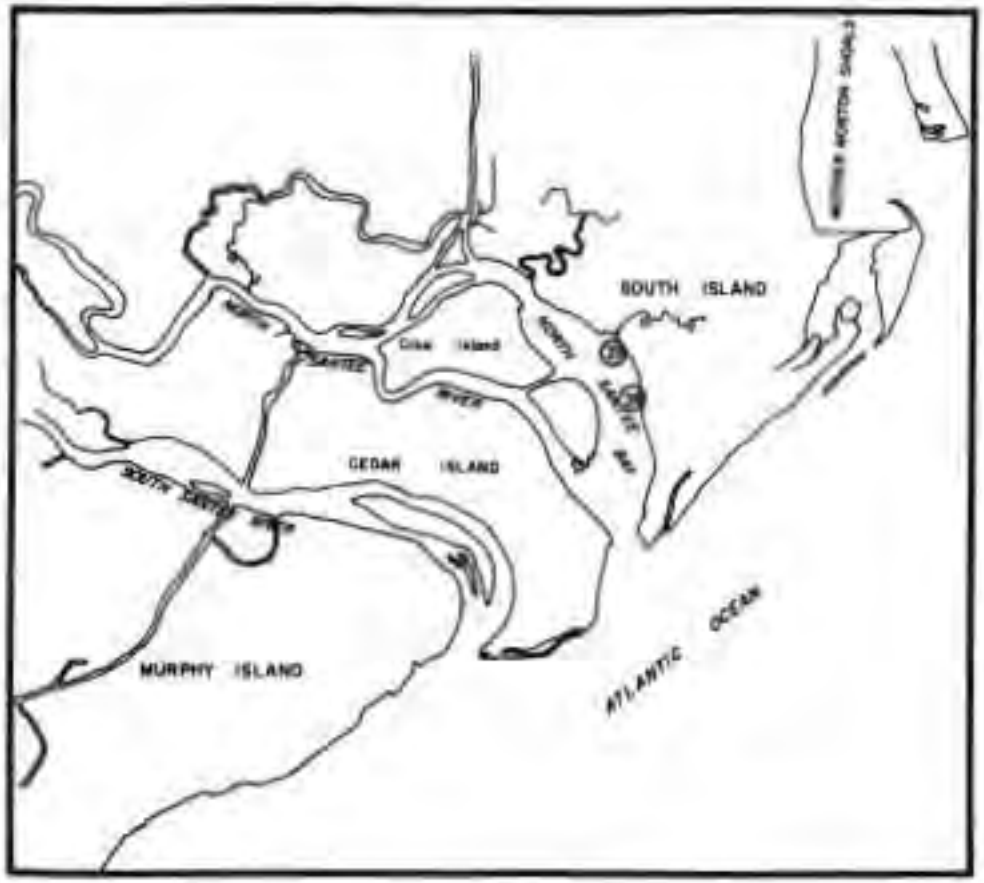
Figure 17. St. Helena Sound

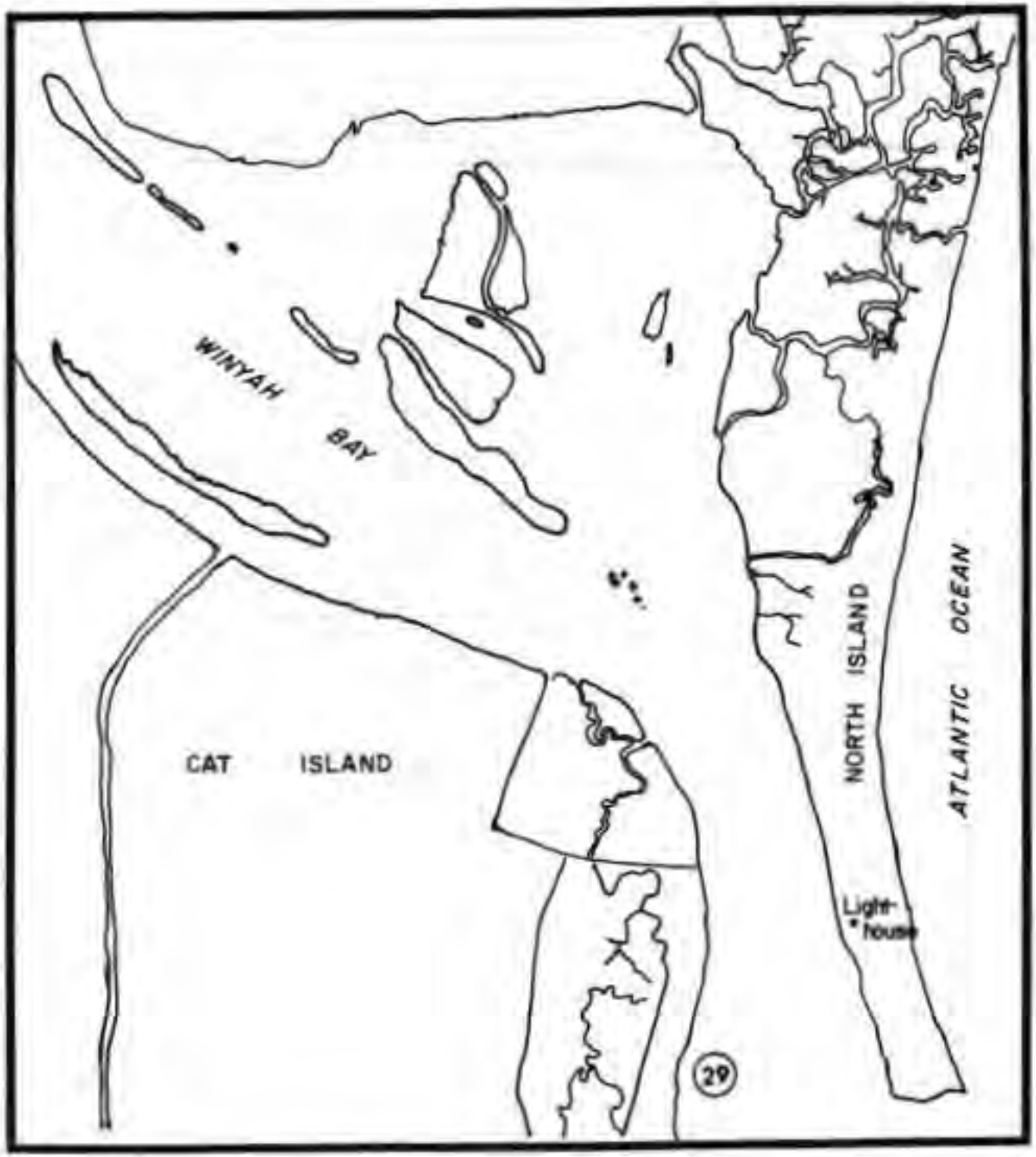
14 Morgan River off Coffin Creek
15 Morgan River beside Morgan Island
16 Below Morgan Island, "The Hump"
17 Coosaw River beside Marsh Island
18 Coosaw River at Bottle Neck.
19 Coosaw River at Combahee Bank
20 Lower Ashepoo River beside Otter Island
21 Lower Rock Creek

Figure 18. Bull Bay

Figure 19. North Santee Bay

Figure 20. Winyah Bay [right]





Sale of Shrimp Catches

Shrimp catches resulting from Crustacean Management programs and projects are sold to various dealers in the area. If more than 25 lbs. of shrimp are caught during a trawl effort, a sale is transacted using the following guidelines. These guidelines represent the official policy of the South Carolina Wildlife and Marine Resources Department concerning experimental catches. The guidelines are:

- —Shrimp will be sold only to a licensed dealer within the State.
- —Attempts will be made to transact shrimp sales with as many different licensed dealers as possible.
- —All shrimp will be sold at times and places most convenient to the OCM.
- —A minimum 25 (heads-off) lbs. quantity of shrimp will be required for sale.
- —No quantity of shrimp will be sold when size/quantity prices reflect a monetary loss to the OCM.
- —All sales will be made payable by check to the South Carolina Wildlife and Marine Resources Department (Office of Conservation & Management, Crustacean Management) and transmitted to the Comptroller's office by mail.
- —A log identifying all sales transactions will be maintained by the supervisor of Crustacean Management and submitted to the OCM Chief upon request.
- —Revenue received from all shrimp sales will be placed in a special fund and identified for future crustacean management activities.
- —Present sampling techniques reflecting minimum catch requirements will continue.

Channel Nets and the South Carolina Shrimp Fishery

The channel net is basically a modification of the shrimp otter trawl which was introduced into the South Atlantic shrimp fishery during the early 1920's. The shrimp trawl is towed by large and small power craft and may be fished in either shallow inshore waters or used offshore over much deeper bottoms. Otter doors are used to keep the cone-shaped net open. The channel net, in comparison, is a fixed or stationary type of gear which is used only in shallow inshore waters including sounds, bays and smaller rivers. It was developed during the mid-1930's by sound and bay fishermen in North Carolina.

Wooden poles or metal pipes 10 to 15 feet in length replace otter doors for keeping the net open properly. A single pole or pipe is fastened directly to the top cork line and bottom lead line at the end of each wing of the net. Occasionally, a third pole may be used near the center for additional support. Floats are spaced along the top line and galvanized chain is connected to the bottom lead line. Each pole is attached separately by a line to one or more bottom anchors which vary in material and design.

The channel or set net has recently been introduced into the commercial shrimp fishery of South Carolina. In comparison, North Carolina fishermen have used channel nets extensively for many years. By and large, this type of net is inexpensive to purchase, easy to maintain and repair, and relatively simple to operate in comparison to other more elaborate fishing gear. Perhaps most important is the fact that channel nets represent an economical and sometimes effective means of harvesting commercial shrimp. Because of these advantages, channel nets have attracted the attention and growing interest of the fishermen of South Carolina.

While channel nets appeal to small scale fishermen because of their simplicity, trawler operators, shrimp dealers and many

recreational fishermen see the use of channel nets as a threat to shrimp and certain species of fish that are critically dependent upon unspoiled nursery grounds for normal growth, development and survival. Many trawler operators and shrimp dealers believe that:

- channel nets harvest large quantities of small immature shrimp
- channel nets catch shrimp before they migrate offshore from the sounds and bays
- channel net fishermen operate only occasionally in an effort to supplement their income
- the retail market is adversely affected by the sale of large quantities of small shrimp taken by channel net fishermen;
- shrimp taken by channel nets are generally of "poor" quality.

Recreational fishermen also are concerned about species of sport fish being injured or destroyed.

Because of the undetermined impact channel nets might have on the present shrimp resource, a pilot study was conducted by Crustacean Management personnel from September through December 1974. This study is being continued with modification each year. A thorough examination of channel net activities in 1974 was started by checking net operations on a regular basis throughout South Carolina's inshore waters. All permit holders were requested to give information on their fishing operation and to cooperate with a field sampling program.

The survey consisted of on-site observations of fishing primarily in the Beaufort and Georgetown areas. Shrimp were carefully examined during each sampling period. Heads-on and heads-off counts were recorded, as well as individual lengths and total weights. The species composition of entire catches, including fish, crabs and other invertebrates, was also recorded.

In all, only 13,565 pounds of shrimp (heads-off) were reported by channel fishermen from September through December 1974. Catches came primarily from the coastal waters of Georgetown and Beaufort counties. In comparison, a total of 4.7 million pounds of shrimp (heads-off) was reported by commercial trawlers between April and December 1974. On the basis of these figures, channel net shrimp catches represent less than 1% of the total annual South Carolina shrimp landings during the year. (Fig. 21)

Figure 21

Comparative South Carolina Commercial Shrimp Landings in Pounds, (heads-off) as Reported by Shrimp Dealers and Channel Net Fishermen by month for 1974.

Month	Shrimp Trawlers (Pounds, heads-off)	Channel Nets (Pounds, heads-off)	Approximate Percent Of Total Catch (For Channel Nets)
April	10,506	S	S
May	540,343	S	S
June	235,533	S	S
July	936,492	S	S
August	600,213	S	S
September	1,089,144	956	Less than 1
October	827,705	3,854	1
November	471,800	8,339	2
December	260,966	416	Less than 1
Total	4,744,722	13,565	Less than 1

S = Channel Net Season Not Opened

Sixty-one channel net permits were issued to South Carolina resident fishermen in 1974. Four permits were issued to non-resident Georgia and North Carolina fishermen. Greatest channel net fishing activity occurred in Georgetown and Beaufort counties, where 70% of all permits were issued. (Fig. 22)

October and November represented the most productive fishing months for channel net fishermen, with 12,193 pounds of shrimp (heads-off) reported. Individually, 3,854 pounds were taken in October and 8,339 pounds in November. In comparison, September and December landings were much lower, with only a total of 1,372 pounds of shrimp being reported. Although 65 channel net permits were issued in South Carolina during 1974, not all permit holders fished regularly throughout the season. Many fishermen are employed either full or part-time in other occupations which conflict with fishing schedules. It is fair to say that few fishermen, if any, are completely dependent on income derived from the operation

Figure 22

List of 1974 Channel Net Permits Issued to South Carolina Fishermen by County and Percentage by County. Non-resident Permits are Included by State.

