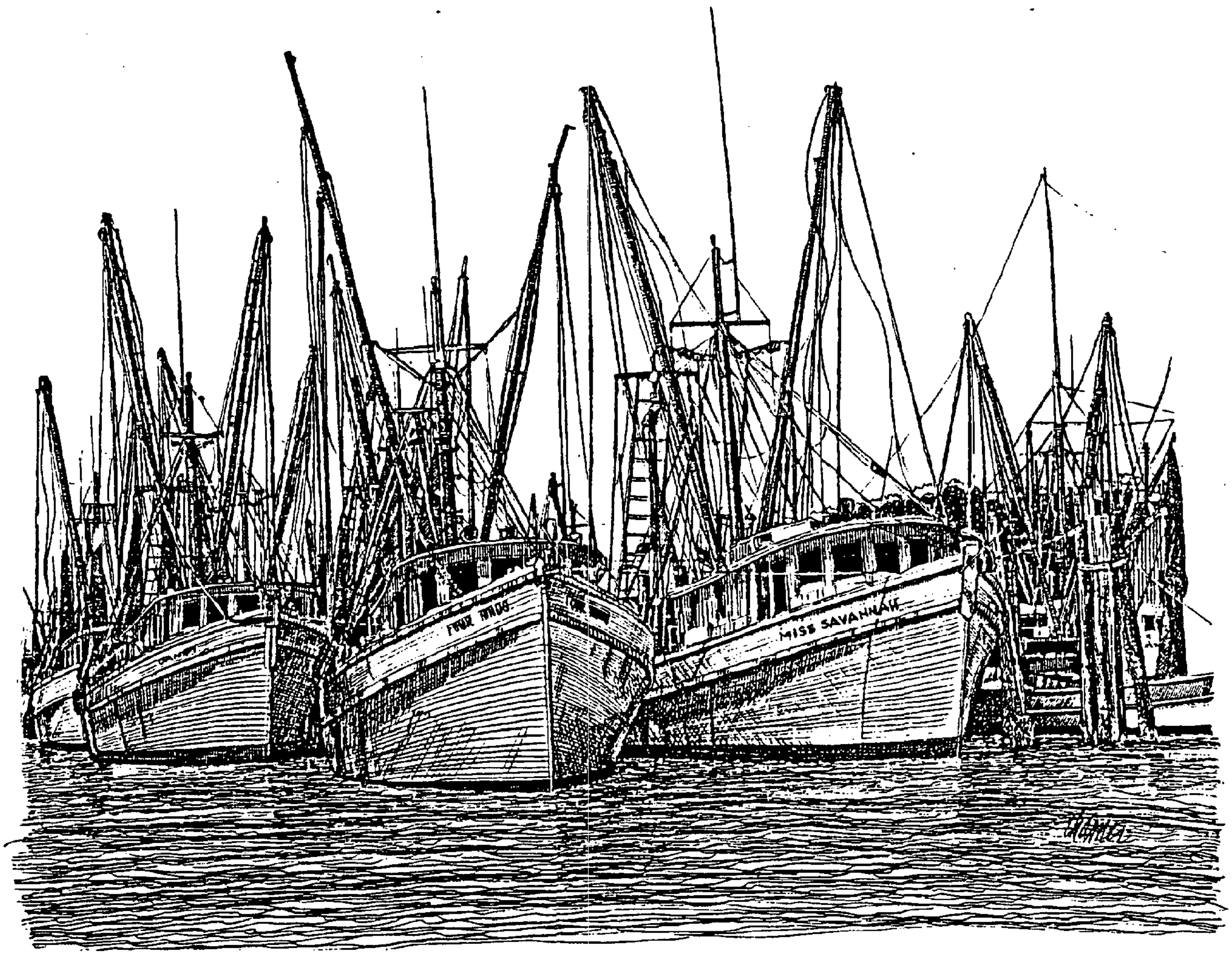
PROFILE OF THE

PENAEID SHRIMP FISHERY

IN THE

SOUTH ATLANTIC



SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL
SOUTHPARK BUILDING, SUITE 306
ONE SOUTHPARK CIRCLE
CHARLESTON, SOUTH CAROLINA 29407

NOVEMBER 1981

PROFILE OF THE PENAEID SHRIMP FISHERY IN THE SOUTH ATLANTIC

South Atlantic Fishery Management Council
Southpark Building, Suite 306
One Southpark Circle
Charleston, South Carolina 29407

Financial assistance for producing this profile was provided by grant funds from the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, under Public Law 94-265, the Magnuson Fishery Conservation and Management Act.

NOVEMBER 1981

PREFACE

In 1973 the South Atlantic Technical Committee for Shrimp Management was formally established to examine the feasibility and desirability of managing the shrimp fishery on a regional level and within the concept of a state-federal partnership. The need for a management planning profile of the region's shrimp fishery was identified as a logical starting point. This work, which summarized existing knowledge of the South Atlantic shrimp fishery, was completed and published in 1974 by the Division of Marine Resources (South Carolina Wildlife and Marine Resources Department) in cooperation with Technical Committee members and staff from the four State fisheries agencies in the region.

Development of the management planning profile identified key information gaps concerning shrimp population dynamics, lack of socio-economic data and movement of fishermen between states. It also identified inadequate catch and effort statistics and limited jurisdiction outside the states' territorial waters. The profile subsequently identified the need for a policy plan which would serve as a guide for implementation of a regional shrimp management program. This work was completed and published in 1975 by the same group. It was a strategic plan to show what inputs and methodology might be used by a regional management group in arriving at shrimp management policies. The two most important recommendations in this plan dealt with the formation of a State-Federal Regional Fisheries Management Board and use of a regional catch and effort statistics system.

Since completion of the 1974 document, a number of profound changes in the economic structure of the fishery have taken place. The numbers and sizes of shrimp vessels have increased dramatically during this period. As pointed out in 1974, the shrimp resource was already being fished to its full biological potential. Thus, with the recent rise in numbers of vessels and gross tonnage, there has been a sharp decrease in average vessel productivity. This decrease in vessel productivity coupled with general depressed economic conditions has accentuated economic hardships in the shrimp fleet.

In February 1981, the South Atlantic Fishery Management Council initiated a work plan for development of a fishery management plan (FMP) for penaeid shrimp in the region. A FMP would appear to be a logical and necessary step in addressing biological, ecological, economic and social factors that interact in the South Atlantic shrimp fishery.

Members of the Shrimp FMP Steering Committee agreed that an update of the 1974 management planning profile was needed to reflect recent changes in the fishery. A plan development team, composed of individuals from the four State agencies and Council staff with coordination through the South Carolina Division of Marine Resources, was organized to update the profile.

CONTRIBUTORS

This profile was prepared by a team of scientists composed of individuals from the four state agencies and Council staff with coordination and major writing responsibilities through the South Carolina Wildlife and Marine Resources Department, Division of Marine Resources.

SOUTH CAROLINA DIVISION OF MARINE RESOURCES, CHARLESTON, S.C.

Michael D. McKenzie	Editor, Project Coordinator
J. David Whitaker	Biology of the Species and Habitat Descriptions (Chapters 5.0 and 6.0)
Charles M. Bearden	Fishery Management Jurisdiction, Laws and Policies (Chaper 7.0)
Dale L. Theiling	Description of Fishing Activities, Gear Types and Landings (Chapter 8.0)
David S. Liao	Economic Characteristics and Social/ Cultural Framework (Chapters 9.0 and 11.0)
Raymond J. Rhodes	Economics and Description of Businesses and Markets (Chapters 9.0 and 10.0)
Emily S. Schroeder	Typing and Editorial Support
Karen Swanson	Graphics

PROJECT OFFICER

Gregg T. Waugh
South Atlantic Fishery Management Council
Charleston, South Carolina

TECHNICAL COMMITTEE

Susan Shipman
Georgia Department of Natural Resources
Coastal Resources Division
Brunswick, Georgia

Frank S. Kennedy
Florida Department of Natural Resources
Marine Resources Laboratory
St. Petersburg, Florida

Dennis Spitsbergen
North Carolina Department of Natural and Economic Resources
Division of Marine Fisheries
Morehead City, North Carolina

ACKNOWLEDGEMENTS

In addition to those people specifically mentioned as contributors, we gratefully acknowledge John Maiolo and Mark Fisch, Department of Sociology and Anthropology, East Carolina University, for their assistance in providing timely information on socio-cultural aspects of the fishery. Their research in this particular area was heavily relied upon in preparation of Chapter 11.0. They also provided technical advice throughout the project.

Special acknowledgement is due Peter J. Eldridge of the Southeast Fisheries Center in Charleston, National Marine Fisheries Service, for his assistance in data identification and collection. He was instrumental in obtaining important fisheries statistics from the Technical and Information Management Services of the National Marine Fisheries Service.

We also wish to thank Robert J. Reimold and his staff of the Coastal Resources Division, Georgia Department of Natural Resources, Brunswick, Georgia. Particular thanks are due to Virginia Baisden, Fred C. Marland, John Bozeman, F. P. Pariani, Jr., James L. Music, John M. Pafford, Ronald J. Essig and H. Jolaine Hall for critically reviewing sections of this report and adding significantly to its content.

Edward G. McCoy, North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, Morehead City, North Carolina and his staff were helpful in reviewing the manuscript and assisting with technical matters. We especially acknowledge the assistance and effort of Katy West.

Cover design courtesy of Jack C. Thames, Charleston, South Carolina

TABLE OF CONTENTS

LIST OF TABLES

Table No.		Page

LIST OF FIGURES

5.0 DESCRIPTION OF THE STOCK COMPRISING THE MANAGEMENT UNIT

5.1 Description of the Species and their Distribution

5.1.1 Identity

Shrimp represent the principal fishery resources of the Atlantic Coast of North Carolina, South Carolina, Georgia and Florida. The shrimp industry of these states is based almost entirely on three shallow-water species of the family Penaeidae, the white shrimp (*Penaeus setiferus* Linnaeus), the brown shrimp (*P. aztecus aztecus* Ives) and the pink shrimp (*P. duorarum duorarum* Burkenroad). An incidental species of considerable importance to the Florida fishery is the rock shrimp (*Sicyonia brevirostris* Stimpson).

Penaeus setiferus has a host of common names other than the often used white shrimp, including grey shrimp, lake shrimp, green shrimp, green-tailed shrimp, blue-tailed shrimp, rainbow shrimp, Daytona shrimp, common shrimp and southern shrimp. *P. a. aztecus*, most often referred to as the brown shrimp on the Atlantic Coast, is also known as brownie, green lake shrimp, red shrimp, redtail shrimp, golden shrimp, native shrimp and also the summer shrimp in North Carolina. The pink shrimp, *P. d. duorarum*, is also known as the spotted shrimp, hopper, pink spotted shrimp, brown spotted shrimp, grooved shrimp, green shrimp, pink night shrimp, red shrimp skipper and pushed shrimp (Perez Farfante, 1969).

The three species can be divided into the non-grooved shrimp (*P. setiferus*) and the grooved shrimp (*P. a. aztecus* and *P. d. duorarum*). The grooves occur on the dorsal surface of the carapace of either side of the postrostral carina. *P. setiferus* can also be distinguished from the other species by its much longer antenna (2.5 to 3 times longer than body length), light grey body color and the yellow band on the uropods. Larger grooved shrimp can usually be easily distinguished by body pigmentation when fresh. *P. d. duorarum* typically has a dark-colored spot on each side between the third and fourth abdominal somites. The uropods of pink shrimp usually have a dark blue band while the brown shrimp's coloration on the same band is usually more variable, ranging from purple to reddish purple. Some green and/or yellow pigmentation is also common on brown shrimp tails. Perez Farfante (1969) provides a key to species identification and thorough descriptions of each species.

Juveniles of the grooved shrimp can easily be distinguished from the juveniles of the non-grooved species. Separation of juvenile grooved shrimp, however, can be very difficult. Williams (1953) and Perez Farfante (1969) addressed this problem and found characters that would identify juveniles with careful scrutiny. Identification of the postlarvae is even more tenuous. Several investigators have examined postlarvae (Pearson, 1939; Williams, 1959; Chuensri, 1968; Ringo and Zamora, 1968) but due to overlap of meristic and morphometric characters, pink and brown shrimp postlarvae remain very difficult to reliably distinguish.

5.1.2 Morphology

The three penaeid species addressed here have basically very similar morphology. The adult shrimp are somewhat laterally compressed with a cephalothorax (head) that makes up roughly 1/3 of the body length. The carapace has a mid-dorsal rostrum which has dorsal and ventral teeth. There are ten periopods (walking legs) that are slender and relatively long. Five pair of pleopods (swimming legs) are located on the ventral surface of the abdomen. The tail fan is made up of the centrally located telson and the adjoining uropods. This structure facilitates rapid backward movement when the large abdominal muscles quickly flex the abdomen. Williams (1965) and Perez Farfante (1969) give descriptions of all three species and Young (1959) provides a detailed description of the white shrimp's morphology.

5.1.3 Incidental Species

A fourth commercially valuable shrimp species is caught occasionally along with the shrimp addressed here. That species, the rock shrimp (Sicyonia brevirostris), is usually found in waters deeper (36.6-54.9 m; 20-30 fm) than those where Penaeus is traditionally fished.

Rock shrimp have a thick exoskeleton which is pinkish to mottled brown. The rostrum is much shorter and the body bulkier than that of Penaeus. Rock shrimp is a high quality seafood product that is steadily growing in popularity.