County	Permits Issued	Percent Issued
Georgetown	23	35
Beaufort	22	34
Charleston	7	11
Jasper	6	9
Allendale	2	3
Hampton	1	2
State of Georgia	3	5
State of N. Carolina	1	2
Total	65	

of channel nets. Most fishermen also chose to fish only during periods when larger shrimp catches were anticipated. Furthermore, the number of desirable fishing days is severely limited by tide and adverse weather.

Channel net shrimp catches by individual fishermen were generally small during 1974. A total of 2,655 pounds of shrimp (heads-off) represent the single largest reported annual catch for any individual fisherman. The second most productive fisherman reported a total annual catch of 2,415 pounds of shrimp. Only two other fishermen reported total catches in excess of only 9 to 199 pounds. Twenty-nine fishermen reportedly did not fish during the entire season.

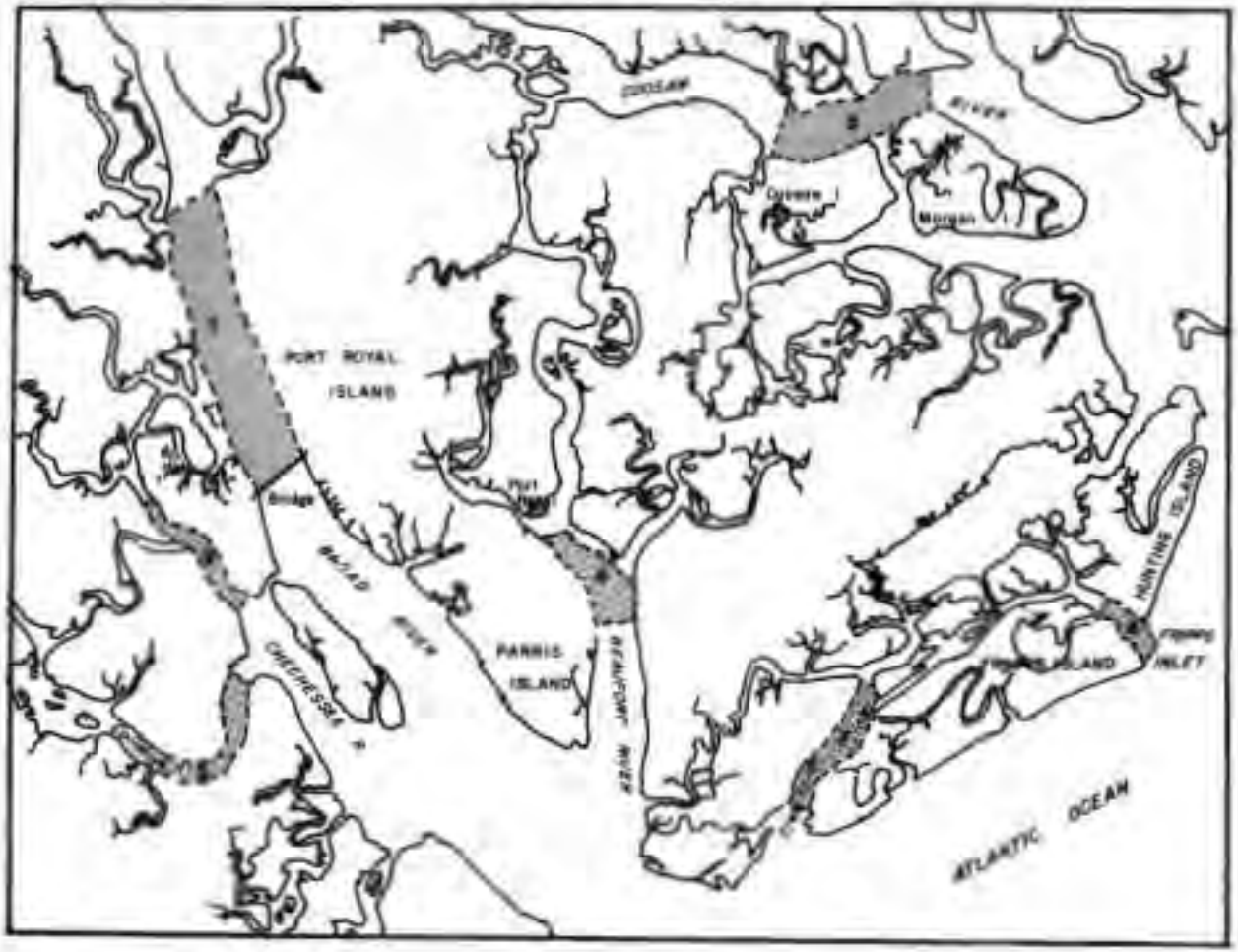
Heads-off counts of reported channel net shrimp ranged from 31/35 per pound to 81/85 per pound. Much smaller shrimp, however, ranging in count from 100 to 120 per pound, were observed during the field survey program. More than 50% of the channel net shrimp observed fell between 31/35 and 46/50 per pound. A remaining 20% probably included smaller shrimp in excess of 76/80 per pound.

The establishment of desirable channel net fishing locations outside upper estuarine nursery grounds immediately benefits both fishermen and the resource. Fishermen profit less from the harvest of smaller shrimp which are normally associated with these upper estuarine areas. At the same time, juvenile shrimp are free to mature in size without being disturbed. Boundaries of several channel net fishing areas were moved seaward by the Division during 1974 to reduce fishing pressures in these upper estuaries. Of particular concern were two areas previously set aside for channel net fishermen in the upper reaches of Whale Branch and in Chechesse Creek at Callawassie Island Bridge in Beaufort County. By changing these and other boundaries "Approved Channel Net Fishing Areas" now appear more favorable to resource conservation.

Approved Channel Net Locations For 1976-77

1. Broad River — Mouth of Whale Branch to Broad River bridge.
2. Chechessee River from 200 feet north of Highway 170 bridge South to legal trawling area.
3. Colleton River — from Sawmill Creek to legal trawling boundary.
4. Beaufort River — mouth of Battery Creek to legal trawling boundary.
5. Coosaw River — Sam's Pt. to legal trawling area (Marker 187).
6. Fripp Inlet — from mouth of Old House Creek to Inlet.
7. Trenchards Inlet — mouth of Station Creek to legal boundary mouth of Inlet.
8. Edisto River — from St. Pierre Creek to Ocean.
9. North Edisto — from mouth to Leadenwah Creek to Inlet.
10. Stono River — Johns Island Airport seaward
11. South Santee — Intracoastal waterway south to Ocean.
12. North Santee — Intracoastal waterway to

Figure 23. Approved channel net locations, Beaufort area.



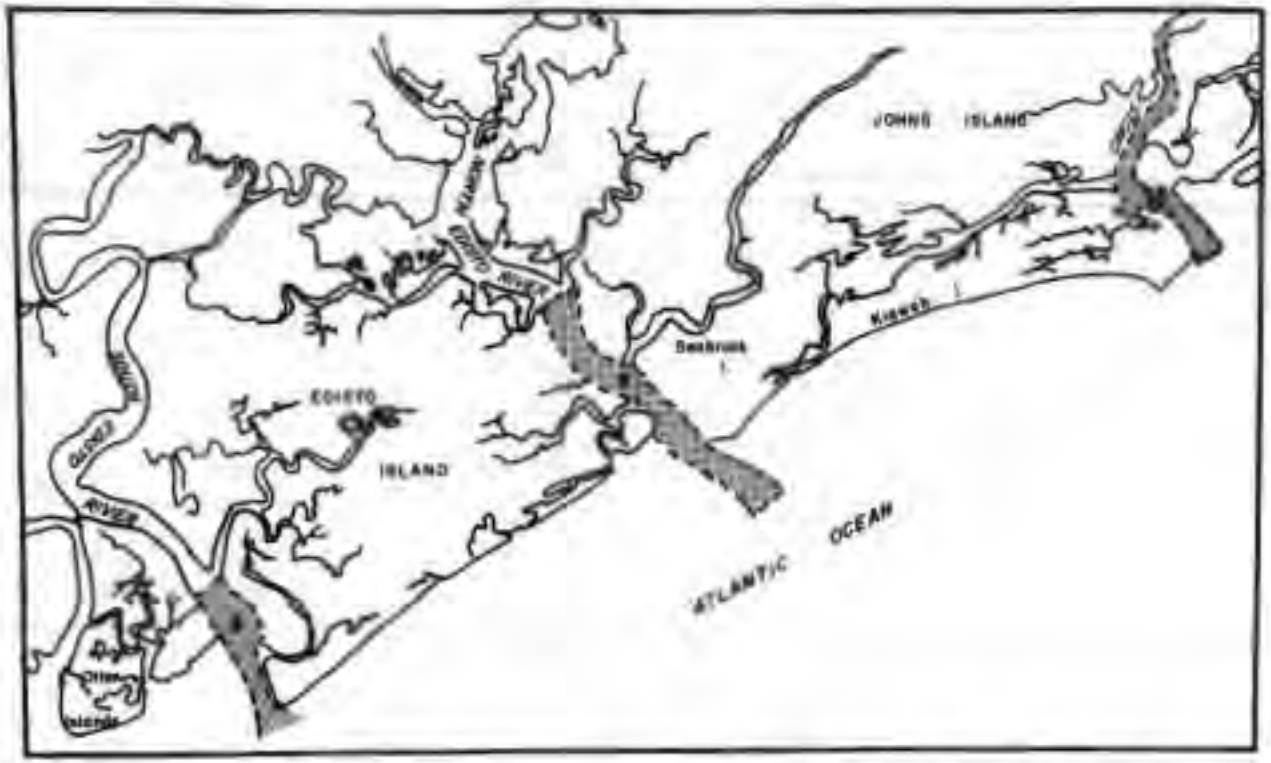


Figure 24. Approved channel net locations, Edisto River.

legal trawling boundary.

13. Winyah Bay — from a line running from the mouth of Mosquito Creek eastward to the mouth of Cottonpatch Creek, to the legal trawling boundary. (Figs. 23-26)

Many similarities in fishing procedures were observed during the initial channel net field survey. Generally, fishermen elected to fish at night during ebb or outgoing tide. Strongest tides were preferred and almost always determined the success of a fishing period. Consequently, tides severely limit the use of channel nets. The average net size determined by the study was 70 to 80 feet along the head rope, and 10 to 15 feet in height. Normally, two fishermen are required to fish a single net. Occasionally, one fisherman will attempt to fish two smaller 30 to 40 foot channel nets which are set simultaneously in the same general vicinity.

Fourteen on-site observations of channel net catches were made by Crustacean Management personnel in the Beaufort and Georgetown area between September and December 1974. A total of 16,691 fish were recorded. The most abundant species observed in catches were the bay anchovy, silver perch, Atlantic silverside, spot, summer trout, striped anchovy and the harvest fish. These 7 species comprised 95% of all fish caught, and had a total weight of approximately 413 lbs. Only three species of commercially important fish occurred in any abundance. These were Atlantic menhaden, spot and summer trout.

Twelve species of fish having sport or recreational value entered the channel net catches observed. The most familiar species were spot, summer trout, Spanish mackerel, Atlantic spadefish, southern flounder, summer flounder, black sea bass and bluefish.

A total of 44,901 white shrimp were recorded during the survey having a combined weight of 1,053 pounds (heads-on). An average of only approximately 47 pounds of shrimp (heads-off) was caught during each of the fourteen channel net sets. The size of shrimp also varied according to fishing locality.

Shrimp observed in channel net catches from Beaufort County averaged between 46-55 per pound count (heads-off), while those observed in catches from Georgetown County areas averaged 61-65 count (heads-off). This size difference may be attributed to a wide variety of environmental conditions present in each of the estuarine habitats.