A considerable rock shrimp fishery has developed off the east Florida coast, growing from about 200,000 lb landed in 1972 to over 2.6 million lb in 1979. Rock shrimp occur in commercial quantities as far north as South Carolina but state landings have been highly variable ranging from 16,000 lb in 1980 to 463,000 lb in 1979. Aspects of the biology of Sicyonia brevirostris off Florida have been reported by Cobb et al. (1973) and Kennedy et al. (1977) and by Davis (1981) for stocks off the South Carolina coast.

5.1.4 Distribution

Much of the information in this subsection is summarized from Perez-Farfante (1969), who reviewed in detail the geographic occurrence of white, brown, and pink shrimp. With the exception of P. d. duorarum, which is also found off Bermuda, the three species are restricted to the Atlantic Coast of the United States and the Gulf of Mexico.

P. setiferus ranges from Fire Island, New York to Saint Lucie Inlet on the Atlantic Coast of Florida, and from the Ochlockonee River on the Gulf Coast of Florida to Ciudad Campeche, Mexico. Atlantic and Gulf populations have presumably been separated since elevation of the Florida peninsula and closure of Suwannee Straits at the end of the Pleistocene. In addition to the disjunct distribution around the Florida peninsula, other gaps occur in the range of the white shrimp within restricted areas. These interruptions have not been adequately explained, although salinity, temperature, substrate, food, and cover have been suggested as possible limiting factors.

Along the Atlantic Coast of the United States, the white shrimp has centers of abundance in South Carolina, Georgia and northeast Florida. Anderson and Lunz (1965) and Lindner and Cook (1970) noted that it is most abundant in regions where extensive brackish marshes are in contact, through passes, with a shallow offshore area. White shrimp generally are concentrated in waters of 27 m (89 ft) or less, although Lindner and Cook (1970) noted that specimens have been obtained from depths of 82 m (269 ft). Anderson (1956) conducted 428 trawls with a 10-foot try net in the Atlantic Ocean off the southeastern United States. The 30-minute trawls, made between 35° 13' to 27° 30' N during January through April, produced 270 white shrimp. Of these, 99.6 percent were taken inside 16.5 m (9 fm) (Table 5-1). The highest percentage of samples (33 percent) by depth strata where shrimp were present was at locations in 7.3 m (4 fm) or less as was the highest mean number of shrimp per tow (3.6 shrimp/tow).

P. a. aztecus is known from Martha's Vineyard, Massachusetts, to the Florida Keys and northward into the Gulf to the Sanibel grounds. It reappears near Apalachicola Bay and occurs around the Gulf coast to northwestern Yucatan. While it may occur seasonally along the middle Atlantic states, breeding populations apparently do not range north of North Carolina.

While brown shrimp reach maximum abundance in the Gulf of Mexico, the species is moderately abundant along the Atlantic Coast of the United States, particularly in North and South Carolina (Cook and Lindner, 1970). Although brown shrimp occur in commercially exploitable quantities to 110 m (361 ft), the species is most abundant in waters of less than 55 m (180 ft). Specimens have been taken in depths of 165 m (541 ft).

P. d. duorarum occurs from southern Chesapeake Bay to the Florida Keys, and around the coast of the Gulf of Mexico to Yucatan south of Cabo Catoche. Maximum abundance is reached off southwestern Florida and the southeastern Golfo de Campeche. Along the Atlantic Coast of the United States, it occurs in sufficient abundance to be of major commercial significance only in North Carolina. Costello and Allen (1970) observed that the largest numbers of pink shrimp occur in regions where shallow bays and estuaries of the coastline border on a broad and shallow

Table 5-1. Trawl results for P. setiferus from the continental shelf of the Atlantic Ocean off the southeastern United States (Source: Anderson, 1956; Note: 1 fm = 6 ft).

Depth (fm)	Total Samples	Total Shrimp	% Samples with Shrimp	Mean Number Shrimp per Sample
≤ 4	15	54	33.3	3.6
5	18	7	16.7	0.4
6	22	27	18.2	1.2
7	24	13	16.7	0.5
8	45	109	26.7	2.4
9	32	13	12.5	0.4
10	38	39	10.5	1.0
11	32	7	3.1	0.2
12	19	0	0	0.0
13	11	1	7.7	0.1
≥ 14	172	0	0	0.0
TOTAL	428	270	8.6	0.6

shelf area. Pink shrimp are most abundant in waters of 11-37 m (36-121 ft) although in some areas they may be abundant as deep as 65 m (213 ft). Specimens have been recorded down to depths of 329 m (1,079 ft).

Penaeus abundance in the south Atlantic appears to be directly related to distance from shore. In 1980, a nearshore survey (4.9-18.3 m, 16-60 ft) with bottom trawl was conducted from Cape Fear, North Carolina to Cape Canaveral, Florida by personnel of the South Carolina Wildlife and Marine Resources Department as part of the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program. Preliminary analysis of the data indicates that Penaeus is most abundant within five miles of the coastline (Figure 5-1). Generally, shrimp abundance decreases with distance from shore in the South Atlantic but a second peak occurs at 4-5 na.mi. Examination of the same data separated by state (Figure 5-2) shows that this second peak at 4-5 na.mi. is made up almost totally of shrimp taken off the Georgia coast. The greater distance from shore for Penaeus off Georgia appears to be related to depth. Shallow water extends further offshore on the Georgia coast relative to the other areas examined in the MARMAP survey. The mean distance from shore of the 3-fathom (5.5 m) curve (computed from distances for every minute of latitude) for Georgia was 3.2 na.mi. as opposed to 2.1 na.mi. for South Carolina and 0.4 na.mi. for Florida. Although shrimp apparently occur further offshore along the Georgia coast, few shrimp were collected beyond 5 na.mi.

5.1.5 Biological Characteristics

5.1.5.1 Reproduction

The commercially important penaeids of the southeastern United States are dioecious and sexually dimorphic (Lindner and Cook, 1970; Cook and Lindner, 1970; Costello and Allen, 1970). Beyond a total length of 100 mm (3.9 in), females are larger than males of the same age (Williams, 1955; Joyce, 1965; Perez Farfante, 1969).

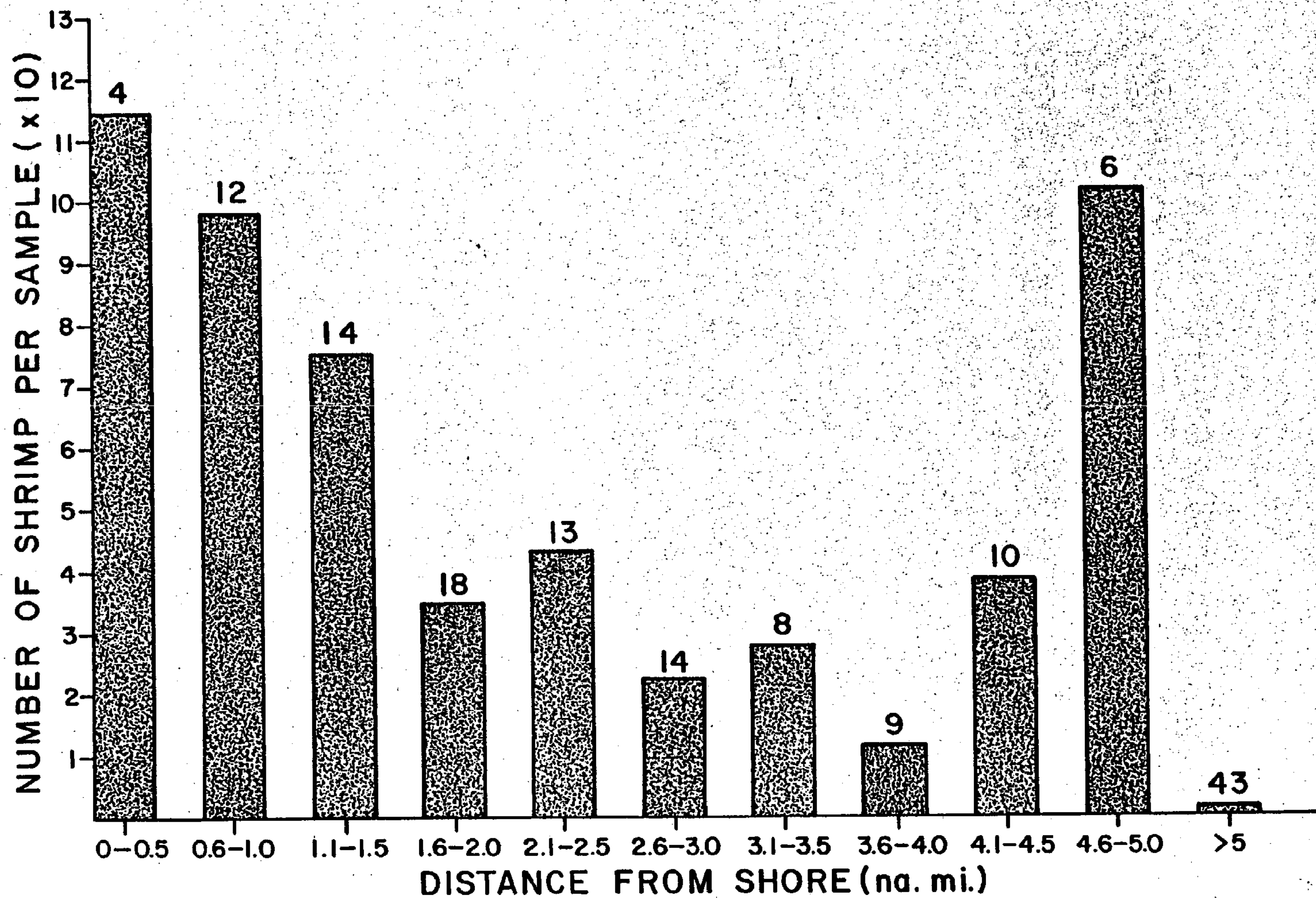


Figure 5-1. Mean number per sample of Penaeus taken by trawl between Cape Fear, North Carolina and Cape Canaveral, Florida as related to distance from shore. Numbers above bars are sample numbers (n).

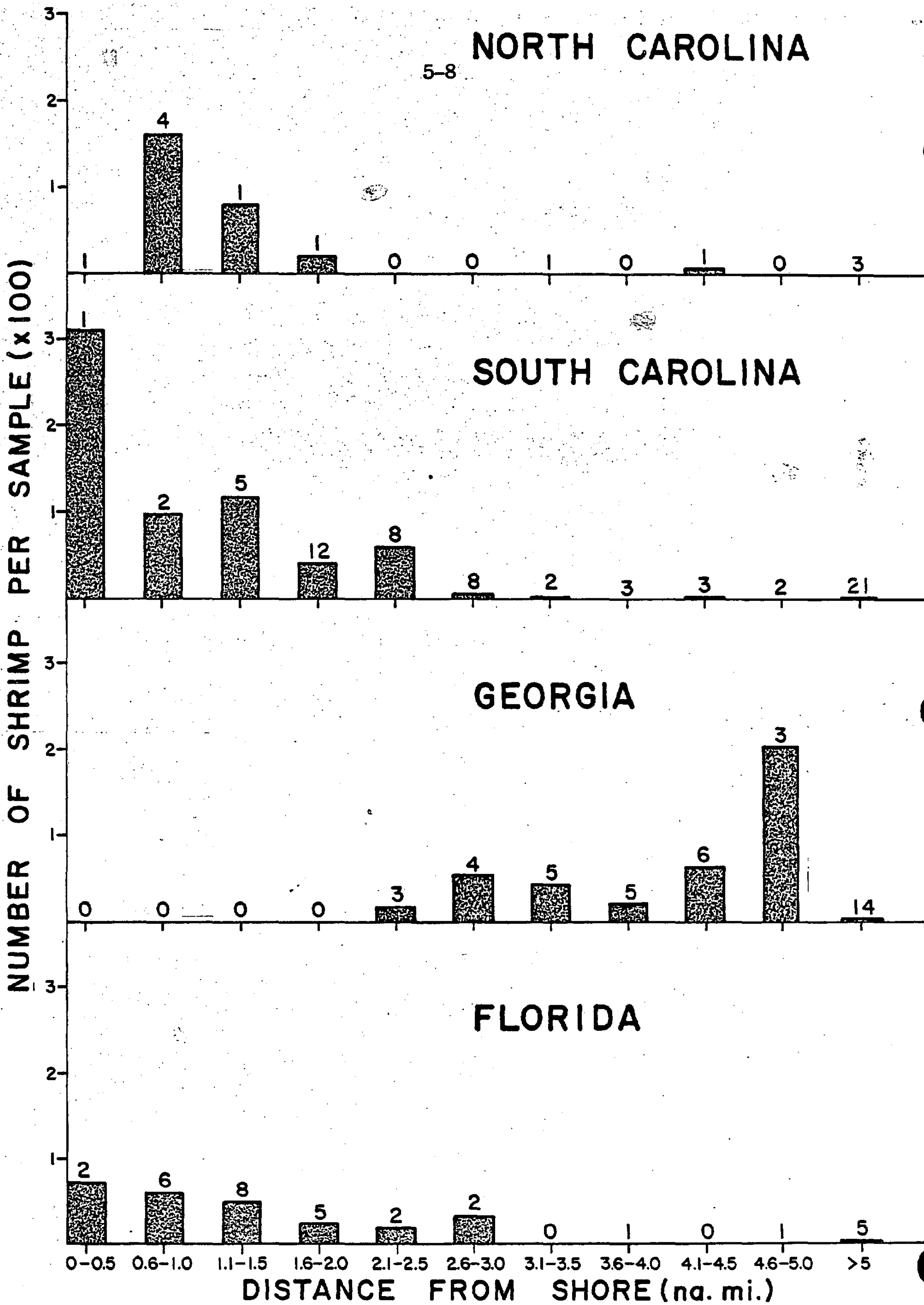


Figure 5-2. Mean number per sample of Penaeus taken by trawl between Cape Fear, North Carolina and Cape Canaveral, Florida by state as related to distance from shore. Numbers above bars are sample numbers (n).