A total of 519 blue crabs were recorded, with a total weight of 65 pounds. Of these 28% were immature males, 9% were mature males, 48% were immature females and 16% were mature females. No mature females were observed with egg masses (sponge) attached. Only 24% of the channel net crabs were greater than five inches in width (carapace width), which is the minimum legal possession size for either commercial or

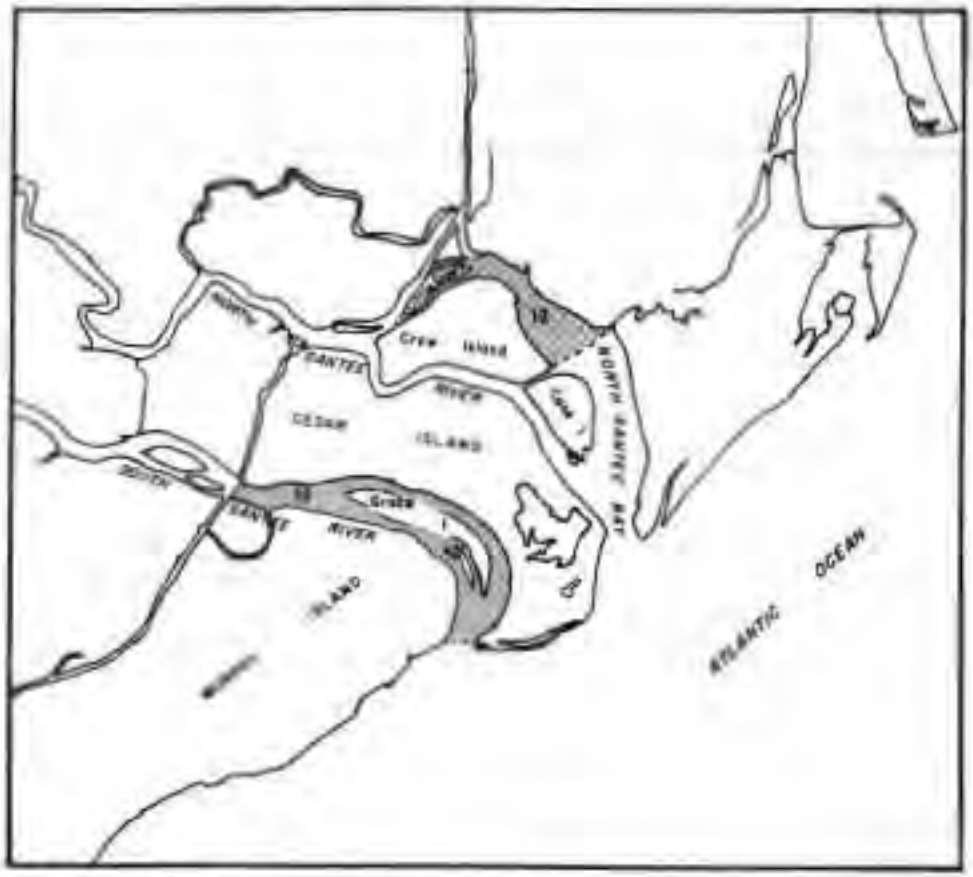


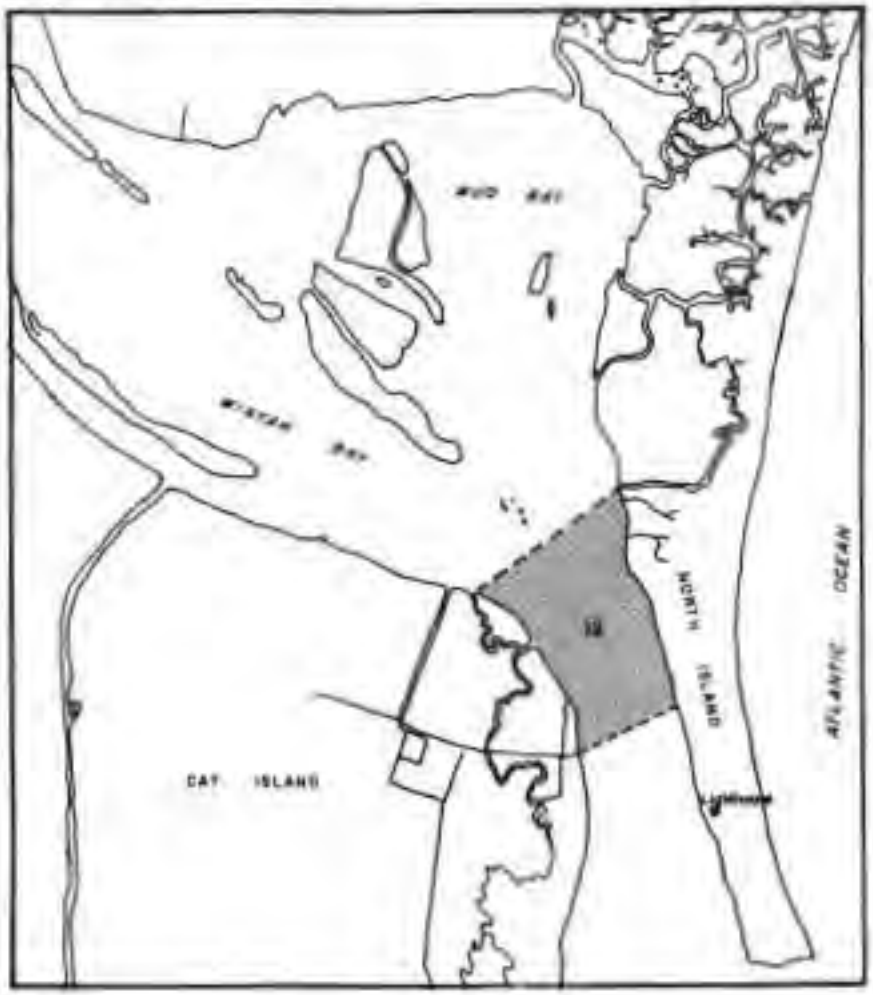
Figure 25. Approved channel net locations, Santee River.

recreational crabbers.

As a result of the channel net survey, several general conclusions may be drawn in an effort to answer some of the questions surrounding the growing "channel net controversy". They are as follows:

- Presently, large quantities of commercial shrimp are not constantly harvested by individual channel net fishermen. Channel net shrimp catches represented less than 1% of the total annual South Carolina shrimp landings during 1974.
- Large quantities of commercially important blue crabs are not taken by channel net fishermen. Crabs which do enter a catch are normally discarded overboard while still alive.

Figure 26. Approved channel net locations, Winyah Bay.



- Catches of commercial or sport related fish species are also generally small.

Overwintering White Shrimp and Shrimp Tagging

Several important questions concerning both commerical fishermen who harvest shrimp and management biologists who study them are: (1) where do white roe shrimp come from in the spring each year, and (2) what are the patterns of movement and migration of these shrimp along the coast?

It is known from previous shrimp tagging studies conducted in the fall of 1970 by the Marine Resources Division that between October and December large adult white shrimp migrate out of protected South Carolina estuaries and south down the coast as far as Georgia and Florida. But where do large adult roe shrimp which support our local fishery come from the following spring? Investigators once believed that white shrimp migrated back north along the South Atlantic coast from Florida when winter water temperatures increased to favorable levels. In fact, a federal tagging program conducted by the Bureau of Commercial Fisheries in 1935 suggested as much. A shrimp tagged in January at Cape Canaveral, Florida, was recaptured off South Carolina in July, a distance of approximately 260 miles. However, with increased knowledge of shrimp behavior, the prospect of a major northern migration each year is now believed unlikely or it represents only a very small part of the answer. It is now believed that increased fishing effort along the South Atlantic States has reduced the shrimp available to return north in the spring.

Management biologists today support the idea that small immature white shrimp which remain in the protected estuaries of the State in December and survive through the winter represent the major source of spring roe shrimp stocks. These shrimp grow rapidly as winter water temperatures increase and as food becomes plentiful the following spring. One indirect source of supporting evidence for this theory is that poor roe shrimp seasons normally have followed severe cold winters in recent years. Shrimp trawling data gathered over the same years also indicate this trend. From a preliminary analysis of data, it appears that when winters are severe, high mortalities of white shrimp occur. Correspondingly, roe shrimp landings during May and June in years following severe winters have been low in almost all cases.

In an effort to focus on the continuing questions and problems surrounding the white roe shrimp fishery in South Carolina, a pilot study to determine the overwintering patterns of white shrimp was initiated by the Department. The first year of a two-year federally funded study has now been completed. During the initial year, experimental shrimp trawls were conducted on a weekly basis from December 1975 through June 1976 from aboard the R/V CAROLINA PRIDE. Eight sampling stations were located within the Charleston Harbor estuary and adjacent ocean waters. Stations were established in areas known to be populated by overwintering white shrimp near the mouths of rivers entering the harbor, in the harbor proper and offshore. As part of the overall study, a desirable number of large shrimp were caught, tagged and released.

The tagging program began in April, 1976. The primary purpose was to determine inshore-offshore movement patterns of adult white shrimp. Over a five week period, the majority of approximately 2400 tagged shrimp were released in Charleston Harbor. The remainder

Figure 27. Shrimp bearing Marine Resources Division Tag.

were released in St. Helena, Calibogue and Port Royal Sounds to the south. Tagging activities began when shrimp at the harbor stations reached a sufficient size suitable to carry a three-inch red plastic streamer tag. Tagging efforts were terminated May 13 or immediately prior to the opening of the offshore commercial shrimp trawling season.

The capturing and handling of shrimp for tagging required extra care and effort. Short 15 minute tows were made with two twenty-foot flatline otter trawls of half-inch mesh webbing. Shrimp were quickly placed in temporary tanks. Uninjured, active shrimp were then transferred by hand to a larger holding tank. Dead or injured shrimp were discarded. Holding tanks were periodically flushed with fresh sea water to ensure an adequate oxygen supply. After a suitable number of live shrimp were collected, the tagging operation began. A team of three workers recorded data, determined the size and sex of each shrimp, and inserted tags.

In female shrimp, the stage of roe or "egg" development was recorded. A tagging gun was used to insert the end of the tag through the 5th or 6th tail segment either from above or crosswise, with care taken to avoid injuring the intestine. Once inserted through the musculature of the shrimp, the "T" shaped end of the tag insured permanent placement. The shrimp were immediately released overboard. (Fig. 27)

As expected, most tags were returned by the commercial trawling fleet. Only two tagged shrimp were caught in the harbor during the overwintering project. A total of 25 tags were returned by trawler operators before the season opened on May 14, and these shrimp were presumably caught more than three miles off the beach. Of the shrimp tagged in Charleston Harbor, 352 returns were reported from areas either adjacent to the harbor mouth, or to the south. The majority were caught near or on the beaches of Morris and Folly Islands, which are the two nearest sea islands south of the harbor entrance (less than 19 nautical miles). A number of shrimp traveled greater distances, with some reaching Kiawah Beach and Hunting Island, a distance of at least 55 nautical miles south of Charleston Harbor. (Similarly, of the shrimp tagged in the Beaufort area, none of eight returns were from more northern locations.) The exact number of shrimp tagged at different locations and dates of release and recapture are presented in Figure 28.

Through the help of many shrimp fishermen and dealers, 20% of the shrimp tagged were returned. This is quite high for a tagging experiment of this kind, and valuable information was gained through this effort.

The results of this study were influenced strongly by the offshore shrimp season, since 90% of the returns were reported after the official season opening. The length of time between tagging and recapture probably was influenced by the trawling season as well.

Figure 28. **Summary of White Shrimp Tagging Studies From April - June, 1976**

	Shrimp Released					Tags Returned					
				Miles Traveled			Days Out				
Tag Numbers	Location	Date	Total Number	Min.	Ave.	Max.	Min.	Ave.	Max.	Mi./Day	Percent Returned
09849-09976	Ft. Johnson	April 6	127	5	13	56	20	40	56	0.3	8
09977-10036	Ft. Johnson	April 14	59	5	9	15	1	14	40	0.7	10
10041-10095	Ashepoo River	April 20	54	7	7	7	28	28	28	0.2	2
10096-10370	Morgan River	April 20	274	6	11	15	14	30	30	0.4	1
10371-10454	Dolphin Head	April 21	83	8	8	8	11	11	11	1.0	1
10455-10570	Calibogue Sound	April 21	115	8	10	12	7	16	26	0.5	3
10574-11214	Ft. Johnson	April 28	706	0	10	55	6	21	39	0.5	23
11221-11287											
11216-11220	Ft. Johnson	May 3	601	5	16	55	4	17	36	0.9	19
11288-11770											
11821-11936											
11771-11820	Ft. Johnson	May 13	422	5	8	23	1	8	23	1.1	14
11937-12310											

Shrimp tagged on April 6 (38 days before the season) were out 20 to 56 days before recapture and were out an average of 49 days. Shrimp tagged on May 13 (one day before the season) were returned in 1 to 23 days with an average of only 8 days. Less predictable was the distance the shrimp traveled. A few shrimp moved south as far as Hunting Island, 55 miles from the tagging site, while most traveled much shorter distances. Even shrimp tagged and caught on the same day showed variety in the distances travelled, indicating that shrimp do not move at a constant rate.