The sex ratio is 1:1 for the three species; however, occasionally there appears to be some segregation by sex (Weymouth et al., 1933; Perez Farfante, 1969). Joyce (1965) found that female P. setiferus made up 55.5 percent of the catch in offshore samples from Florida's east coast. In two different studies along the Georgia coast, Frisbie (1967) and Harris (1974) found 67.6 percent and 70.2 percent females in June samples and 67.6 percent and 64.7 percent in July samples. Bishop and Shealy (1977) found 57 percent of 11,680 P. setiferus in South Carolina to be females. Farmer et al. (1978), also working in South Carolina, found females outnumbered males in 15 of 16 samples in which sample number was 200 or more. Although females appear to be dominant during some seasons, Whitaker (S.C. Wildl, Mar. Res. Dept., Charleston, SC; unpubl. data) found male to female ratios of 1.6:1 to 1.9:1 in three areas along the South Carolina coast in May 1980.

P. a. aztecus sex ratios appear to be about 1:1 in offshore samples (Renfro and Brusher, 1963; Joyce, 1965). However, inshore samples taken in Florida by Joyce (1965) found females to make up 55.2 percent of 1,648 shrimp examined. Estuarine investigations in South Carolina also found 60 percent of 3,184 shrimp to be female (Bishop and Shealy, 1977).

Broad (1965), interpreting from Lindner and Anderson's (1956) data, determined that sexual maturity of female P. setiferus is attained at 140 mm[1] (5.5 in). Farmer et al. (1978) judged some females to be ripe (by ovarian coloration) in the 121-130 mm (4.8-5.1 in) size class. However, ripe females were much more common at lengths greater than 130 mm (5.1 in). By converting Burkenroad's (1934) findings from carapace length to total length, Perez Farfante (1969) reported that females first mature at 135 mm (5.3 in) and that males have fully developed spermatophores at 155 mm (6.1 in) but ripe sperm first appear at 118 mm (4.6 in). In

1 All references to shrimp size (length) are total length (TL) unless otherwise noted.

female P. aztecus, maturity is reached at about 140 mm (5.5 in) (Renfro, 1964; Cook and Lindner, 1970). Burkenroad (1939) reported that female brown shrimp attain gonadal ripeness at about 145 mm (5.7 in) (as converted by Perez Farfante, 1969). In P. d. duorarum, maturation apparently occurs at a considerably smaller size. Eldred et al. (1961) found mature females at 85 mm (3.3 in) and mature males at 74 mm (2.9 in). Kennedy and Barber (in press), in examining specimens from Florida's east coast, found that the first sign of imminent spawning (near ripe or ripe ovaries) was at 35 mm CL (137 mm TL).

All three shrimp addressed here have ovaries that extend from the anterior end of the cephalothorax to the posterior end of the abdomen. Each ovary consists of one anterior lobe and six to eight lateral lobes in the cephalothorax and one long lobe in the abdomen (Perez Farfante, 1969). All available information places Penaeus fecundity at 500,000-1,000,000 ova (Burkenroad, 1934; Anderson, 1955; Lunz, 1967). Anderson et al. (1949a) determined that a 172 mm (6.8 in) P. setiferus had about 860,000 eggs and Hudinaga (1942) reported a 200 mm (7.9 in) P. japonicus with approximately 700,000 eggs. Eggs of the three species are demersal, measuring 0.28 mm (0.01 in), 0.26 mm (0.01 in) and 0.31-0.33 mm (0.01 in) in diameter for P. setiferus, P. a. aztecus, and P. d. duorarum, respectively (Pearson, 1939; Dobkin, 1961; Cook and Lindner, 1970; Lindner and Cook, 1970). Gross descriptions of the developmental stages of the ovaries are similar for all three species and are shown in Table 5-2.

Relatively little is known about mating in Penaeid shrimp. Burkenroad (1939) suggested that copulation in P. setiferus takes place between hard-shelled individuals. During copulation, the male anchors the spermatophore to the female's thelycum by various attachment structures and a glutinous material. Apparently, the spermatophore can be easily dislodged since females with attached spermatophores are rarely found in trawl samples. P. aztecus and P. duorarum apparently have copulation between hard-shelled males and soft-shelled females (Burkenroad, 1939; Perez Farfante, 1969). Impregnated females can be easily

Table 5-2. Gross descriptions of fresh ovaries of P. setiferus, P. a. aztecus and P. d. duorarum for the five basic ovarian developmental stages. (Sources: Perez Farfante (1969)[a], Cummings (1961)[b], King (1948)[c], Cook and Murphy (1969)[d], Brown and Patlan (1974)[e].

	Undeveloped	Developing	Near Ripe	Ripe	Spent
P. setiferus[a,c,d,e]	small and translucent	larger, opaque and yellowish with melanophores scattered over surface	larger, yellow to yellowish orange, visible through exoskeleton, dark green melanophores	occupies all available space, drap olive brown	flaccid "muddy" green becomes yellow or milky with regression
P. a. aztecus[a,d,e]	slender, flaccid translucent	opaque, yellowish with numerous heavy granular ova	large, yellowish brown becoming darker brown, red to pink melanophores	golden brown[a] dark green[d,e]	much smaller, flaccid, light brown to yellowish
P. d. duorarum[a,b,c]	very slender, translucent very flaccid, invisible through exoskeleton	flaccid but larger, opaque, white to olive-bluff	larger, light bluish green (glaucous), somewhat turgid and visible through exoskeleton	dark bluish green, olive green	flaccid color fades, becoming milky with regression

detected macroscopically by the bulging of the lateral plates. Eldred et al. (1961) suggested that mating behavior of young shrimp is possibly related to migratory behavior. Perez Farfante (1969) noted that copulation of pink shrimp was apparently not directly related to maturation and spawning. It is generally agreed that fertilization takes place as ova and spermatozoa are simultaneously explused (Perez Farfante, 1969; Lindner and Cook, 1970).

In Georgia and northern Florida, some spawning by *P. setiferus* may occur inshore, although most spawning occurs more than 1.9 km (1.2 miles) from the coastline (Lindner and Anderson, 1956). Harris (1974) and Music (1979) found some females with ripe ovaries in Georgia creeks and sounds but females with attached spermatophores were found in outside waters only. The highest percentages of ripe shrimp came from offshore samples. Farmer et al. (1978) found ripe females in Charleston Harbor and just offshore but the only spent shrimp were taken at offshore locations. Joyce and Eldred (1966) noted that spawning off Florida occasionally takes place inshore, at or near inlets, but most occurs offshore at depths of 6.1-24.4 m (20-80 ft).

Spawning is correlated with bottom water temperatures (Lindner and Anderson, 1956; Cummings, 1961; Barrett and Gillespie, 1973). Subrahmanyam (1971) found spawning of Penaeid shrimp to occur with a bottom temperature range of between 17^{o} and 29^{o}C (63^{o} - 84^{o}F). Lindner and Anderson (1956) observed that the beginning of spring spawning of *P. setiferus* coincides closely with the rapid rise in water temperature. Spawning in the fall, however, appears to end when there is a decline in temperature even though that temperature is considerably higher than the range which evidently induced spawning in the spring. According to Lindner and Anderson (1956), spawning of *P. setiferus* commences during April (Florida and Georgia) or May (South Carolina) and continues into September (South Carolina, Georgia, and northern Florida) or October (central Florida). It is uncertain whether individual shrimp spawn once or several times per year, although repeated spawning is probable (Perez Farfante, 1969). Lindner and Anderson (1956) believed that a given shrimp may spawn up to four times a season, and that some females may survive to spawn a second season.

Most evidence indicates the P. a. aztecus spawns in relatively deep water. In a study in the northwestern Gulf of Mexico, it was concluded that spawning did not take place at depths of 14 m (45 ft) or less and the greatest percentages of ripe females were at 46 m (151 ft) (Cook and Lindner, 1970). Anderson (1970) reported a large concentration of P. a. aztecus at a depth of 55 to 59 m (180-194 ft) south of Cape Canaveral in January 1965. He speculated that these shrimp were recruited not only from Florida but South Carolina and Georgia as well. Joyce (1965) proposed that P. a. aztecus spawns during February and March and Hoese (1973) speculated that it spawns during spring. The rationale for these decisions was the large influx of postlarvae into the estuaries in February and March. Bearden (1961) suggested that spawning occurred during fall and winter. Anderson (1970) found that during September, 23.7 percent of the brown shrimp off Georgia were ripe and 6.4 percent off Florida were ripe. Frisbie (1967) collected two ripe shrimp one mile off Sapelo Sound in October 1966 which contained spermatophores. C. M. Bearden (S.C. Wildl. Mar. Res. Dept., Charleston, SC; pers. comm.) found mature males and females three to four miles off Stono Inlet, South Carolina during October and November 1965 and 1966.

P. d. duorarum apparently spawns at 3.7-47.5 m (2-26 fm). Eldred et al. (1965) reported that the depth of intensive spawning activity off Tampa Bay, Florida varied from one year to the next. Williams (1955) reported large pink shrimp in water up to 32.9 m (19 fm) offshore of North Carolina during winter. P. d. duorarum on the Tortugas grounds apparently spawn to some extent throughout the year and considerable activity occurs during spring, summer and fall (Cummings, 1961; Eldred et al., 1961; Allen et al., 1980). Kennedy and Barber (in press) examined pink shrimp ovarian maturation and abundance off eastern

Florida. They found that offshore migration of mature pink shrimp continues to at least 40 m (131 ft) and that peak spawning activity occurs during summer. Williams (1955) reports that roe-bearing females in North Carolina are first collected in May along with maturing males and by June most shrimp are sexually mature. He states that the first arrival of mature shrimp in the ocean immediately precedes the appearance of postlarvae. P. d. duorarum is probably capable of spawning more than once (Perez Farfante, 1969).

5.1.5.2 Larval and Postlarval Phases

The shrimp species addressed here all have eleven larval stages (5 naupliar, 3 protozoean, and 3 mysid) before developing into postlarvae (Perez Farfante, 1969; Cook and Lindner, 1970). Sizes of the various stages of P. setiferus and P. d. duorarum are shown in Table 5.3. Cook (1966) reports that the larval stages of P. a. aztecus are very similar to those of P. d. duorarum. Duration of larval life is apparently dependent upon temperature, food and habitat. Records suggest 10-12 days for P. setiferus (Johnson and Fielding, 1956), 11-17 days for P. a. aztecus (Cook and Murphy, 1969), and 15-25 days for P. d. duorarum (Ewald, 1965).

Postlarval size (total length) ranges from about 2.9 to 12 mm (0.12 - 0.47 in). White and pink shrimp postlarval sizes overlap while brown shrimp postlarvae are usually larger. Anderson et al. (1949a) and Bearden (1961) give white shrimp postlarval lengths of 5-6 mm (0.20 - 0.24 in) and 6-9 mm (0.24 - 0.35 in), respectively. Baxter and Renfro (1967) report a mean size of 7.0 mm (0.28 in) and a range of 5.0-9.5 mm (0.20 - 0.37 in) for postlarval white shrimp from Texas.

Established size ranges of first pink shrimp postlarvae are 3.8 - 4.8 mm (0.15 - 0.19 in) (Dobkin, 1961) and 2.9 - 4.6 mm (0.11 - 0.18 in) (Ewald 1965). Dobkin gave a size range of 4.7 - 6.6 mm (0.19 - 0.26 in) for second postlarvae pink shrimp. Baxter and Renfro (1967) found brown shrimp postlar-

Table 5-3. Size ranges of *Penaeus setiferus* and *P. d. duorarum* larval stages. (Sources: Pearson, 1939[a]; Dobkin, 1961[b]; Ewald, 1965[c]).

	Nauplii	Protozoeae	Mysis	First Postlarvae
P. setiferus[a]	0.35 - 0.61 mm	0.86 - 2.7 mm	2.9 - 4.4 mm	3.8 - 4.8 mm[a]
				2.0 - 4.6 mm[b]
P. d. duorarum[b, c]	0.30 - 0.56 mm	0.80 - 2.6 mm	3.2 - 4.4 mm	4.0 - 5.0 mm

vae from Galveston Bay to range from 8.5-12.0 mm (0.33-0.47 in) and have a mean of 11.5 mm (0.45 in). Bearden (1961) reported a size range of 9-12 mm (0.35-0.47 in) for brown shrimp postlarvae collected in South Carolina. Baxter and Renfro (1967) noted that by late June the length distributions of white and brown shrimp postlarvae begin to overlap. The modes of the length distribution of brown shrimp postlarvae decreased while some white shrimp postlarvae as large as 10.5 mm (0.41 in) entered the estuary.

The effects of light on larval and postlarval shrimp have been recorded by several investigators. Pearson (1939) noted a "positive, though probably complicated" phototrophism of nauplii and protozoea of P. setiferus. Bearden (1961) observed that postlarvae were equally abundant near the bottom in daylight and near the surface at night. He found no postlarvae at the surface during daylight and bottom samples at night yielded fewer than night surface samples. Ewald (1965) reported that larval pink shrimp stages are "strongly positively phototrophic". Williams and Deubler (1968) suggested that abundance of pink shrimp postlarvae in surface waters is influenced by moonlight. Jones et al. (1970) working in Florida Bay, found postlarval abundance to be higher at night in surface and midlevel water than during daylight.

The mechanism by which postlarvae are brought from distant spawning areas to estuarine waters is not known. Sick (1970) found naupliar stages only in shallow waters off North Carolina and postlarvae were concentrated 80.4 km (50 mi.) seaward of the Outer Banks. He reasoned that there must be a seaward transport of larvae to the offshore areas. Two major cells of counterclockwise circulating surface water probably account for the seaward transport of larvae and the eventual return of postlarvae to the estuaries. Shoreward countercurrents north of Cape Canaveral have also been suggested as the mechanism for transport of P. d. duorarum larvae from spawning areas to nursery areas along northeast Florida (Kennedy and Barber, in press). Movement of white shrimp postlarvae into the estuary is done by nearshore tidal currents as white shrimp spawn relatively close to shore. Investigations using seabed drifters have shown that bottom currents along the Georgia coast move north thus facilitating the movement of postlarvae into the Georgia sounds (R. J. Reimold, Ga. Dept. Nat. Res., Brunswick, GA, pers. comm.).

Research conducted in the northwestern Gulf of Mexico suggested that larvae, postlarvae or both may overwinter in offshore waters and migrate into estuaries the following spring (Temple and Fischer, 1967). Laboratory work by Aldrich et al. (1968) determined that postlarval P. a. aztecus bury in response to low temperatures (12° - 17° C; 54° - 63°F) and emerge as temperature increases (18° - 21.5° C; 64° - 71°F). Baxter and Renfro (1967) showed that postlarval specimens of P. a. aztecus were larger in spring than those collected during all other seasons. Aldrich et al. (1968) reasoned that the larger postlarvae found during the spring were the result of a fall spawn that had overwintered offshore and increased in size during an extended period of slow growth. Postlarvae on the South Carolina coast taken in late winter and spring are also large (Bearden, 1961), indicating the possibility of overwintering brown shrimp postlarvae on the South Atlantic coast.

Brown shrimp postlarvae apparently enter the estuaries just after water temperature begins to rise in late winter and early spring. Christmas et al. (1966) found no postlarvae at temperatures less than 12°C (54°F). Bearden (1961) first collected brown shrimp postlarvae in South Carolina during 1960 when water temperatures were 11 - 12°C (52 - 54°F). Postlarval abundance, however, decreased when water temperature subsequently dropped below 12°C. Williams and Deubler (1968) collected postlarvae in Bogue Sound, North Carolina on a regular basis from 1957 to 1967. They reported that 90 percent of the postlarval P. a. aztecus were collected when water temperature was 11°C (52°F) or above.

Temperature, per se, probably has little effect on the movements of white or pink shrimp postlarvae into the estuaries since this occurs during the warm season, late spring and summer (Bearden, 1961; Eldred et al., 1961; Christmas et al., 1966; Williams and Deubler, 1968).

5.1.5.3. Juvenile and Adult Phases

After entering the estuaries, postlarval shrimp occupy nursery areas which offer abundant food, suitable substrate, and shelter from predators. In the South Atlantic, these areas are for the most part dominated by *Spartina alterniflora* (*Juncus* in Pamlico Sound) (See Section 6.1 for a more complete review of habitat). There is some temporal and/or spatial segregation of the juvenile phases of the three species. *P. a. aztecus* juveniles usually occupy the estuarine nursery grounds from March through July before emigrating offshore although some individuals may emigrate in June. Growth rates are apparently dependent to a great extent on water temperature, salinity, and salinity-temperature interaction. Cooler than normal temperatures during spring will result in lower growth rates and can delay time of emigration and, consequently, the commercial shrimp season.

P. setiferus and *P. d. duorarum* enter the estuaries at about the same time, usually beginning in April and early May in the southern South Atlantic and in June and July in North Carolina. There is little competition for nursery habitat between the species because pink shrimp only occur in abundance in the North Carolina sounds where white shrimp are uncommon. The large white shrimp begin emigrating to the commercial fishing areas in August and continue through December. The smaller white and pink shrimp remaining in the estuaries during the winter are termed the overwintering stocks.

Severe winter weather causes mass mortalities of overwintering shrimp or premature emigration which results in a reduction of commercial catches. The severe winters of 1976-77 and 1977-78 caused North Carolina pink shrimp landings to decrease to 42.4 percent and 31.6 percent, respectively, of the 1967-1980 mean (N.C. Dept. Nat. Res. Comm. Dev., 1981). Mean water temperatures in North Carolina were 3.7°C (39°F) in January 1977 and 4.7°C (40°F) in February 1978 (N.C. Dept. Nat. Res. Comm. Dev., 1978). Williams (1955) collected pink shrimp in North Carolina from 6°C (42°F) water but noted that the shrimp became almost completely narcotized at temperatures below 10°C (50°F).

The deleterious effects of cold weather on white shrimp populations have been observed by several investigators. Gunter (1941) recorded the occurrence of dead white shrimp washing ashore on Texas beaches after the passage of a severe cold weather front that resulted in a rapid drop in water temperatures. Lindner and Anderson (1956) reported the effects of the 1939-40 winter on P. setiferus of the South Atlantic states. This unusually cold winter preceded a very poor commercial white shrimp season in the spring of 1940. In 1958, passage of a severe cold front in South Carolina resulted in the appearance of dead shrimp in commercial trawl nets several days afterward (Lunz, 1959). Winter weather again caused water temperatures in South Carolina to drop to 4.4°C (40°F) in January 1966 resulting in severe damage to the overwintering stocks. Joyce (1965) reported that 20 percent of the white shrimp caught in a bottom trawl in December 1962 were dead after a rapid 4.5°C drop in bottom water temperature to 8.0°C (46°F) in the St. Johns River, Florida.

More recently, Farmer et al. (1978) in South Carolina and Music (1979) in Georgia have examined the effect of severe winter weather on overwintering white shrimp. The winter of 1976-1977 severely damaged white shrimp stocks and resulted in much reduced commercial landings in the South Atlantic (only 37 percent of the 1957-1980 average). Water temperature in Charleston Harbor, South Carolina reached 5.6°C (42°F) during the third week in January 1977. Dead shrimp were collected in bottom trawls at this time and were reported washing ashore at local beaches. Prior to this, shrimp appeared to congregate in the deeper areas of Charleston Harbor and vacate surrounding shallower waters as water temperature approached about 9°C (48°F). Similar conditions occurred in Georgia when surface water temperatures in estuarine areas fell to 3.0°C (37°F) during the third week in January 1977. Coastwide sampling completed on January 26 found live shrimp only in Cumberland Sound.

White shrimp are apparently very susceptable to water temperatures of 4 to 5°C (39-41°F) or less (Music, 1979). The lethal temperature is probably variable, however, depending on salinity acclimation, rate of temperature change, season, and probably other variables. It is known that low temperature mortality of some decapod crustaceans is inversely related to salinity (Broekema, 1941; McLease, 1956; Kinne, 1964). Panikkar (1951) observed that several marine Crustacea of colder waters were represented in tropical areas by brackish water or fresh water species and concluded that osmoregulation in low salinity was "easier" in warmer climates. Dehnel (1960) examined the effects of temperature and salinity on the respiratory metabolism of the intertidal crabs, *Hemigrapsus oregonensis* and *H. nudus*. He found that weight-specific oxygen consumption was highest at low temperature - low salinity combinations. This was not attributed to increased muscular activity, but to increased work to maintain osmotic balance. Williams (1960) examined the effect of temperature on osmotic regulation in *P. a. aztecus* and *P. d. duorarum*. He determined that survival of both species in laboratory tests was better in higher salinities at low temperatures. Joyce (1965) observed that all three shrimp species (white, brown and pink) were relatively abundant in low salinity areas during the warm seasons but apparently vacated these areas as water temperatures reached 12°C (54°F).

In the South Atlantic, juvenile and adult brown shrimp are rarely affected by severe winter weather because most have been captured by fishermen or predators and others have moved offshore prior to onset of cold weather. In the Gulf of Mexico, however, mortalities resultant from cold weather have been noted.

Gunter (1941) collected a dead brown shrimp by trawl along with dead white shrimp following passage of a severe cold front in 1940 which lowered water temperature to 3.9°C (39°F). Another cold wave hit the Texas coast in 1951 and dropped water temperature to 3.3°C (38°F) (Gunter and Hildebrand, 1951). Dead brown shrimp were again observed and reports were received of windrows of brown shrimp on the islands of lower Aransas Bay. Williams (1960) found in laboratory tests that the ability of P.a. aztecus to osmoregulate was impaired at 8.8°C (48°F).

Eldred et al. (1961) reported that they knew of no known mortalities of P. d. duorarum due to cold waves. They did observe, however, mortalities in bait tanks as water temperature approached 12°C (54°F). Williams (1955) reported taking pink shrimp in North Carolina during winter when minimum water temperature was 4°C (39°F). He also noted that pink shrimp bury deeply (to 15 cm, 6 in.) with the onset of cold temperatures. McCoy (1972) reported that pink shrimp in North Carolina buried and were unavailable after water temperature dropped to about 10 to 12°C (50-54°F) and sampling by trawl did not produce shrimp in winter and spring until temperatures increased to about 12°C (54°F). He was, however, successful in collecting shrimp from the substrate with a pump and suction hose. Williams (1960) reported that pink shrimp osmoregulate better than brown shrimp at lowered salinities and temperatures. Pink shrimp can be adversely affected by low temperatures, however, as evidenced by the mass mortalities in North Carolina during the winters of 1976-77 and 1977-78 (N.C. Dept. Nat. Res. Comm. Dev., 1978).

Pink and white shrimp that survived the winter grow rapidly in late winter and early spring before migrating to the ocean. The migrating white shrimp, so called "roe shrimp", make up the valuable spring fishery. When a majority of white shrimp do not survive the winter conditions, the North Carolina, South Carolina, and Georgia fisheries are dependent on a northward spring migration of white shrimp to form the spawning stocks (See Section 5.1.5.5).

Joyce (1965) concluded that he agreed with Lindner and Anderson's (1956) mark-release work. He suggested that there is a major southward migration and that the northward migration is relatively minor being "primarily a movement out of the Cape Canaveral region." Some sources, however, indicate that fishing pressure is responsible for the reduced spring northward migration. Lunz (1944) attributed, in part, South Carolina's poor rank in shrimp production to "depletion of migratory shrimp due to the intensity of trawling off Florida when shrimp are wintering there." He apparently based this observation on a letter (see Lunz, 1944) from W. W. Anderson. Anderson's letter, in part, follows:

> "Prior to about 1935, which was before the fishery became so intense, the migratory shrimp that wintered in Florida would return north for spawning with the warming of the waters in the spring. In the past several years, however, the fishing during the fall, winter, and spring has been so intense that the migratory group is practically annihilated. This group can no longer be depended upon for spawning. For the past several years the annual crop of shrimp has been the result of the spawning of the shrimp of the local wintering groups."

Lunz (1944) followed this by stating that cooperation among the South Atlantic states in passing laws for protection of migratory shrimp was important if the stocks were to be "materially increased." There is little doubt that white shrimp abundance is greatly influenced by climatic conditions, but there exists the possibility that stocks could be benefited if migratory shrimp off Florida were protected during winter and early spring. This would allow a larger northward migration of spawners in the spring and stocks could possibly recover more quickly following a severe winter.

5.1.5.4 Growth Patterns

Rates of growth in Penaeid shrimp are highly variable, and depend on factors such as season, water temperature, shrimp density, salinity, size, and sex of the organisms. Adolescent shrimp grow rapidly with estimates ranging from 1.0 - 2.3 mm (0.04 - 0.09 in) per day (28 - 64 mm; 1.1 - 2.5 in per month) in P. setiferus, 0.5 - 2.5 mm (0.02 - 0.10 in) per day (14 - 70 mm; 0.55 - 2.76 in per month) in P. a. aztecus, and 0.25 - 1.7 mm (0.01 - 0.07 in) per day (7 - 47.6 mm ; 0.28 - 1.87 in per month) in P. d. duorarum (Lindner and Cook, 1970; Cook and Lindner, 1970; Costello and Allen, 1970; Knudsen et al., 1977).

Lindner and Anderson (1956) estimated that 100-mm (3.9 in) P. setiferus grow to 141 mm (5.6 in) in 2 months for a growth rate of 20.5 mm (0.8 in) per month. Klima (1964, 1974) concluded that 120-mm (4.7 in) white shrimp grow at 21 mm (0.8 in) per month in late summer and fall and 177-mm shrimp grow at 29 mm (1.1 in) per month in August. The difference in growth rates was attributed to lower water temperatures in late summer and fall. Lindner and Anderson (1956) noted an almost total cessation of growth near the end of October when water temperature dropped below 20°C (68°F). Harris (1974) actually recorded a decrease in average shrimp size in Georgia during winter months which he attributed to southern migration of larger animals. He found white shrimp to overwinter at 118 mm (4.6 in) modal length and Farmer et al. (1978) found overwintering inshore shrimp in South Carolina to average 98 mm (3.9 in) by the third week in February. (A summary of established growth rates for white shrimp is shown in Table 5-4).

Salinity has also been implicated as affecting white shrimp growth. Zein-Eldin and Griffith (1970) found high salinities to be detrimental to postlarval growth. Twice as much body tissue was produced at intermediate salinities than at salinities of 25 and 35 ppt. Hysmith and Colura (1976) reared white shrimp from postlarvae in ponds and found much better growth rates at 7 and 15 ppt than at 21 ppt.