It appears that once adult white roe shrimp reach the ocean they do not necessarily migrate such great distances as was observed in late fall during the 1970 shrimp tagging program. In the fall migration, shrimp may travel hundreds of miles.

The rate at which tagged shrimp traveled is difficult to estimate. There is little doubt they are both helped and hindered by currents and tides and they probably do not move continuously. Several shrimp traveled as much as 5 miles in 1 day, a few covered 23 miles in 11 days and some went 55 miles in 32 days. A more accurate estimate of speed, however, would be to take the average number of miles traveled by those shrimp tagged just before the season opened. These shrimp moved 8 miles over an average of 8 days before recapture or 1 mile per day. This rate of movement is, however, a very rough estimate.

Only eight of the shrimp that were tagged in the Beaufort area were returned, so it is difficult to draw conclusions about movement. Six of the tagged shrimp were reported off Hunting and Hilton Head Islands, one was returned from Fripp Island, and the last was recaptured off Tybee Beach 26 days after being tagged in Calibogue Sound. Most of the Beaufort area tags were returned within 10 days before the offshore season opened.

Some growth information was obtained by subtracting the length of the shrimp when it was tagged from its length when captured. We were able to measure 84 returned shrimp to get an estimate on growth. On the average, shrimp grew about a third of an inch over a period of approximately 17 days. The change in per pound counts of shrimp (heads-off) would be approximately 7 to 10 shrimp per pound depending upon how large the shrimp were initially. For example, size would have increased from 34 to 27 count or from 45 to 35 count in about 2½ weeks.

With the combined help of many individuals throughout the State, management biologists were successful in gathering enough information during the shrimp tagging study to propose the following:

- Small white shrimp found in Charleston Harbor and other inshore areas during the winter and early spring appear to comprise a large part of the roe shrimp catch in May and June.
- Once white roe shrimp reach the ocean, they probably do not migrate very great distances along the coast.
- The shrimp that move away from the waters adjacent to Charleston Harbor generally move in a southerly direction.

Effects of 1977 Winter on South Carolina White Shrimp

The winter of 1976-77 was one of the coldest on record for South Carolina. Bottom water temperatures recorded at nine weekly trawling stations reached an average low of 42.0° Farenheit in Charleston Harbor and 43.3°F offshore of the harbor on January 17 and February 1, respectively. Temperatures began to drop dramatically during the first two weeks in January and fell to the lowest level following the severe cold spell which began on January 16. Prior to that time, temperatures were generally comparable to those recorded last year on about the same dates. The lowest average bottom temperatures recorded last year were 47.7°F at the inshore harbor stations and 50.0°F at the offshore stations. These occurred in early January, but were followed by a continuous warming trend, which minimized damage to the overwintering white shrimp population.

Shrimp catches in the harbor for early December 1976 were relatively high, tapering off sharply in January, 1977. In comparison, last year's offshore catch increased through January, indicating a migration from the harbor to near shore ocean waters. A similar trend was noted this year, but catches were noticeably smaller and finally dropped to zero in Charleston Harbor and at all State-wide sampling stations by the second week in February.

Further confirmation of white shrimp mortalities were also made in January and February, 1977 when numerous dead white shrimp were washed ashore on local beaches and collected in trawl catches in the Charleston Harbor and St. Helena Sound areas. Intensive State-wide sampling was conducted at regular stations during February, March and April from the Santee River to Calibogue Sound, and no live shrimp were found.

Information from previous years in South Carolina indicates that water temperatures lower than about 45.0°F are very critical for white shrimp survival.

Some of the most severe winters in past years, from the standpoint of sea water temperatures, have been 1940, 1958, 1961, 1963, 1964, 1966 and 1970. Since 1970 mild winters have prevailed, and the overwintering, spring "roe" shrimp and fall white shrimp populations have been above average to exceptionally high.

A summary of water temperatures and the white shrimp situation in South Carolina during the most severe winters in past years is as follows:

1940 — A severe cold wave in January resulted in high mortalities of white shrimp in

Figure 29.

A Comparison of Average Water Temperatures and Average Catch in the Winter of 1975-76 and 1976-77 in Charleston Harbor and in the Ocean Near the Harbor Entrance. Note the Disappearance of Shrimp in February, 1977

	Average Bottom Temperatures				Catch (lbs. Heads-On)			
	1975-1976		1976-1977		1975-1976		1976-1977	
Week	Hbr.	Ocean	Hbr.	Ocean	Hbr.	Ocean	Hbr.	Ocean
Dec. 1	59	59	53	53	130.3	5.2	39.4	10.8
2	57	59	52	52	15.7	1.3	43.2	25.6
3	60	62	54	53	35.2	1.1	52.3	22.8
4	52	53	49	49	23.0	13.9	15.4	10.0
5	53	53	49	50	31.1	7.8	74.5	27.0
Jan. 1	46	50	47	50	4.7	8.8	11.2	16.5
2	54	51	45	46	35.1	3.8	5.0	16.7
3	46	50	42	44	1.0	11.0	0.7	2.6
4	49	54	43	46	3.9	26.1	0	2.8
Feb. 1	54	53	44	43	1.0	7.6	0	0.1
2	53	53	44	41	0.5	3.1	0	0
3	59	59	49	47	9.5	0.4	0	0
4	59	57	51	49	0.3	0.3	0	0
Mar. 1	63	64	52	51	4.9	0	0	0
2	62	66	56	54	0.2	0.1	0	0
3	62	59	60	57	7.4	0.1	0	0
4	61	61	59	59	21.1	1.0	0	0
5	67	66	66	63	12.5	0.2	0	0
Apr. 1	67	—	69	63	0.5	—	0	0
2	63	67	67	64	3.6	1.6	0	0
3	71	70	71	70	0.2	0.2	0	0

South Carolina and Georgia. The following spring, the white roe shrimp population was very low in South Carolina and fall white shrimp landings were also very low. Only about 1.2 million pounds of shrimp (heads-off) were reported in South Carolina that year. Georgia landings, on the other hand, were down only about 10% from the previous year.

1958 — A severe cold spell occurred in February of 1958. Water temperatures were less than 45°F for at least 11 days, including 8 consecutive days. Reported roe shrimp landings during the spring were very low. The fall (Sept.-Dec.) catch of white shrimp was very low (1.1 million pounds heads-off). Georgia roe shrimp landings in April-June were low and the fall catch was well below normal also.

1961 — Unusually cold weather in January and February resulted in low water temperatures, but did not result in the disappearance of overwintering white shrimp. Spring roe shrimp catches were moderately low in South Carolina (52,055 pounds, heads-off for April-June). The fall catch of white shrimp was about 1.75 million pounds, which is below average.

1963 — Although this winter was not as cold for an extended period, a very cold spell in December 1962 dropped water temperatures to as low as 41.5°F for several days. Overwintering white shrimp disappeared in experimental trawl catches and May-June roe shrimp landings were zero. The fall catch of white shrimp was the lowest on record (183,000 pounds, heads-off).

1964 — This was another comparatively severe winter, and during December and January water temperatures were in the low 40's for 8 consecutive days. Spring roe shrimp landings reported for South Carolina were zero. The fall (Sept.-Dec.) catch of white shrimp was only 487,000 pounds.

1966 — Water temperatures were below 45°for 7 days. Overwintering white shrimp were not decimated, but experimental trawl catches were low following the winter. Roe shrimp landings in the spring were moderately low (31,000 pounds). The fall catch of white shrimp was 1.33 million pounds, about one million pounds below normal.

1970 — Water temperatures dropped in January to below 45°F for about 14 consecutive days. Roe shrimp landings in the spring were quite low (6,500 pounds). The fall catch of white shrimp was 1.8 million pounds, about 700,000 pounds below the 1965-74 average.

Although the above summary would indicate that severe winter water temperatures affect not only the spring roe shrimp catch, but fall white shrimp landings as well, data from 1968 and 1969 indicate that this may not be the case. Both 1968 and 1969 were moderately cold winters in terms of local sea water temperatures, and very few overwintering white shrimp were found during the spring. Reported white roe shrimp landings during each of these years in April-June were low (0 pounds in 1968 and 943 pounds in 1969). Fall landings of white shrimp during these two years, however, were well above average for South Carolina (4.7 million pounds in 1968 and 4.1 million pounds in

1969), and for the entire South Atlantic coast. It should be noted that white roe shrimp populations in Georgia and Florida during the 1968 and 1969 spring seasons apparently were not depleted to the extent that they were in South Carolina. From the above information it would appear that:

- Following very severe winters in South Carolina which result in high mortalities of overwintering white shrimp, the commercial catch of roe shrimp the following spring will be low (0-50 pounds in past years).
- Although severe winters may result in drastic declines in the numbers of overwintering white shrimp and subsequent spring spawners (roe shrimp) in coastal waters, the fall catch of white shrimp during the same year may not necessarily be affected. It should be pointed out, however, that in seven out of nine years having severe winters for which records are available, the fall catch of white shrimp ranged from below average to very poor.

Figure 30 presents South Carolina landings for white and brown shrimp during the spring and summer months (April-August). As can be seen, the direct economic loss from the April-June white shrimp catch could be substantial e.g., in 1976 this catch was valued at over $2.5 million to South Carolina fishermen.

In summary, it appears that the 1977 spring catch of white roe shrimp will be virtually nonexistent, and the brown shrimp season may be somewhat later than usual this year. Although it is impossible to predict what the fall white shrimp catch will be at this time, there is a good possibility that this harvest may be adversely affected also.

Research Vessel CAROLINA PRIDE

In an effort to further expand the research and management capabilities of the Division of Marine Resources, a Florida built Thompson Trawler was purchased by the Department in the spring of 1974. The R/V CAROLINA PRIDE is constructed of fiberglass throughout and has the speed and versatility necessary for inshore and offshore work. The vessel has an overall length of 51 feet, a beam of 16 feet and a draft of 4.5 feet. Twin 300 H.P., V-871 GM diesels power the craft at a cruise speed of 18 knots and a top speed of 21 knots. The vessel is equipped to carry 850 gallons of fuel providing a cruising range of approximately 40 hours. (Fig. 31)

Onboard navigational equipment includes two depth recorders, scanning sonar, radar unit, LORAN, VHF radio and Department radio. Depth recorders include an Apelco and a DE-727A white line model manufactured by the

Figure 30 Volume and Value (in thousands of pounds and thousands of dollars) of Brown and White Shrimp (heads-off) Landed in South Carolina each Month, April through July, During 1972-1976.

	April		May		June		July		August	
Brown Shrimp	**Volume**	**Value**	**Volume**	**Value**	**Volume**	**Value**	**Volume**	**Value**	**Volume**	**Value**
1972	0	0	0	0	57	31	669	612	726	643
1973	0	0	0	0	156	165	497	746	653	933
1974	0	0	3	3	77	32	838	540	916	575
1975	0	0	1	3	543	757	721	1,260	1,265	2,020
1976	0	0	4	13	547	757	815	1,374	1,366	2,174
White Shrimp										
1972	34	52	407	536	622	727	20	32	1,083	1,319
1973	0	0	143	271	386	724	25	46	554	1,041
1974	11	19	503	762	181	274	132	170	827	1,225
1975	0	0	320	765	305	465	89	170	714	1,400
1976	9	30	446	1,730	212	723	42	105	709	2,588
Brown and White Shrimp										
1972	34	52	407	536	679	758	689	644	1,809	1,962
1973	0	0	143	271	542	889	522	794	1,207	1,974
1974	11	19	506	765	258	306	970	710	1,725	1,800
1975	0	0	321	768	748	1,222	810	1,430	1,979	3,120
1976	9	30	450	1,743	759	1,510	857	1,579	2,075	4,762

Figure 31. The "Carolina Pride"

Raytheon Company. The radar unit is a Decca super 101 MK3 with a Precision Range Marker and 24 mile scanning ability. The LORAN is a Nelco set, model Auto Fix 500. The VHF radio is a Modar M03002 Triton. the vessel is also equipped with an Airex intercom/hailer for communications between captain and crews, indoor-outdoor thermometers and wind meters.

The R/V CAROLINA PRIDE has sleeping capacity for a party of five with four bunks below deck and one above. A private head with shower is available offering hot and cold running water. The aft portion of the cabin is equipped with wet lab facilities including sinks, sorting area and storage for specimens. Shelving is also available for filing data records and reference literature.