Density of individuals may affect growth rates of white shrimp. Analysis of 1971-1980 South Carolina P. setiferus landings indicates that during years when densities are low (as indicated by low landings) overall shrimp size is greater (Table 5-5). This may reflect reduced intraspecific competition in the

Table 5-4. A summary of monthly growth rates for P. setiferus. (Taken in part from Loesch, 1965). Note: 1 in. = 25.4 mm.

Investigator	Average Growth Per Month	Method
Lindner and Anderson (1956)	30 mm	Tagging 100 mm shrimp
Pearson (1939)	20 mm	Aquarium growth of juveniles
Gunter (1950)	30 mm	Length-frequency studies of field samples, juveniles
Williams (1955)	36 mm	Length-frequency studies of field samples, juveniles
Johnson and Fielding (1956)	57 mm	Pond growth, juveniles
Loesch (1965)	13 - 27 mm	Length-frequency studies of winter field samples, juveniles
	18 - 31 mm	Length-frequency studies of summer field samples, juveniles
	65 mm	Length-frequency studies of spring field samples, juveniles
Joyce (1965)	33 mm	Comparison of sizes of largest animals, juveniles
Harris (1974)	30 mm	Length-frequency studies in July-August field samples, 78 mm
	22 mm	Length-frequency studies of August-September field samples, 108 mm
Gaidry (1974)	14 - 15 mm	Length-frequency studies of winter field samples, 60-80 mm
Klima (1974)	29 mm	Tagging 117 mm shrimp
Bishop and Shealy (1977)	25 - 30 mm	Length-frequency studies of field samples, juveniles
Farmer, et al (1978)	20 mm	Length-frequency studies of March and April field sample, 95 mm

Table 5-5. South Carolina late summer and fall *P. setiferus* landings by weight, number of individuals and average count (tails per pound). Count was computed by dividing total number of shrimp (computed from South Carolina landings count data) by total pounds for shrimp of 40 count and greater in August and all shrimp from September through January. (Weight and number X 1,000).

Count	Pounds	Number	Year
23.9	427	10,191	1977
28.2	1,713	46,132	1978
36.7	3,448	126,783	1979
43.2	2,455	106,164	1980
45.5	2,709	123,216	1974
45.5	3,651	165,974	1975
46.2	5,010	231,222	1971
46.6	3,656	170,434	1973
49.1	2,738	134,468	1972
49.5	2,995	148,355	1976

nursery habitat or perhaps simply a longer residence time in the nursery area allowing a longer growth period before moving to commercial fishing grounds as was suggested by Parker (1970). Whichever the case, shrimp apparently reach the South Carolina fishing grounds at a larger size when density is relatively low.

Working with P. a. aztecus in the northern Gulf of Mexico, Parrack (1979) determined that males apparently grow to approximately only three-fifths the weight and five-sixths the length of females. He noted that growth rate tends to decrease at an earlier age for males than for females and that these ages generally conform with the ages of sexual maturity.

Temperature is important in determing growth rates for P. a. aztecus as it is with other Penaeus. In two years of field work, Loesch (1965), working in Mobile Bay, Alabama, found growth rates of 12-35 mm (0.5-1.4 in) per month in winter, 50 mm (2.0 in) per month in spring and 24-43 mm (0.9-1.7 in) per month in summer. St. Amant et al. (1966) found, "little or no measurable growth...at cumulative average water temperatures below 16°C (61°F)." Growth was less than 1.0 mm (0.04 in) per day when water temperature was below 20°C (68°F) and less than 1.5 mm (0.06 in) per day when temperature was below 25°C (77°F). Ringo (1965) found brown shrimp juveniles in East Galveston Bay, Texas to grow at less than 0.1 mm (0.004 in) per day when daily maximum water temperatures were well below 20°C (68°F). As water temperature increased to 25°C (77°F), the average growth rate increased to 1.7 mm (0.07 in) per day and to 3.3 mm (0.13 in) per day as temperatures exceeded 25°C. (Results of other growth rate studies for brown shrimp are shown in Table 5-6).

Salinity has also been shown to affect P. a. aztecus. St. Amant et al. (1966) concluded that growth was enhanced if salinities were in excess of 10 ppt. White (1975) reported that low salinities in Louisiana, coupled with low temperatures resulted in reduced growth rates for brown shrimp. Hysmith

Table 5-6. Summary of P. a. aztecus growth rate results for various studies. Growth rates were converted to mm/day if originally reported in other units. (Source: Knudsen et al., 1977).

Investigator	Average Growth Per Day (Total Length)	Method
Williams (1955)	0.8-1.54 mm	Length-frequency studies of field samples, 20-120 mm
St. Amant et al. (1966)	0.7-1.7 mm	Length-frequency studies (largest and modal) of field samples, 23-125 mm
Loesch (1965)	1.0-1.2 mm	Length-frequency studies of field samples, juveniles-subadults
McCoy (1968)	1.0 mm	Mark-recapture, 115+mm
Jacob (1971)	1.32 mm	Length-frequency studies (largest) of field samples, 12-145
Knudsen et al. (1977)	0.53-0.87 mm	Mark-recapture, 45-84 mm

and Colura (1976) found that brown shrimp grew at 0.19 g/day (0.07 oz) in a 15 ppt culture pond and 0.15 g/day (0.05 oz) in a 21 ppt pond. They could not attribute the growth rate difference to salinity alone, however, since survival in the 15 ppt pond was extremely low. Hunt et al. (1980) reported a salinity threshold value of 10 ppt below which shrimp harvests were poor.

Several authors have examined growth in juvenile and sub-adult P. d. duorarum. Using tagging procedures, Costello and Allen (1960) found that Florida Bay shrimp grew from 240 to 180 heads-off count during winter (3.5 mm CL per month; 0.14 in) and 138 to 96 heads-off count during early spring (1.9 mm CL per month; 0.08 in). Williams (1955), working in North Carolina, found winter growth rates of 5 to 8 mm (0.20 - 0.31 in) per month and summer rates of 44 mm (1.7 in) per month in summer 1952 and 60 mm (2.4 in) per month in summer 1953. Lindner (1966) estimated that Tortugas shrimp grow from 100 mm (3.9 in) to about 138 mm (5.4 in) in about 9 weeks (16.9 mm per month; 0. 7 in). Kutkuhn (1966), also working on the Tortugas grounds using mark and recapture techniques, found a weekly growth rate of 3.4 mm (0.13 in) for pink shrimp sub-adults.

5.1.5.5 Population Size Distribution and Movement Patterns

Being an annual stock having a relatively high growth rate, shrimp of the genus Penaeus have an ever-changing size distribution. Size at any particular time depends on time since spawning, water temperature and any number of factors related to growth. Gunter (1950) stated that the seasonal and local changes in P. a. aztecus and P. setiferus abundance are, "best discussed in relation to size frequencies." Gunter found a distinct size difference of brown and white shrimp which he related to salinity. He found the largest shrimp in the highest salinity waters and, in general, the smallest animals were in the less saline waters. It is not clear whether this size distribution is related exclusively to growth or migration. Once out of the nursery habitat, there is little doubt that shrimp migrate seaward with increasing size. Size at time of emigration is almost always greater than 100 mm under normal conditions. Once at sea, growth apparently continues until the shrimp dies as evidenced by the occasional capture of some very large shrimp.

It is well known that Penaeus shrimps use the estuary as a nursery area. After entering the estuary (or inshore marsh lakes and bays) as postlarvae, growth is rapid as shrimp become juveniles and subsequently, subadults. It is usually at this sub-adult stage that shrimp begin moving from the inshore habitat to the higher salinity oceanic waters. Bishop, et al. (1980) hypothesized that as shrimp increase in size, they seek higher, stable salinities because of a decrease in osmoregulatory ability. They concluded, "...varying salinities (may) be more expensive energetically for larger shrimp and partially responsible for their offshore movement prior to maturity."

Weymouth et al. (1933) published one of the first complete life histories for P. setiferus. They reported that 20 - 50 mm (0.8 - 2.0 in) shrimp moved seaward through the summer and fall with a gradient of decreasing size from waters of greater salinity toward fresh water. The shrimp first entered the commercial catches in high salinity waters at about 90 mm (3.5 in). Williams (1955) found that young white shrimp first entered the North Carolina commercial fishery in July and continued to enter it until October. More recently, white shrimp have been caught in the commercial fishery through December (D. Spitsbergen, N.C. Dept. Nat. Res. and Comm. Dev., Morehead City, NC, pers. comm.). Joyce (1965) determined that white shrimp left Florida's inshore waters at about 120 mm (4.7 in). Baisden (1979), working in Georgia, reported mean lengths of 84 mm (3.3 in) for shrimp from creek headwaters and 109 mm (4.3 in) for shrimp taken in areas adjacent to open ocean.

Joyce (1965) noted that the movement of white shrimp to offshore waters could be caused by cold, storms, high tides, and/or large influxes of fresh water but that size alone appears to be mainly responsible. Shipman (Ga. Dept. Nat. Res.; Brunswick, GA; unpubl. data) concluded from mark-recapture data that fall white shrimp emigration along the Georgia coast in 1980 was apparently related to rainfall, northeast winds, decreases in water temperature or a combination of these variables. Lindner and Anderson (1956) found that shrimp leave inshore areas as they approach adulthood and that a drop in water temperature merely hastens the normal movement. Pullen and Trent (1970) showed that peaks of emigration were associated with drops in water temperature. Farmer et al. (1978) monitored white shrimp during the severe winter of 1976-1977 and observed shrimp movement to deeper, warmer waters in Charleston Harbor, South Carolina before moving offshore and/or succumbing to the cold temperatures. During fall 1980, emigration of white shrimp along the south Atlantic coast was apparently delayed and commercial landings were reduced (D. Whitaker, S.C. Wildl. Mar. Res. Dept., Charleston, SC; unpubl. data; S. Shipman, Ga. Dept. Nat. Res., Brunswick GA, pers. comm.). The prolonged residence in "inside" waters was probably attributable to the above normal salinity of these waters resultant from a severe drought. Shrimp tagging experiments made along the Georgia coast in 1980 indicated that a relatively larger percentage of the fall white shrimp migrated to Florida (S. Shipman, Ga. Dept. of Nat. Res., Brunswick, GA; unpubl. data). Total fall and winter recaptures off the Florida east coast were 13 percent of all recaptures in 1979 and 27 percent in 1980. The apparent increased southward migration was attributed to the shrimp remaining in the above normal salinity waters of the sounds until the major offshore movement and southward migration was triggered by the onset of low water temperature.

P. a. aztecus first enters the commercial fishery in North Carolina in June at a size of about 100 mm (3.9 in) (estimated from a graph, Williams, 1955). Size at emigration appears to be variable (Perez Farfante, 1969). Some move to sea at lengths of only 70 - 80 mm (2.8 - 3.1 in) (Copeland, 1965). Joyce (1965) found brown shrimp to move offshore at 100 - 105 mm (3.9 - 4.1 in) and Trent (1967) reported a size range of 60 - 130 mm (2.4 - 5.1 in) for emigrating shrimp. Blackmon (1974) used a wing net to sample brown shrimp emigrating from a Louisiana bay. He found a size range of 32 - 132 mm (1.3 - 5.3 in) and a range of mean lengths (estimated from a graph) from just less than 80 mm to about 100 mm (3.1 - 3.9 in). Parker (1970) indicated that size at emigration may be dependent on inshore shrimp density. The first shrimp to move gulfward in 1964 were 86 - 100 mm (3.4 - 3.9 in), whereas 41 - 55 mm (1.6 - 2.2 in) shrimp were found in the Gulf of Mexico in 1963, a year when inshore densities were much higher. St. Amant et al. (1966), also suggested that offshore movement may be related to density.

Movement of brown shrimp appears to take place primarily at night with peak movement at dusk and just after (De la Bretonne and Avault, 1971; King, 1971). However, Joyce (1965) reported high catches during daylight hours. In a more recent study, Clark and Caillouet (1975) found diurnal activity of brown shrimp and suggested that brown shrimp may have a circadian rhythm in phase with the light-dark cycle which is subject to modification under turbid or cloudy conditions.

After entering Florida estuaries as postlarvae, P. d. duorarum leave after two to six months, mostly on ebb tides (Perez Farfante, 1969). Hughes (1969, 1972) has found evidence of offshore movement being under endogenous control. Juvenile pink shrimp held in the laboratory were found to become active at time of ebb tide. In North Carolina, young pink shrimp enter the commercial catches in August. Shrimp that overwinter in the estuaries migrate to sea in May and June, at which time spawning takes place (Williams, 1955). Perez Farfante (1969) reviewed the results of several Florida studies. One study (Tabb et al., 1962) found that many pink shrimp move into Florida Bay at about 82 - 92 mm (3.2 - 3.6 in) and practically all before reaching 105 mm

(4.1 in). Another study (Idyll et al., 1965) determined that the average length of emigrating shrimp was about 65 mm (2.6 in). Greatest numbers of shrimp move to Florida Bay in late summer and early fall with a peak in September. A second peak occurs from January to April. Eldred et al. (1961) found shrimp moving out of Tampa Bay at 85 mm (3.3 in) in April through July but did not move in large quantities during the fall and winter. Kennedy and Barber (in press) reported that recruitment to the offshore Cape Canaveral area begins in April and May and occurs again during October and November.

Along the Atlantic Coast of the southeastern United States, considerable research has been conducted towards the elucidation of Penaeus migratory behavior. Most of this work has dealt with P. setiferus. Lindner and Anderson (1956) marked 46,532 shrimp in the South Atlantic and Gulf of Mexico. In their analysis of the 7,055 returns, they concluded that as white shrimp move offshore, they do not move into very deep water but do execute seasonal migrations parallel to the coast. White shrimp apparently migrate south during fall and early winter and north during late winter and early spring. Little migration, north or south, occurs between April and August. They found that in February about 37 percent and in March about 78 percent of those shrimp captured outside their respective release areas were taken in areas north of where they had been released. Northward migration was found to begin as early as January in the Cape Canaveral area, but not until February in the areas between Darien, Georgia and New Smyrna, Florida. The greatest northward migration was from a specimen released at Cape Canaveral in January and recaptured off South Carolina 168 days later after traveling about 260 miles. Of the shrimp examined, those greater than 130 mm (5.1 in) showed much more movement than those less than 130 mm. Because the northward migration is probably linked to temperature, timing of movement may vary from year to year.

Additional white shrimp tagging studies in South Carolina have supported the findings of Lindner and Anderson (Table 5-7). Bearden and McKenzie (1972)

Table 5.7. Results of P. setiferus tagging experiments in South Carolina. (Sources: Lindner and Anderson (1956)[a], Bearden and McKenzie (1972)[b], and Farmer and Whitaker (1980)[c].

Tagging Period	Total Number Released	Total Returns		Returns		
		No.	%	South Carolina	Georgia	Florida
Fall 1936 and 1937[a]	3,067	171	5.6	110	41	20
Fall 1970[b]	1,871	304	16.2	290	7	7
Fall 1978[c]	1,900	262	13.8	251	10	1
Fall 1979[c]	1,985	388	19.5	370	7	11
Spring 1976[c]	2,400	352	14.7	352	0	0

tagged 1,871 shrimp during fall 1970. Of the 304 returns, 14 came from Georgia and Florida. Additional tagging work in South Carolina by Farmer and Whitaker (1980) has shown that white shrimp not taken in the local fishery are likely to migrate south during fall. Joyce (1965) in studying white shrimp in the Cape Canaveral area concluded that the scarcity of shrimp in this area during most of the year, except winter, together with the larger size of these individuals indicated that these shrimp must have migrated from another area. Shrimpers also reported to Joyce that during late fall and early winter, it is possible to locate and fish upon southward migrating schools of white shrimp. These schools, reportedly, travel about 6 to 12 miles per day.

White shrimp tagging studies in Cape Fear River, North Carolina indicated that shrimp moved out of the estuary as water temperature dropped in the fall (Schwartz, 1977). One individual was recaptured just south of Jekyll Island, Georgia in January, some 575 km (357 mi) from the release point. McCoy and Brown (1967) also tagged white shrimp in Cape Fear River and had two white shrimp recaptured off St. Augustine, Florida.

Shipman (1980) has recently investigated white shrimp migrations along the South Atlantic coast. Tagging 15,810 white shrimp in Georgia, she found migration patterns similar to those of previous investigators. Shrimp of 90 mm length and greater, tagged during the third project year (October 1979-September 1980), were released in Wassaw Sound, Sapelo Sound and St. Andrew Sound which represented northern, central and southern areas, respectively, of the Georgia coast. Roughly equal numbers of shrimp were tagged and released in each sound. The predominant year-round movement, as indicated by recaptures, was southward parallel to the coast with 87.7 percent (791 shrimp) being recaptured south of the release points. During spring, however, 24.3 percent of the offshore recaptures were made north of the respective release areas as compared to 7.5, 3.7, and 15.2 percent during fall, winter and summer, respectively. Of the 111 shrimp that moved north in offshore waters, most of these (66 percent) came from St. Andrew Sound and 33 percent came from Sapelo Sound. Only 0.9 percent came from Wassaw Sound. This information suggests that shrimp migratory activity may be a function of latitude with the greatest activity coming from the most southern shrimp. This agrees with Joyce's (1965) conclusion that the northward migration in winter along the east Florida coast is not as large as the fall southward migration and that most northward movement of white shrimp occurs along the southern coastal area near Cape Canaveral.

Tagging efforts on the Atlantic coast with P. a. aztecus and P. d. duorarum have taken place primarily in North Carolina. McCoy (1968) tagged 6,163 brown shrimp in Swan Quarter Bay, Pamlico Sound, North Carolina. A total of 1,030 shrimp (16.7 percent) were returned with an average time free of 13 days and average distance traveled of 4.8 km (3 mi). Only one shrimp was recovered from the Atlantic Ocean, which led the researcher to conclude that "... relatively few brown shrimp from the northern and western areas of Pamlico Sound reach the ocean." In another study, brown shrimp tagged in the lower half of the New River, North Carolina moved an average distance of only 10.1 km (6.3 mi) before recapture (McCoy, 1972). Further tagging of brown shrimp during the summers of 1971 and 1972 in Pamlico Sound indicated that brown shrimp only moved toward the inlets after attaining maximum size, thus making the sound fishery "self-contained" (Purvis and McCoy, 1974). Once out of the sound, North Carolina brown shrimp apparently move to the south and perhaps to deeper, non-trawlable waters. Shipman (1980) tagged 3,252 brown shrimp in three Georgia sounds. Only 122 (3.8 percent) were recaptured and returned. Southward movement was observed in 67, 92 and 76 percent of the returns which were tagged in Wassaw, Sapelo and St. Andrew Sounds, respectively. The only significant northward movement was by 21 percent of the returned shrimp which were tagged in the St. Andrew area, the southernmost of the three tagging areas. Return rates of brown shrimp tagged in Georgia were roughly half those of white shrimp. Because white shrimp are known to migrate parallel to the coast the lower return rates may indicate that brown shrimp may move offshore, out of the nearshore trawling grounds.

Little is known about P. d. duorarum movements along the South Atlantic coast. McCoy (1968, 1972) examined pink shrimp movements in North Carolina's sounds. Tagged shrimp released in Pamlico Sound in 1967 were at large for an average of 14 days and traveled an average of 9.7 km (6 mi) before recapture. Shrimp tagged in May to July, 1968 in Core and Bogue Sounds were at large for an average of 17.4 days and traveled 11.9 km (7.4 mi). McCoy (1968) concluded that most pink shrimp in Pamlico and Core Sounds apparently moved south and entered the Atlantic through Beaufort and Barden Inlets. Pink shrimp from Bogue Sound appear to move through Beaufort and Bogue Inlets. Upon entering the ocean, the pink shrimp seem to move in a southerly direction along the coast, although some shrimp are believed to move offshore to rugged areas deeper than 15.2 m (50 ft). Pink shrimp from Florida's northeast coast migrate south and offshore to an area off Cape Canaveral in 18 to 50 m (59-164 ft) (Kennedy and Barber, in press).

5.1.5.6 Length-Weight Relationships

The length-weight relationships of P. setiferus, P. a. aztecus, P. d. duorarum are shown in Table 5-8. Anderson and Lindner (1958) noted that mature P. setiferus were heavier than immature individuals of the same length. This could result in seasonal changes in length-weight relationships. Kutkuhn (1966) noted some seasonal differences in relationships but concluded that it was not of practical significance.

5.1.5.7 Mortality Rates

The death of shrimp in a natural population is due either to natural causes (predation, disease, senility, etc.) or to man-made causes (fishing, pollution, etc.). Coefficients of fishing mortality (F), natural mortality (M) and total mortality (Z) rates are presented as instantaneous rates. Mortality

Table 5.8. Length-weight equations for P. setiferus, P. a. aztecus and P. d. duorarum
W = weight (g), TL = Total Length (mm), CL = Carapace Length (mm)

Species	Sex	Equation	No. Measured	Source
P. setiferus	male	$W=2.02 \times 10^{-6} TL^{3.261}$	970	Fontaine and Neal (1971)
	female	$W=2.32 \times 10^{-6} TL^{3.234}$	1,120	Fontaine and Neal (1971)
	combined	$w=2.16 \times 10^{-6} TL^{3.247}$	2,090	Fontaine and Neal (1971)
P. a. aztecus[1]	combined	$W= 8.12 \times 10^{-6} TL^{3.02}$	2,104	McCoy (1968)
	male	$W=11.61 \times 10^{-6} TL^{2.911}$	1,396	Fontaine and Neal (1971)
	female	$W= 9.53 \times 10^{-6} TL^{2.966}$	2,016	Fontaine and Neal (1971)
	combined	$W=10.52 \times 10^{-6} TL^{2.938}$	3,412	Fontaine and Neal (1971)
	male	$W= 8.19 \times 10^{-4} CL^{2.94}$	259	McCoy (1972)
	female	$W= 1.13 \times 10^{-3} CL^{2.84}$	243	McCoy (1972)
P. d. duorarum[1]	combined	$W= 1.03 \times 10^{-5} TL^{2.98}$	2,641	McCoy (1968)
	male	$W=10.02 \times 10^{-6} TL^{2.967}$	1,173	Fontaine and Neal (1971)
	female	$W= 5.93 \times 10^{-6} TL^{3.092}$	2,125	Fontaine and Neal (1971)
	combined	$W= 7.71 \times 10^{-6} TL^{3.029}$	3,298	Fontaine and Neal (1971)
	male	$W= 1.48 \times 10^{-3} CL^{2.77}$	297	McCoy (1972)
	female	$W= 2.09 \times 10^{-3} CL^{2.66}$	503	McCoy (1972)

[1] Conversions of CL to TL obtained from North Carolina shrimp (McCoy, 1972) are: P. a. aztecus male TL=3.50 + 4.16CL, female TL=10.50 + 3.83 CL; P. d. duorarum male TL=12.37 + 3.81 CL, female TL=21.90 + 3.40 CL.

rates from several studies are shown in Table 5-9. In most cases, researchers involved in estimating these mortality rates cautioned that several assumptions were made which may not be valid.

Some of the assumptions and requirements[2] necessary in providing reliable estimates are: (1) Natural mortality rate is constant. This is probably not true since a predator's preference of prey may largely be based on size, thus changing with growth of the prey. Behavioral and environmental factors may also influence natural mortality rates. (2) Fishing mortality is constant. Fishing mortality is a function of fishing effort which can be very variable. (3) Recruitment to the experimental stock is minimal. There are probably few cases when this is reliably known. (4) Fishing effort is known accurately. Number of boats and fishing days may be obtainable but actual fishing hours are probably rarely known with precision. (5) Emigration is minimal or accurately known. This is unknown in most cases. (6) All tagged shrimp (or a constant ratio) that are recaptured are detected and reported. There is evidence that at least a small percentage of tagged shrimp are routinely overlooked and many are detected and never reported unless a monetary reward is offered. (7) All tagged shrimp are available to the fishery. This is probably not true in most cases since shrimp may reside in non-trawlable areas (e.g. rough bottom, around "hangs", shallow water, etc.). (8) The tag (or tagging procedure) does not cause mortalities. Some tags may in fact act as fish lures or impair an individual's ability to escape. (9) The tagged shrimp's behavior is not altered making it more or less vulnerable to the fishing gear. This probably cannot be determined. (10) The tagged shrimp do not lose their mark. Marks other than dyes are probably lost when a shrimp sheds its exoskeleton. The rate of tag loss to moulting or other causes is very difficult to determine (Kutkuhn, 1966; McCoy, 1968, 1972; Kilma, 1974; Ricker, 1975).

[2]These requirements apply primarily to mark-recapture methods which are often used in estimating mortality rates.

Table 5-9. Comparison of instantaneous rate of mortality (in weekly values) for P. setiferus, P. a. aztecus, and P. d. duorarum.

Species	Natural Mortality	Fishing Mortality	Total Mortality	Source
P. setiferus	0.08	0.06 - 0.19	0.14 - 0.27	Klima and Benigo (1965)
	0.04 - 0.12	0.10 - 0.13	0.16 - 0.22	Klima (1974)
	0.21 - 0.56	0.02 - 0.25	0.24 - 0.80	Phares (1980)
P. a. aztecus	0.21	0.06	0.27	Klima (1964)
	-	-	0.99, 1.24	McCoy (1968)
	0.36	0.21	0.57	McCoy (1972)
	0.22, 0.33	0.05, 0.11	0.27, 0.43	Purvis and McCoy (1974)
P. d. duorarum	0.55	0.96	0.71 - 1.51	Kutkuhn (1966)
	0.08 - 0.12	0.12 - 0.18	0.25	Lindner (1966)
	0.02 - 0.06*	0.16 - 0.23	0.22 - 0.27	Berry (1967)
	0.08 - 0.11*	0.03 - 0.07*	0.11 - 0.18*	Costello and Allen (1968)
	0.01 - 0.03	0.02 - 0.16	0.07 - 0.16	Berry (1970)
	-	-	0.32 - 0.35	Purvis and McCoy (1972)
	0.28	0.34	0.61	McCoy (1972)

*Adjusted by Berry (1970)

Obviously, these assumptions cannot always be made with certainty. This results in a range of mortality estimates which make it difficult to construct useful yield-per-recruit (YPR) models. Some ranges of estimated weekly total mortality rates as percentages (computed from Table 5-9) for Penaeus are:

White Shrimp	13.1 - 55.1 percent
Brown Shrimp	23.7 - 71.1 percent
Pink Shrimp	6.8 - 77.9 percent

The wide-range of mortality rates can result in a wide range of recommended harvest strategies. The lower rates are probably nearest to reality for juveniles and adults. Managers will have difficulty calculating optimal harvest size of shrimp until mortality rates are more reliably known.