The galley is furnished with an electric three burner stove with oven and a dining table which seats five. Food storage consists of a standard refrigerator and half-size freezer. Living quarters, pilot house and deck house are heated and air conditioned throughout.

The rigging on the vessel's stern deck is similar to a standard shrimp trawler. A Stroudsburg winch, model no. 515DD with a 2,000 lb. lifting capacity is hydraulically driven for setting and retrieving trawl nets. Towing booms measure 15 feet in length and are lowered and raised in the usual manner. Twin 20 foot flatline otter trawls with 1 7/8 inch mesh webbing are used as standard gear. Spare nets and doors are stored below deck in the stern.

Hand davits filled with 1/8 inch stainless steel cable are located on either side of the cabin. These are used primarily for retrieving bottom sediment samples and for towing plankton nets. A sorting table and a 300 gallon live fish tank are also available.

The R/V CAROLINA PRIDE has proven extremely valuable in our state-wide sampling programs. The vessel is used primarily to survey white roe shrimp during the spring of the year in preparation for the offshore shrimp season and during the sound and bay shrimp monitoring program in summer and fall.

Other Investigations Related to Shrimp Management

In addition to the shrimp management activities described in previous sections of this report, the Marine Resources Division is currently engaged in a wide variety of research and other activities which are directly or indirectly related to shrimp management. A brief summary of some of these investigations follows.

The Marine Resources Research Institute of the Division is currently conducting a number of research investigations valuable to shrimp management. These include the Estuarine Survey Program, which is a continuing assessment of biological, chemical and physical characteristics of South Carolina estuaries. Shrimp data from trawl sampling in various estuaries is provided for use in the management program.

The Marine Resources Division is also much involved in the State-Federal Fisheries Management Program in the South Atlantic region, which includes the states of North Carolina, South Carolina, Georgia and Florida. Under this program, a regional shrimp management plan has been developed which identifies major problem areas and future needs for improved management of the South Atlantic shrimp fishery. Ongoing projects in South Carolina under the State-Federal regional program include: the development of a regional

fisheries statistics system; the overwintering white shrimp investigation described in a previous section; a study of incidental catches by shrimp trawlers off the South Atlantic coast; and an economic study on the mobility of shrimp vessels in the South Atlantic States.

Other investigations currently being conducted or recently conducted related to shrimp management in South Carolina include a project to investigate the impact of incidental sea turtle catches by shrimp trawlers and surveys of recreational shrimping in the State. The Division is also very much involved in the review and evaluation of permit applications and proposals for coastal developments and alterations which could affect water quality or result in other adverse effects upon the estuaries or marshlands of the State.

COLLECTING FISHERIES STATISTICS

The Fisheries Statistics Section of the Office of Conservation and Management (OCM) is responsible for collecting a broad base of information concerning all commercial fisheries in South Carolina. Pound and value figures are compiled for shrimp, blue crabs, oysters, clams and a variety of finfish which are harvested throughout the state each year. Supplemental data are received from the OCM's License and Leasing Section concerning the number and location of licenses and leases issued. Additional landing data are also furnished by individual fishermen and docks from all coastal counties.

Once this information is received, it is organized and filed as permanent records. Much of the information is then forwarded to the National Oceanic and Atmospheric Administration, National Marine Fisheries Service in Washington, where it is published in a number of bulletins such as *South Carolina Landings*. These publications are in turn used by Marine Resources Center personnel to study trends and

conditions within the various fisheries. The bulletin *South Carolina Landings* is also available to commercial fishermen by request to the National Marine Fisheries Service.

Catch and effort data (size of catch versus the number of hours fished), especially in the shrimp and blue crab fisheries, are also collected by the Fisheries Statistics Section. A total of nineteen shrimp dock owners throughout the coastal counties supply unloading tickets indicating the name of the vessel, pounds landed, fishing time, general fishing location and pounds by count for each vessel unloading at each dock. Dock samplers also check shrimp landed by commercial vessels to determine the percentage of brown shrimp versus white shrimp from as many fishing locations as possible. This information, together with biological data gathered by Crustacean Management personnel, is extremely valuable when management decisions such as opening the offshore and the sound and bay shrimp season are being considered.

The Fisheries Statistics Section also collects economic data including prices of shrimp by grade; costs of heading; packing and shipping; costs of fuel, ice, bait and gear as well as employment and wages during various seasons.

Personnel within the Marine Resources Division, as well as organizations and individuals outside the Division, constantly request information concerning the various fisheries of South Carolina. Information collected by the Section is available on request. However, the production of an individual fisherman or dealer is held *strictly confidential*. Requests can be made for information by fishery, by year, by month, by district, by county, and by fishing location but *not by dealer or fisherman*.

Figure 32

Total Pounds and Dollar Value of Seafoods Landed by South Carolina Commercial Fishermen during 1975

	District*	Pounds	Value
All Fin Fish	Northern	2,387,672	$ 420,164
	Central	1,165,566	196,523
	Southern	40,658	12,875
	TOTAL	3,594,096	$ 629,562
Crabs	Northern	53,272	8,305
	Central	1,283,247	181,796
	Southern	5,615,659	674,853
	TOTAL	6,952,178	$ 864,954
Shrimp (heads-off)	Northern	781,499	1,473,617
	Central	2,951,806	5,662,157
	Southern	1,913,893	3,666,858
	TOTAL	5,647,198	$10,802,632
Clams (Meat)	Northern	11,147	13,377
	Central	151,110	190,413
	Southern	14,163	16,994
	TOTAL	176,420	$ 220,784
Oysters (Meat)	Northern	48,593	25,482
	Central	293,748	183,381
	Southern	694,060	427,686
	TOTAL	1,036,401	$ 616,549
Squid	Northern	215	65
	Central	24,969	5,036
	Southern	343	73
	TOTAL	25,527	$ 5,174
TOTAL SHELLFISH		13,737,724	$12,510,093
TOTAL — ALL SEAFOOD		17,431,820	13,139,755

*Northern District — Georgetown County
Central District — Charleston County
Southern District — Beaufort County

Figure 33. Total Shrimp Volumes (in thousands of pounds) Landed in South Carolina each month during 1960 through 1975.

	Jan.	Feb.	Mar.	April	May	June	July	August	Sept.	October	Nov.	Dec.	Total
1976	32	0	4	14	714	1,215	1,377	1,048	1,859	1,377	950	111	8,701
1975	0	0	0	0	489	1,164	1,196	763	2,227	1,439	863	491	8,626
1974	0	0	0	17	796	380	1,526	964	1,649	967	682	447	7,430
1973	55	1	0	0	220	847	837	1,291	1,755	1,659	904	686	8,255
1972	10	0	0	52	627	1,049	1,108	966	1,684	1,291	838	439	8,084
1971	69	0	0	0	22	251	1,792	1,339	2,294	2,218	1,823	945	10,753
1970	2	0	0	0	0	356	870	796	788	1,066	739	337	4,952
1969	0	0	0	0	1	23	878	953	1,386	1,290	961	524	5,816
1968	6	0	0	0	0	227	792	594	1,179	1,747	1,384	407	6,336
1967	0	0	0	0	24	386	1,270	749	472	734	392	53	4,080
1966	22	0	0	0	0	49	950	1,068	818	676	413	248	4,264
1965	0	0	0	0	65	639	1,368	802	1,377	1,571	654	316	6,795
1964	0	0	0	0	0	127	1,261	470	311	352	103	8	2,632
1963	0	0	0	0	0	346	910	533	269	60	45	9	2,194
1962	13	0	0	0	60	764	1,432	1,468	1,160	791	570	218	6,476
1961	**	0	0	0	2	85	263	622	1,016	1,115	646	173	3,922
1960	0	0	10	0	12	264	1,430	1,243	1,556	1,629	1,303	394	8,031

**Less than 500 pounds.

CURRENT SHRIMPING LAWS AND REGULATIONS

The following is a summarization of South Carolina's management and regulatory system as it pertains to the shrimp fishery.

A. *Licenses and Taxes*

(1) *Commercial Fishing Vessels*
Resident Shrimp Trawler — $75.00
Non-resident Shrimp Trawler — $200.00
*Commercial Vessels 18 feet and under — $2.50
*Commercial Vessels in excess of 18 feet — $10.00
Bait shrimp trawl license — $200.00 (in addition to trawler license). (*Not required by shrimp trawlers but required by channel netters.)

(2) *Shrimp Dealers and Individual Licenses*
Individual Commercial Shrimp License* — $5.00
Shrimp Dealers License — $20.00
Shrimp Processors License — $100.00
Bait Dealers License — $5.00
(*Captain's License)

(3) *Taxes on Shrimp caught in S. C.* — None

(4) *Shrimp Gear Licenses*
Channel Net — $5.00

(5) *Annual Licensing Period* — July 1 - June 30

(6) *Record Keeping Requirements* — Sections 28-962.

B. *Reciprocal Agreements*

There is presently no authorization in the S.C. Code of Laws for the Department or Division to enter into reciprocal agreements with other states pertaining to shrimp management or licensing.

C. *Regulations* (Statutes)

(1) *Restrictions on Gear and Fishing Methods*

(a) *Section 28-922.1.* — It is unlawful to place any net, seine or other device to extend more than one-half the width of any tidal stream or waterway at any stage of the tide.

(b) *Shrimp Seines* - (Section 28-922). — May be used for commercial or personal use and cannot exceed 40 feet in length. A minimum mesh requirement of ¼ inch (nylon) or 9/16 inch (cotton), square mesh, is provided. No restrictions on cast nets, drop nets, or dip nets for personal shrimping.

(c) *Channel Nets* - (Section 28-922) — Maximum mouth width allowable for channel nets is 80 feet, and a mesh size no smaller than ¼ inch (square mesh) may be used.

(2) *Seasons, Areas, Etc.*

(a) *Trawling Season and Areas"* (Section 28-861, 28-861.1). — Shoreline to three mile limit - May 15 through December 15. (June 1 - December 15 in Game Zone 7); Sounds and Bays - August 15 through December 15, except for Calibogue Sound (September 1 through November 1).

Trawling is restricted within one quarter or one-half mile of the shoreline along most inhabited beaches, during May through September 15. It is also unlawful to trawl within one-half mile of any fishing pier in Horry County.

All coastal areas other than offshore waters and six sounds and bays are off limits to shrimp trawling and considered nursery areas.

Section 28-861.5 provides for three zones in S.C., the northern, central and southern zones. The Marine Resources Division may prohibit trawling or other commercial fishing in any of these zones or specific areas therein, at any time, or open such fishing zones or specified areas therein, in or out of season, if it feels such action should be taken in the best interests of the State.

(b) Trawling is unlawful from official sunset to official sunrise in any legal State waters from September 1 through December 31.

(c) *Bait Shrimp Regulations* — South Carolina has provisions for bait shrimp trawling operations only in Beaufort County (Section 28-949). Cast nets, seines, drop nets, and dip nets may be used to take bait shrimp in tidal creeks, rivers or streams.

(d) *Miscellaneous Provisions* — Any vessel operating in areas where trawling is closed is required to have trawl nets on board at all times.

Legal trawling boundaries are specified in Article 7, S.C. Code of Laws, 1962 as amended. Shrimp channel net permit requirements are specified by rule and regulation. Each person using a channel or set net for shrimp in coastal waters must obtain a permit from the Division which specifies the area(s) where said net may be used. Channel net areas are adjacent to sounds and bays and the season is the same as that of the sound and bay legal trawling season.

D. *Penalties for Violations*

(1) *Section 28-761.* This is a general penalty section providing fines and/or imprisonment for violations not dealt with in other code sections. Under 28-761, persons convicted for violations are punished by a fine of $25-$100 for first offense or by imprisonment of not less than 10 or more than 30 days. For subsequent offenses fines range up to $500 dollars or imprisonment up to six months.

(2) *Section 28-862 and 28-862.2.* Provides penalties for shrimp trawling in restricted areas which are never opened to shrimping. (Applies to shrimp trawling during the closed season in Sounds, Bays and from shoreline to three mile limit.) First offense fines for conviction are $100.00 or thirty days imprisonment, suspension of Captain's license for one year, suspension of boat license for fifteen (15) days, and confiscation of catch. Subsequent violations result in increased license suspension periods, etc. Boat Captains found operating during license suspension period may be fined up to $1,000.00 or imprisoned for ninety days and boats used during period of license suspension may be confiscated with rigging and equipment and either redeemed for set value or sold by the Division.

(3) *Section 28-944.* Provides penalties for trawling without a license. Under this Section, boats trawling in any State waters without being licensed shall be confiscated with rigging and equipment and if not redeemed for value set by the Division, sold at public sale.