5.2 Abundance and Present Conditions

5.2.1 Abundance

Assuming that the exploitation rate of shrimp in the South Atlantic has remained reasonably constant from 1957 to 1980 (1,095 vessels in 1957 and 1,212 vessels in 1978), one can conclude that annual landings of shrimp truly reflect actual levels of abundance. Furthermore total annual catch in the South Atlantic has shown relatively small variance (mean = 15,717,000 lb. Stand. Dev. = 3,087,000 lb) since at least 1950 which indicates the stocks are being exploited at near maximum.

Annual landings of Penaeus vary considerably; Table 5-10 shows the variability of catches by state and species. Although the range (shown by maximum and minimum) illustrates variability of catches, the coefficient of variation (CV) is a better index of variability. The CV is the standard deviation expressed as a percentage of the mean. This value is useful when comparing populations which have relatively large differences in their means and standard deviations (Sokal and Rohlf, 1969).

A CV of 19 percent for total shrimp catch in the South Atlantic shows less variability than any of the species considered alone. This may indicate a limit-

Table 5-10. Variability of annual commercial landings of shrimp by species and by state for 1957-1980 (landings in thousands of pounds, heads-off); CV (coefficient of variation) = S.D. x 100 ÷ mean (Sokal and Rohlf, 1969).

State	White	Brown	Pink	Total
North Carolina				
Max Catch	1,166	4,894	1,403	6,103
Min Catch	0	601	264	1,501
Mean Catch	262	2,312	895	3,470
CV	114%	43%	40%	32%
South Carolina				
Max Catch	5,193	2,244		6,904
Min Catch	184	527		1,375
Mean Catch	2,506	1,456		3,966
CV	54%	29%		34%
Georgia				
Max Catch	5,143	2,111		6,192
Min Catch	1,943	348		2,938
Mean Catch	3,774	999		4,776
CV	25%	42%		18%
East Coast Florida				
Max Catch	3,699	909		4,043
Min Catch	838	74		1,390
Mean Catch	2,244	465		2,766
CV	32%	45%		29%
Total Commercial Shrimp Landings for Southeast Atlantic Fishery				
Max Catch	12,214	8,306	1,404	19,610
Min Catch	3,222	1,550	332	9,815
Mean Catch	8,785	5,233	920	14,938
CV	29%	29%	38%	19%

ed carrying capacity of the ecosystem but probably reflects the stability of Georgia's landings (CV=18 percent) which contribute the largest share (mean= 31 percent, 1950-1980) of the total South Atlantic landings.

Of the four states Georgia and Florida have the most stable total landings (CV=18 percent and 29 percent, respectively). White shrimp dominate the catches in these states (Figure 5-3) and because the effects of severe winters are minimal, relative to the Carolinas, the total catch shows less variance. The CV values for white shrimp decrease from North Carolina to Georgia indicating the major influence of climate; however, Florida's CV is higher than Georgia's. Florida's higher CV is apparently related to the decline in the State's white shrimp fishery during 1971-78 (excluding 1972) when landings ranged from 37-73 percent of the 1957-1980 mean (See Table 13-12). The reason(s) for the decline is unknown, but it may be related to increased regional fishing pressure resulting in a reduction of the southward migration of white shrimp in the late fall and early winter.

Brown shrimp landings appear most stable in South Carolina, although North Carolina contributes the most (mean=44 percent, 1957-80) toward the region's total brown shrimp landings. The relatively low CV for total South Atlantic brown shrimp may reflect a single stock rather than several small stocks. This may mean that commercial production is dependent on recruitment from a single source which generally produces the same quantity of progeny from year to year. Furthermore, a state's production of brown shrimp may be linked to recruitment success of postlarvae, hence ocean currents. North Carolina biologists, however, believe that brown shrimp production in that state is primarily related to water temperature and salinity in the nursery areas (D. Spitsbergen, NC Dept. of Nat. Res. and Comm. Dev.; Morehead City, NC; pers. comm.).

The CV for total South Atlantic pink shrimp is greatly influenced by North Carolina's pink shrimp landings which annually make up 96 percent (1957-

1980 mean) of the region's landings. A recent increase in Florida (east coast) pink shrimp landings (from 0 in 1972 to 125,000 in 1979) does not represent an increase in stock but is a by-product of the rock shrimp fishery which began in the early 1970's (Kennedy and Barber, in press).

5.5.2 Present Condition

Mean shrimp catch by state and species for 1976-1980 is shown in Figure 5-3. Mean catch (three species) for the last five years is 14.29 million pounds (heads-off) which is 96 percent of the 1957-1980 mean. White shrimp landings, however, have averaged only 7.65 million pounds (heads-off) which is 13 percent below the 1957-1980 mean. The decrease in white shrimp abundance in recent years is directly related to the severe winters of 1976-1977 and 1977-1978. Other than those years, white shrimp landings have been near or above the long term mean (See Table 13-6).

Brown shrimp landings from 1976 to 1980 have been unaffected by the unusually cold weather with the 5-year mean exceeding the 1957-1980 mean by 11 percent. In fact, landings following the very severe 1976-1977 winter were 26 percent above the 1957-1980 mean.

Pink shrimp landings in recent years have fluctuated with climatic conditions. Like white shrimp landings, the 1977 and 1978 pink shrimp landings were below normal because of the mass mortalities of overwintering pink shrimp caused by the severe winters in North Carolina (N.C. Dept. Nat. Res. Comm. Dev., 1981).

Shrimp stocks in the South Atlantic at present are near normal levels. Annual variations in white and pink shrimp stocks caused by severe winter weather continue to occur. Similar conditions existed periodically during the 1960's followed by several unusually warm years in the early 1970's. These warm years were marked by high shrimp production until the severe winter of 1976-1977. Future white and pink shrimp abundance will continue to fluctuate with climatic conditions.

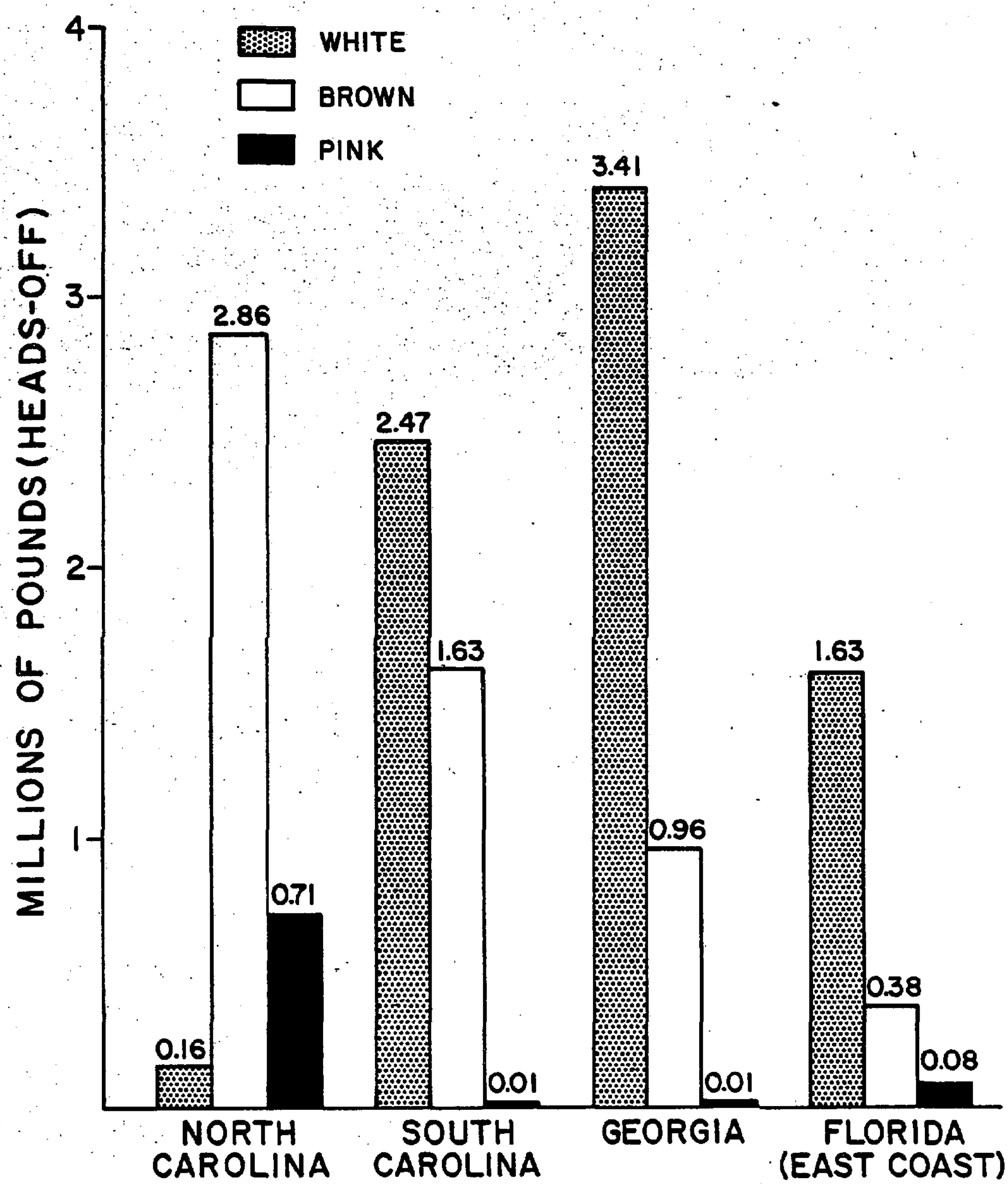


Figure 5-3. Average landings per year of white, brown, and pink shrimp for the years 1976-1980. (Note: Averages were computed from preliminary data for 1979 and 1980.)

Brown shrimp stocks appear to be stable with no anticipated major change in abundance. Annual production appears to be most influenced by late winter and early spring environmental conditions as has been observed for the Gulf of Mexico (Barrett and Gillespie, 1973).

5.3 Ecological Relationships

5.3.1 Food

Penaeus setiferus nauplii subsist on yolk granules until the Protozoea I stage when feeding commences. In the laboratory the first protozoea were fed successfully with microscopic green algae and diatoms and "... considerable matter of unknown idenity ..." (Pearson, 1939). Feeding experiments with *P. a. aztecus* protozoeae in the laboratory showed that the algae *Thalassiosira* was the best of four algae tested and mysis fed well on brine shrimp, *Artemia* (Cook and Murphy, 1969).

Juvenile and adult penaeids are omnivorous bottom feeders with food ingestion occurring largely at night, although, in turbid waters daytime feeding may occur (Eldred et al., 1961; Costello and Allen, 1970). Jones (1973) found a shift in the diet and habitat of juvenile brown shrimp in a Louisiana marsh as they increased in size. The smallest shrimp examined, 25-44 mm (1.0-1.7 in), indiscriminately ingested the top sediment layer. At 45-64 mm, (1.8-2.5 in), they selected the organic fraction of the sediment, and at 65-104 mm (2.6-4.1 in) the shrimp moved to the deeper marsh waters where they became active predators feeding on polychaetes, amphipods, nematodes, and chironomid larvae.

Eldred et al. (1961) examined pink shrimp stomachs and found polychaetes, nematodes, caridean shrimps, mysids, copepods, isopods, amphipods, ostracods, mollusks, and foraminiferans. They also found unidentified body structures, caridean eggs, fish scales, sand and debris. Williams (1955) found that stomachs of shrimp taken in North Carolina estuaries were usually full in summer, full or half-full in autumn, and empty in winter. He suggested that any available organic material may be ingested. Specific food items utilized are often difficult to assess because stomach contents are finely triturated. Williams (1955) observed that material in the stomach of shrimp consisted primarily of unrecognizable debris believed to be semi-digested tissue and organic bottom deposits, fragments of chitin from crustaceans, setae, annelid jaws, plant fragments, and sand. Other items included foraminiferans, small gastropod and pelecypod shells, squid suckers, entire small fishes and fish scales, muscle fibers, ribs, eggs and plant seed pods.

Weymouth et al. (1933) observed that white shrimp in aquaria successfully attacked and consumed fish and other shrimp. Cannibalism of penaeid shrimp may be related to density. Edwards (1977) held P. vannamei in cages and found continuous mortalities attributed to cannibalism which occurred when food became a limiting factor.

Moriarty (1976) determined that the shrimp Metapenaeus bennettae is capable of digestion and assimilation of bacteria. It is apparently capable of digesting the cell walls as well as the cell contents. Moriarty (1976) proposed that bacteria "... are probably the main living component in the food of Metapenaeus bennettae."

While shrimp are able to ingest a wide variety of potential food items, much of the actual material digested is believed to consist of soft parts because large, hard fragments cannot be passed through the straining apparatus of the pyloric stomach. Williams (1955) was uncertain whether hard parts, which may accumulate in the stomach, were further broken down or regurgitated.

Condrey et al. (1972) found that assimilation efficiency in juvenile white and brown shrimp was high (80-85 percent) for a variety of plant and animal materials. Rates of food intake and assimilation were found to vary in relation to the length of time necessary for occurrence of trituration and filtering into the digestive gland. They also noted that lipases and proteinases were more active than carbohydrases.

5.3.2 Substrate

Perez Farfante (1969) reviewed the commercial shrimp and their substrate preferences. P. setiferus, when inshore, lives on muddy or peaty bottoms that are rich in decaying organic matter or vegetation for protection. Offshore, white shrimp are most abundant on soft muddy bottoms, P. a. aztecus appears to prefer a substrate similar to that of the white shrimp. Young shrimp are usually found in muddy or peaty bottoms but also live on sand, silt or clay mixed with shell and rock fragments. Adult brown shrimp are abundant on mud or silt bottoms and, occasionally where the bottom consists of mud, sand, and shell. P. d. duorarum does not prefer a bottom type similar to that of brown and white shrimp but appears to prefer hard sand and calcareous shell substrates (Kennedy and Barber, in press). Hildebrand (1954, 1955) explains the limited distribution of pink shrimp in the northern Gulf of Mexico to the absence of large areas of shell sand. Kennedy and Barber (in press) proposed that pink shrimp abundance off the South Atlantic coast is also governed by substrate type.