(4) *Miscellaneous Penalty Provisions.* During 1973, legislation was enacted to require any commercial fishing vessel operating in State waters to heave to, allowing boarding and cooperate in every reasonable way with conservation officers of the Department. Penalty for violation of this law is a fine of one thousand dollars or imprisonment for one year.

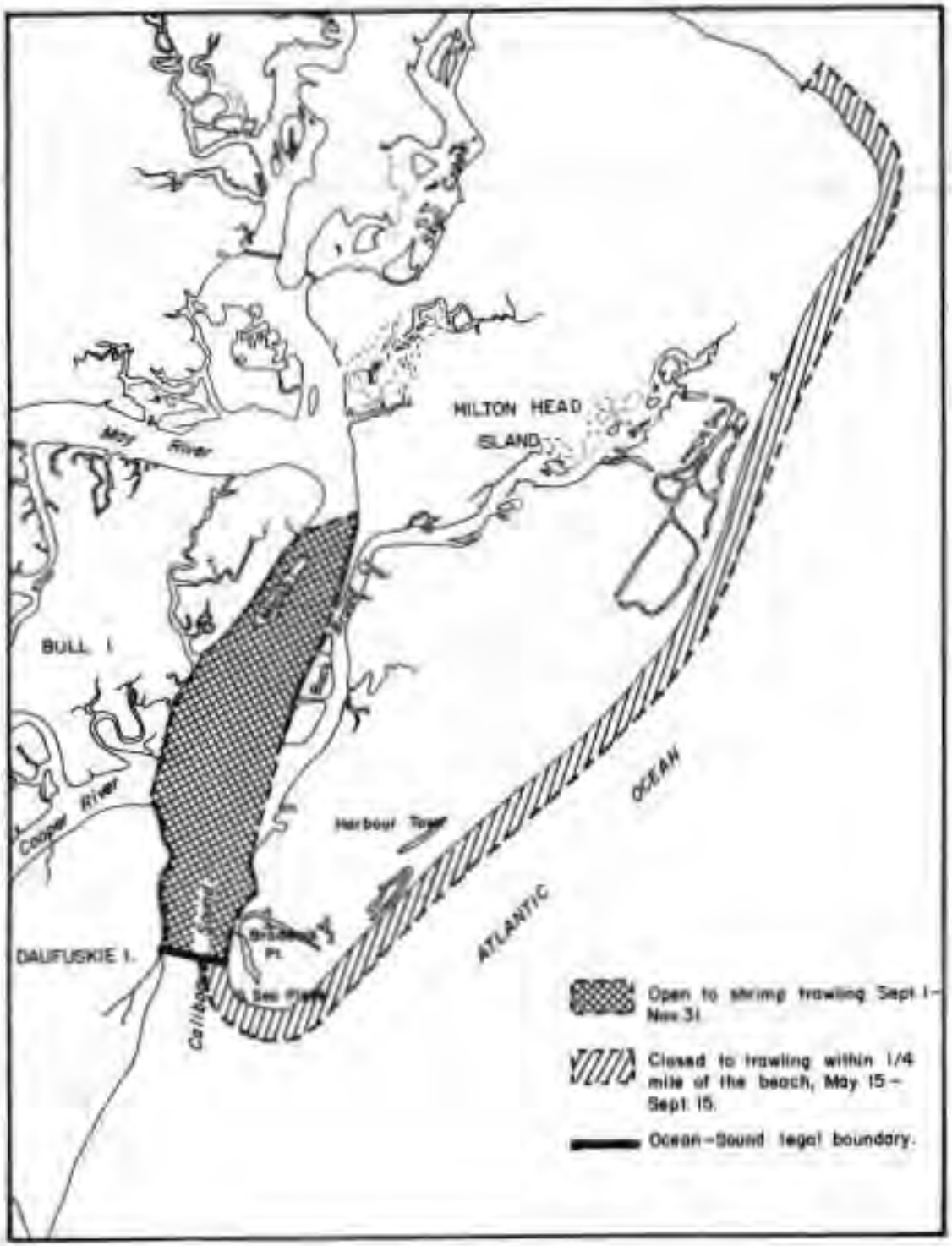
Section 28-866.6 provides penalties for violations of shrimp trawling legislation in Georgetown and Horry Counties. Violations are punishable by a fine not to exceed $1,000.00 or 6 months imprisonment, or both at the discretion of the court.

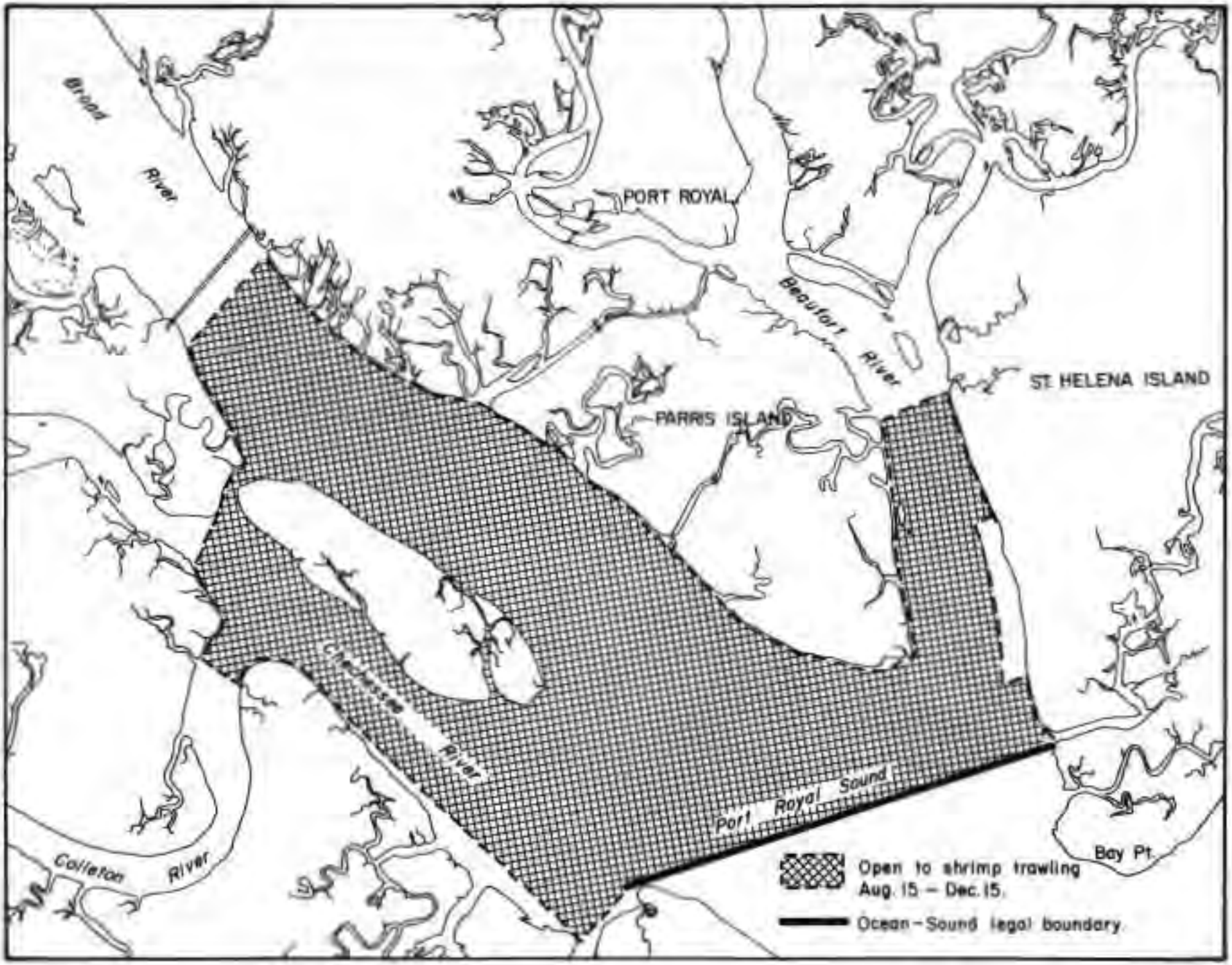
E. *Scientific Collecting Permits* — Section 28-757, S.C. Code of Laws as Amended.

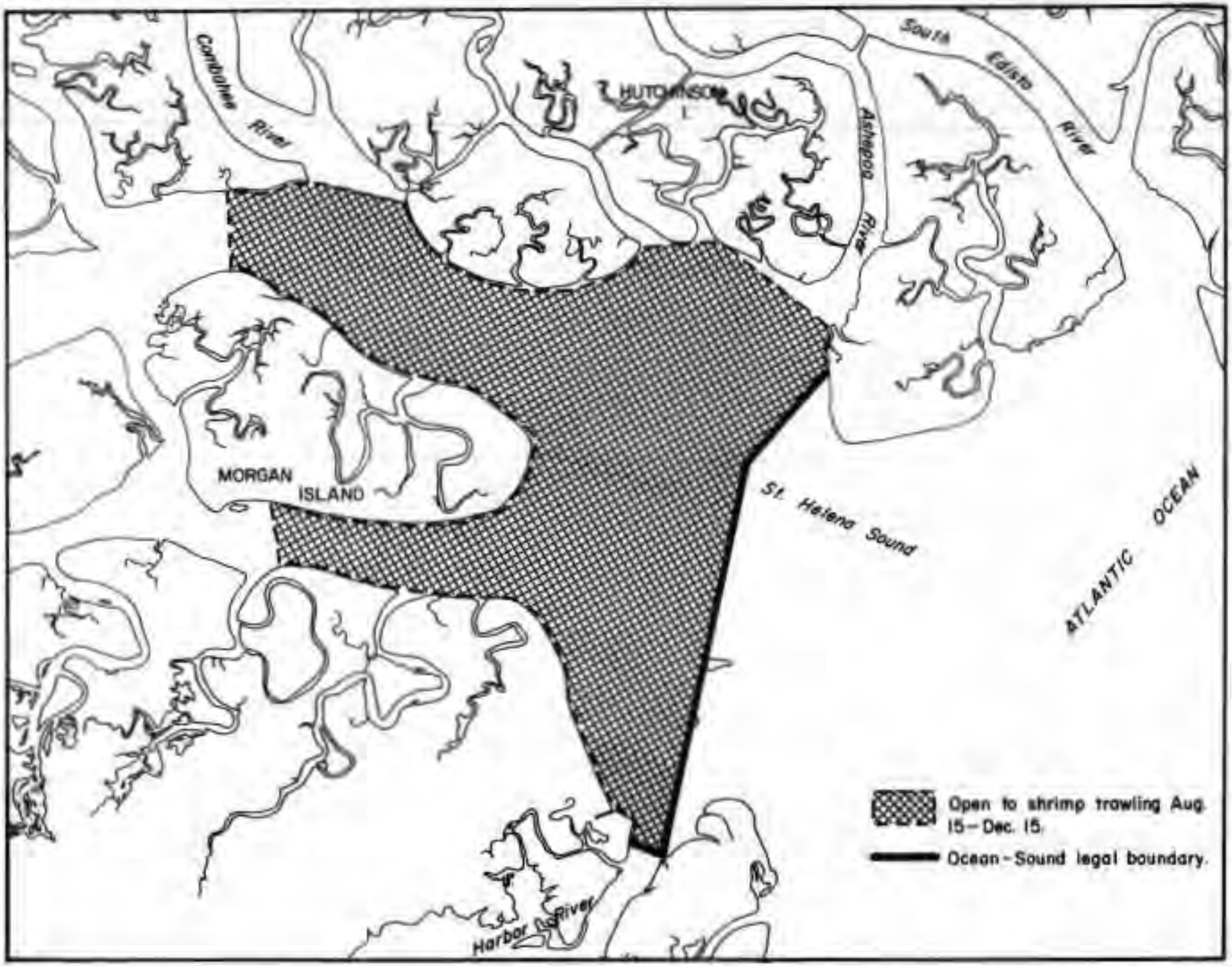
F. *Limited Entry* — No specific provisions are contained in the S.C. Code of Laws.

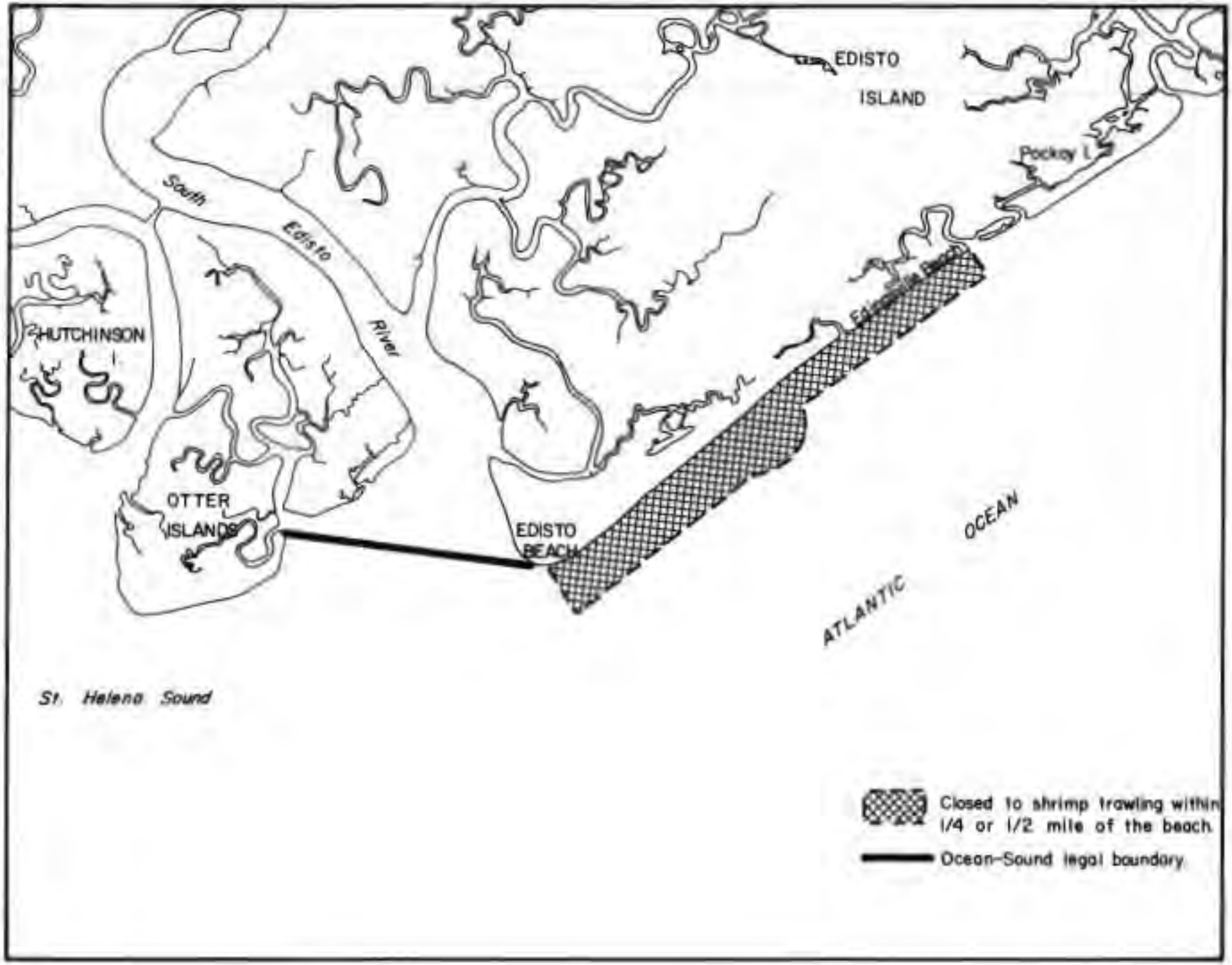
NOTE. The South Carolina Code of Laws is currently being recodified so that the numbers referring to specific sections will all be changed. All of the above laws and regulations are subject to change. Additional information and details may be obtained from the S.C. Wildlife and Marine Resources Department, Division of Marine Resources, P.O. Box 12559, Charleston, South Carolina 29412. Phone: 795-6350.

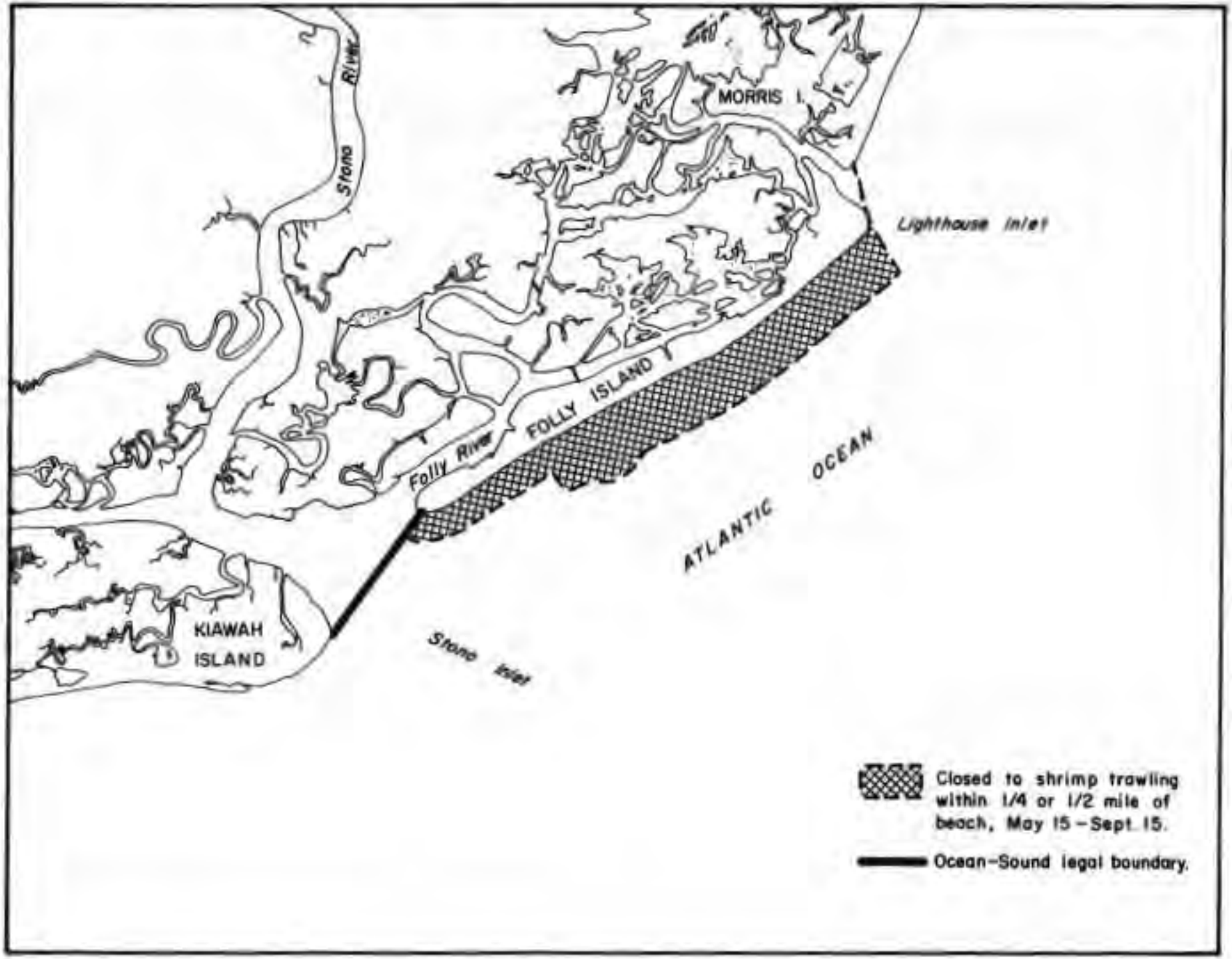
Following pages: mapped locations of S.C. sound and bay trawling areas. All open and closed trawling dates inclusive or subject to change.

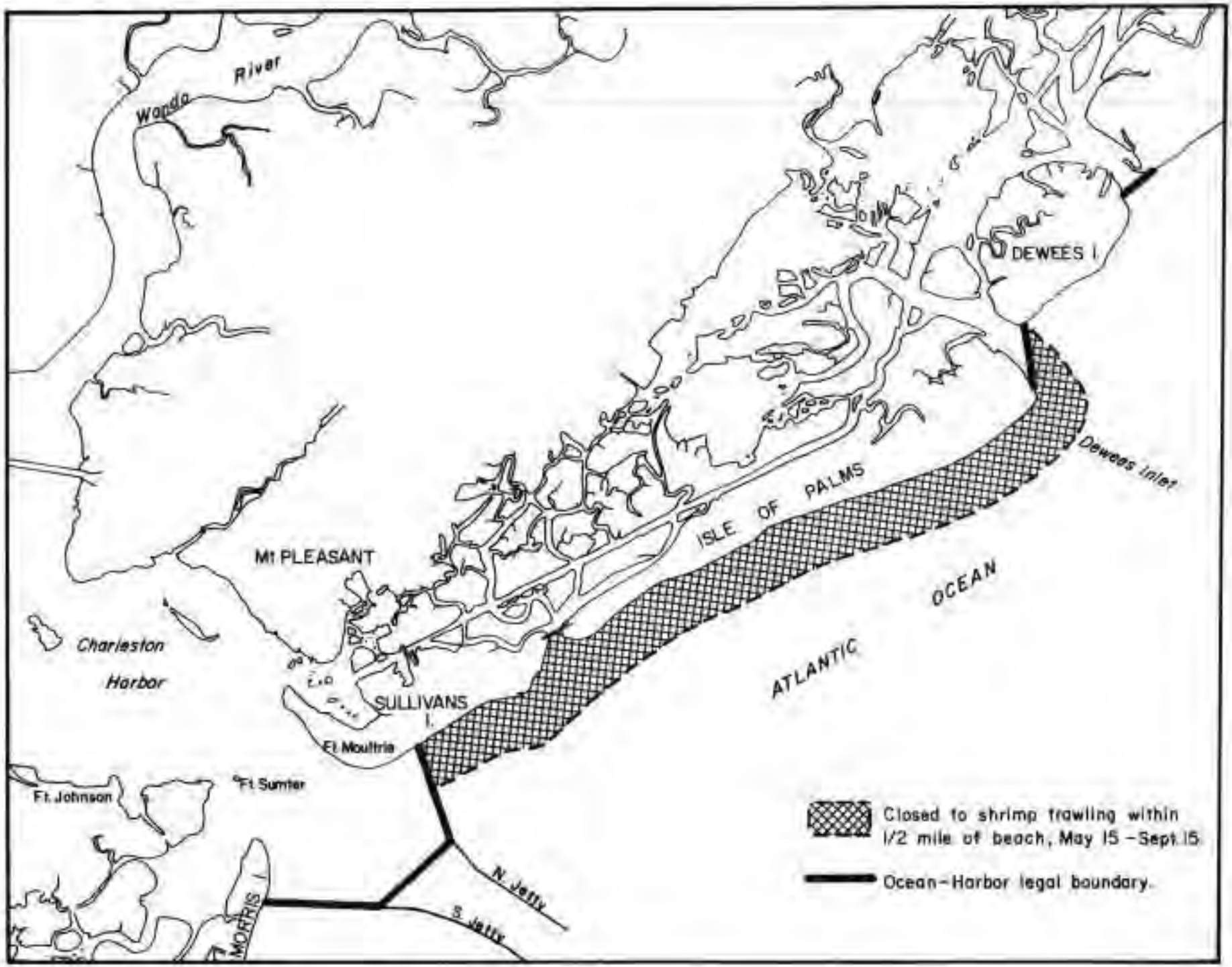


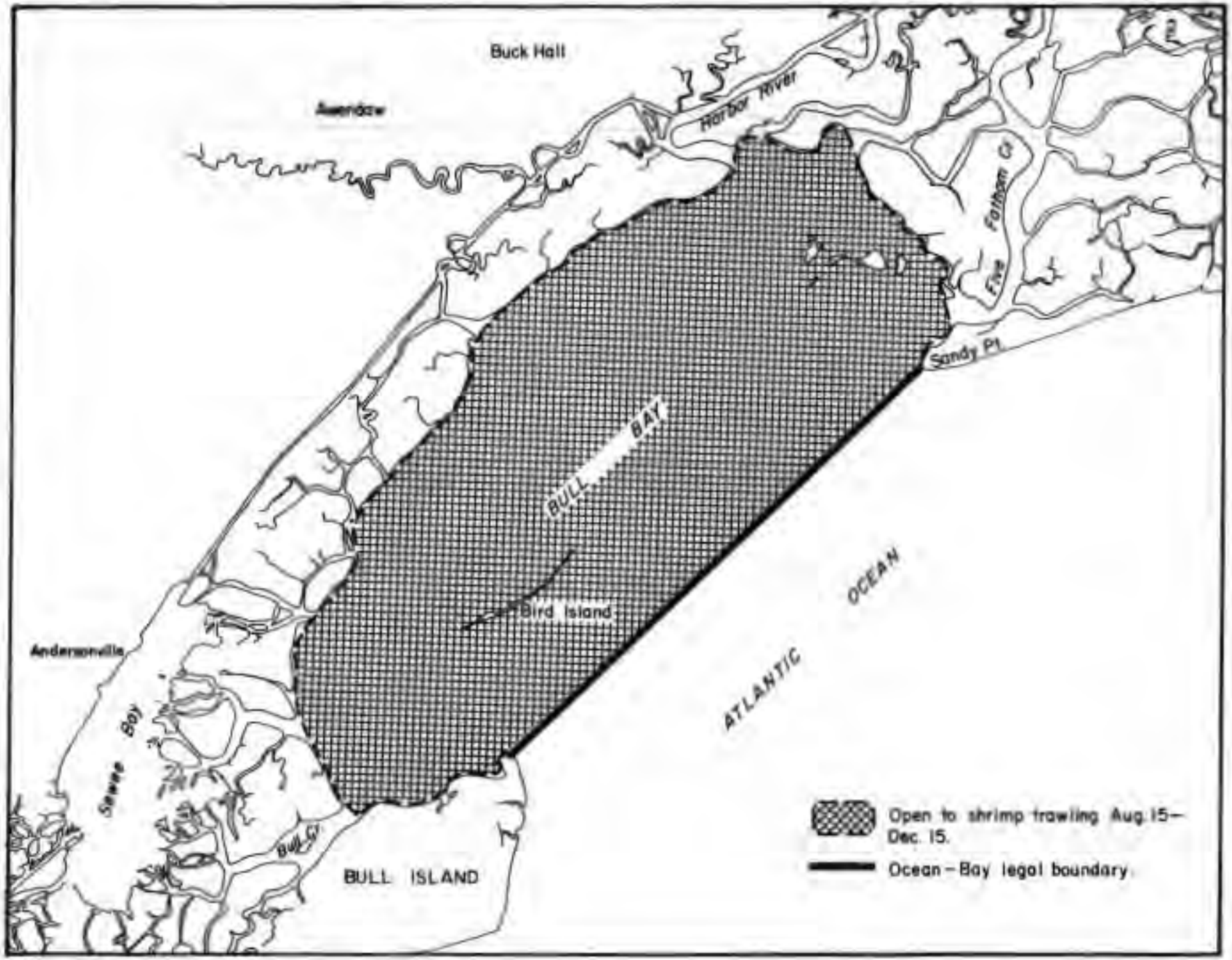

Broad River
PORT ROYAL
Beaufort River
ST. HELENA ISLAND
PARRIS ISLAND
Chechessee River
Port Royal Sound
Colleton River
Bay Pt.
Open to shrimp trawling Aug. 15 – Dec. 15.
Ocean–Sound legal boundary

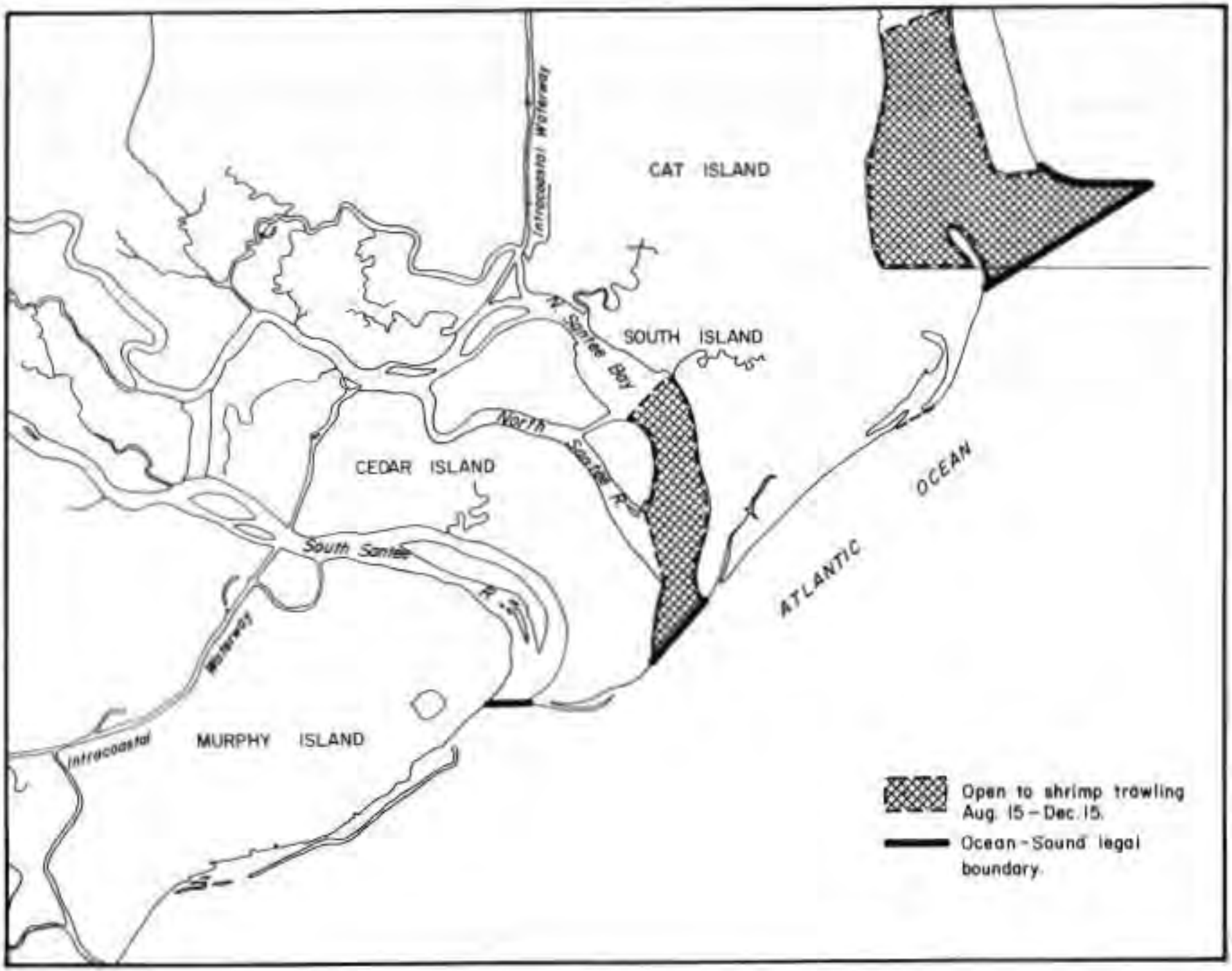

Combahee River
HUTCHINSON I.
Ashepoo River
South Edisto River
MORGAN ISLAND
St. Helena Sound
ATLANTIC OCEAN
Harbor River
Open to shrimp trawling Aug. 15 – Dec. 15.
Ocean - Sound legal boundary.


EDISTO
ISLAND
Pockey I.
South
Edisto
River
HUTCHINSON
I.
OTTER
ISLANDS
EDISTO
BEACH
ATLANTIC
OCEAN
St. Helena Sound
Closed to shrimp trawling within
1/4 or 1/2 mile of the beach
Ocean-Sound legal boundary


Stono River
MORRIS I.
Lighthouse Inlet
FOLLY ISLAND
Folly River
ATLANTIC OCEAN
KIAWAH ISLAND
Stono Inlet
Closed to shrimp trawling within 1/4 or 1/2 mile of beach, May 15 – Sept. 15.
Ocean–Sound legal boundary.


Wando River
DEWEES I.
Dewees Inlet
ISLE OF PALMS
Mt PLEASANT
OCEAN
ATLANTIC
Charleston Harbor
SULLIVANS I.
Ft Moultrie
Ft. Johnson
Ft Sumter
MORRIS I.
N. Jetty
S. Jetty
Closed to shrimp trawling within 1/2 mile of beach, May 15 - Sept. 15
Ocean-Harbor legal boundary.


Buck Hall
Awendaw
Harbor River
Five Fathom Cr
Sandy Pt
BULL BAY
Bird Island
OCEAN
ATLANTIC
Andersonville
Sewee Bay
Bull Cr
BULL ISLAND
Open to shrimp trawling Aug. 15–Dec. 15.
Ocean – Bay legal boundary.


Intracoastal Waterway
CAT ISLAND
N. Santee Bay
SOUTH ISLAND
North Santee R.
CEDAR ISLAND
South Santee R.
Intracoastal Waterway
MURPHY ISLAND
ATLANTIC OCEAN
Open to shrimp trawling Aug. 15 – Dec. 15.
Ocean - Sound legal boundary.


NORTH CAROLINA
SOUTH CAROLINA
Little River
Myrtle Beach
Bucksport
OCEAN
ATLANTIC
North Inlet
Cape Island
Open to shrimp trawling 1/2 mile of beach, Sept. 15 – Dec. 15.
Closed to trawl nets within 1/2 mile of shore
Open to shrimp trawling within 3 miles of beach, June 1 – Dec. 15.

GLOSSARY OF TECHNICAL TERMS

Algae — Single or many-celled plants; found abundant in marine and fresh waters; an important food source to many animals.

Benthic organism — Bottom dwelling plant or animal; lives on or attached to the bottom.

Brackish water — Water more fresh than salt; characterizes low salinity upper reaches of estuaries.

Cestodes — Parasitic flatworms including the tapeworms.

Copulation — Sexual union; sperm transferred from male to female; may be internal or external.

Crustaceans — A group of marine fresh water invertebrate animals; characterized by hard outer shell; shrimp, crabs, etc.

Decapods — A precise group (order) of animals (crustaceans) having ten legs.

Detritus — Partially decomposed plant or animal material; an important food source to many estuarine animals.

Embryo — Earliest stage of development of the fertilized egg.

Estuary — Normally shallow, semi-enclosed body of water where fresh and salt water mix.

Exoskeleton — Hard outer-shell of many invertebrates.

Fishing pressure — Measure of commercial fishing intensity.

Formalin — Liquid preservative used in storing specimens for later examination.

Habitat — Suitable area in which organisms live and grow.

Host — Organism which supports a parasite.

Hydrographic — Pertaining to physical properties of water such as temperature, salinity, depth, etc.

Invertebrate — Animals which lack a backbone.

Larvae — Early, immature, free-living developmental stage of an animal.

Life History — All changes in development which organisms undergo from egg to maturity and death.

Meteorological — Pertaining to the atmosphere or weather such as air temperature, cloud cover, rainfall, etc.

Migration — Movement of animals from one area or region to another; normally associated with seasonal environmental change.

Molt — To cast-off or shed outer shell; allows for growth or increase in body size.

Mysis — Larval stages of shrimp; a planktonic form.

Nauplius — First larval stage in shrimp; stage approximately one to three days old; planktonic.

Nursery ground — Area where many immature organisms congregate to feed on abundant nutrients resulting in rapid growth, like an estuary.

Ovary — Female reproductive gland which produces eggs.

Parasite — An organism living on or in another organism called the host; benefits from the host.

Penaeidae — A family of shrimp found worldwide, three species of which make up South Carolina's commercial catch.

Petasma — A folding body structure connecting the first pair of swimming legs of male shrimp; thought to aid in spermatophore transfer.

Pilot Study — Serves as a guide to future studies.

Postlarvae — Stage of development of young shrimp which follows the larval stage; characterized by a change into adult-like appearance.

Protozoea — Second larval stage in shrimp; approximately three days old; planktonic.

Recruitment — To replenish; a new supply; specifically the movement of postlarval shrimp from the ocean into the estuaries.

Roe — Swollen ovaries; the eggs contained within the ovarian membrane.

Roundworm — A nematode; a primitive free-living or parasitic worm having an exoskeleton.

Salinity — Degree of salt or saltiness of water.

South Atlantic Shrimp Fishery — For this report consider the fishery of the coastal waters of North Carolina, South Carolina, Georgia and Florida (East Coast).

Spartina — Dominant marshgrasses found in South Carolina; grows in areas flooded by the tides.

Spawn or spawning — Release of eggs by female shrimp; spawn complete as eggs are fertilized by sperm of males.

Species — Individual or distinct kind of animal or plant.

Species composition — The different kinds of species found in an area or taken in a catch.

Spores — Primitive, resistant reproductive body.

Sporozoans — Any of a primitive group of small animals which reproduce by means of spores.

Stocks — Referring to a quantity or population of animals.

Thelycum — Specialized female structure used in attachment of male spermatophore.

Trematodes — Any of a primitive group of flatworms, flukes.