Williams (1958) performed laboratory experiments designed to determine substrate preferences of the three shrimp species. Both brown and pink shrimp were active at night. Pink shrimp were observed to bury during daylight and were attracted to the coarse, shell-sand substrate. Brown shrimp also remained buried during daylight but preferred muddier substrates. White shrimp, like brown, preferred the muddier substrate but did not bury with the regularity of pink or brown shrimp.

5.3.3 Predation

Shrimp of the genus Penaeus are important to the diets of many marine species (Gunter, 1945; Knapp, 1949; Darnell, 1958). Rose et al. (1975) observed that sheepshead minnows, water boatmen, and some insect larvae are important predators of shrimp postlarvae. They also noted that grass shrimp (Palaemonetes spp.), killifishes, and blue crabs prey upon young penaeid shrimp. Knapp (1949) examined stomach contents of 34 finfish species and found a 50 percent or greater frequency of occurrence of juvenile and adult shrimp in the following game and food fishes: Elops saurus (ladyfish), Arius felis (sea catfish), Bagre marinus (gafftopsail catfish), Pomatomus saltatrix (bluefish), Rachycentron canadum (cobia), Coryphaena hippurus (dolphin), Cynoscion nebulosus (speckled trout), Menticirrhus sp. (whiting), Scianops ocellatus (red drum, channel bass), and Paralichthys lethostigma (southern flounder). C. M. Bearden (S.C. Wildl. Mar. Res. Dept., Charleston, S.C., pers. comm.) examined numerous spiny dogfish, Squalus acanthias, during winter 1963-1964 which had been preying heavily upon white shrimp in the Charleston Harbor ship channel. Other fish species known to prey upon Penaeus are listed in Table 5-11. The list of predators here is undoubtably a small percentage of the fishes which rely on Penaeus for food.

The importance of predators on a shrimp population was examined by Rose et al. (1975) in shrimp culture experiments in Louisiana salt marsh impoundments. In an impoundment where an effort was made to exclude predators and competitors, the brown and white shrimp harvest was about three times that of another impoundment in which predators and competitors were not removed. Lack of predator control resulted in about a four-fold decrease in survival of marked P. setiferus. Edwards (1977) found natural mortality rates of 41 percent per week for P. vannamei in a Mexican lagoon where he attributed most of the mortalities to predation by Arius (=Galeichthys), Cynoscion and, possibly, Callinectes.

5.4 Estimate of Maximum Sustainable Yield

The concept of maximum sustainable yield (MSY) has been a valuable and useful tool of fishery management for many years. In more recent years it has been recognized that while MSY remains a valuable parameter it is not necessarily a desirable goal to be sought by management. Under the Magnuson Fishery Conservation and Management Act of 1976, optimum yield (OY) has replaced MSY,

Table 5-11. Fish identified by Knapp (1949), Darnell (1958), and Costello and Allen (1970), as feeding on penaeid shrimp.

Species	Common Name
Carcharhinus leucas	Bull shark
Dasyatis sabina	Stingaree
Lepisosteus spatula	Alligator gar
Megalops atlantica	Tarpon
Ictalurus fureatus	Blue catfish
Opsanus beta	Gulf toadfish
Centropomus undecimalis	Snook
Morone mississippiensis	Yellow bass
Epinephelus morio	Red grouper
Mycteroperca bonaci	Black grouper
Micropterus salmoides	Largemouth bass
Caranx hippos	Crevalle jack
Lutjanus analis	Mutton snapper
Lutjanus griseus	Gray snapper
Archosargus probatocephalus	Sheepshead
Bairdiella batabana	Blue croaker
Bairdiella chrysura	Silver perch
Cynoscion arenarius	Sand seatrout
Leiostomus xanthurus	Spot
Micropogonias undulatus	Atlantic croaker
Pogonias cromis	Black drum
Scomberomorus cavalla	King mackerel
Scomberomorus maculatus	Spanish mackerel
Makaira nigricans	Blue marlin

but MSY remains as a point of departure for arriving at OY.

One of the many assumptions underlying MSY is that fishing effort in one year affects the biomass available for harvest the following year or several years into the future. This assumption is clearly not met with short-lived species such as penaeid shrimp which are almost entirely an annual crop. Penaeid stocks can and frequently do fluctuate dramatically from year to year for reasons totally unrelated to the activities of man, including fishing. Fishing effort does reduce the standing crop in a given year, but not to the extent that recruitment the following year is affected.

Even if the MSY concept were appropriate in the case of shrimp, computation of a precise MSY would be difficult by traditional means. One of the more frequently used methods, the Schaefer logistic model, requires a long time-series of both catch and effort data. Although catch data are relatively good, effort data are quite inadequate in the southeast shrimp fishery. Still, an approximation of MSY is obtainable. As has been described in Section 8.0 the harvest of shrimp in the region has fluctuated around a relatively flat plateau of approximately 26 million pounds (heads-on) over the past 30 years. This covers a period during which the harvest potential of the fleet has increased tremendously (see Section 8.0). The lack of a corresponding increase in landings suggests strongly that the resource has been fully harvested for many years. If an estimate of the recreational catch is added to the mean commercial harvest, then this combination should provide a suitable estimate of MSY.

For management purposes, MSY equals all available commercially valuable shrimp that can be harvested in a given year. This value in heads-off pounds for the South Atlantic from 1957 to 1980 has ranged from 9,815,000 to 19,610,000 lb. The mean value with an estimated 10 percent added as recreational catch is 16,432,000 lb (25,962,000 lb, heads-on). This value can be used as an MSY for the region although it will probably be exceeded in some years. During the period 1957-1980 the mean was exceeded 10 times by commercial landings alone, neglecting recreational catch. A possible maximum annual catch for the South Atlantic would be the sum of the maximum annual catches by species for each state. This sum is 26,934,000 lb (42,556,000 lb, heads-on) which is 180 percent of the 1957-1980 mean of commercial landings. The probability of achieving this maximum level, however, is probably very low.

5.4.1 Yield-Per-Recruit (YPR)

Ideally, shrimp managers would prefer to make shrimp management decisions, particularly those involving season opening dates, with the aid of a reliable YPR curve. Economic yield is considered over biological yield (weight) because maximum economic yield usually occurs when shrimp reach a size larger than where maximum biological yield occurs. Lindner (1966) demonstrated this in an analysis of Tortugas shrimp fishery management. A primary requirement in developing an accurate YPR curve is a reliable estimate of natural mortality (M). Reliable estimates of M, however, are difficult to obtain (See Section 5.1.5.7). Shrimp management decisions can vary considerably with different values of M. A lower M dictates postponement of the shrimp harvest until shrimp reach a larger size, whereas, an extremely high M indicates that fishing should proceed as soon as shrimp reach a marketable size.

Several researchers have suggested management strategies for *Penaeus*. Kutkuhn (1966) obtained relatively high values for M (See Table 5-9) and recommended that shrimp in the Tortugas fishery be harvested as soon as they reached marketable size (about 70 count, heads-off). Other studies by Lindner (1966) and Berry (1967) indicated that these relatively high values of M lead to the conclusion that there is merit to management procedures designed to protect small shrimp.

In the South Atlantic, published management strategies related to YPR exist only for North Carolina. Pink shrimp in Core and Bogue Sounds and brown shrimp in the New River apparently have relatively low natural mortality rates and migrate offshore at a relatively small size (McCoy, 1972). For maximum yield, both in weight and value, these shrimp should be caught as soon as they attain an acceptable size. Purvis and McCoy (1972) examined overwintering pink shrimp in Core and Pamlico Sounds and recommended that these pink shrimp should also be fished on as soon as they attained a marketable size in the spring. Brown shrimp, however, remain in Pamlico Sound until they reach a relatively large size. Because of the longer period of residency for brown shrimp and the relatively low mortality rates observed, Purvis and McCoy (1974) recommended that shrimping in Pamlico Sound be prohibited until the shrimp reach a 46-50 count (heads-off).

5.5 Probable Future Condition

Examination of 1957-1980 landings data (Figure 5-4) shows a considerable range in annual landings of P. setiferus. However, P. a. aztecus and P. d. duorarum landings have remained relatively stable. It is doubtful that there will be any long-term increase or decrease in shrimp abundance (landings) which cannot be attributed to natural conditions. Because of high fecundity and migratory behavior, the species are capable of rebounding from a very low quantity in one year, to a large quantity in the next year provided environmental conditions are favorable. There is also no prospect that overfishing employing present methods will harm the stock. Landings over the last 30 years have remained stable while fishing pressure has increased dramatically. Fluctuations in shrimp abundance will continue to occur and will be dictated by environmental conditions (e.g. severe winters, heavy rainfall, drought, etc.). Perhaps the most serious potential threat to the stocks is loss of habitat to pollution or physical alteration.

During years when inshore white shrimp overwintering stocks are greatly reduced because of severe winter weather, there exists the possibility that man-

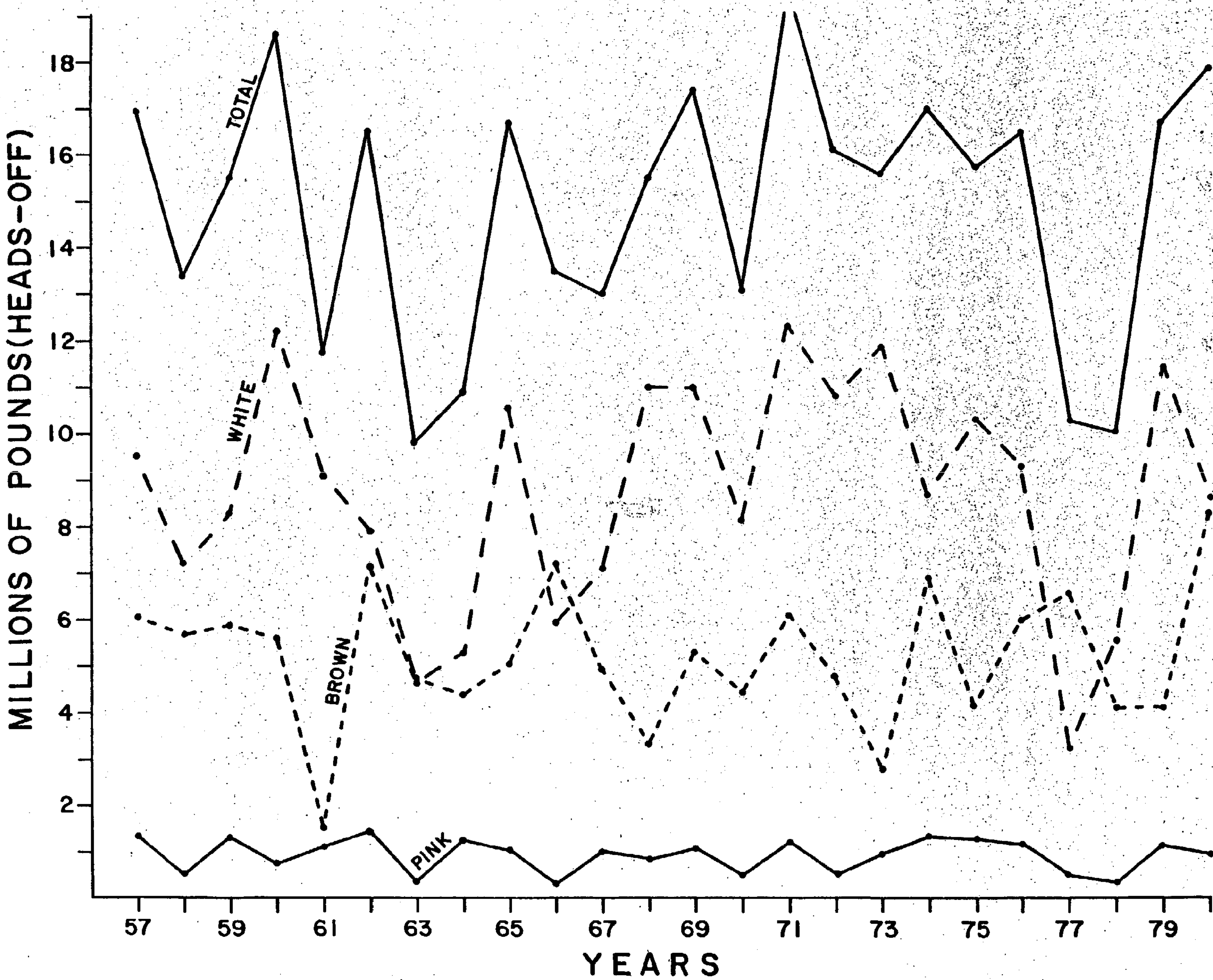


Figure 5-4. South Atlantic shrimp landings, 1957-1980.

agement action could accelerate the recovery of the stocks. Elimination of winter and spring fishing mortality off Florida may facilitate northward migration of a greater quantity of potential spawners and could possibly result in larger regional white shrimp stocks in the following summer and fall.

6.0 DESCRIPTION OF THE HABITAT

6.1 Description of the Habitat

The three commercially important penaeid shrimp of the southeastern United States occupy similar habitats with the greatest differences being in optimal substrate and salinity. (See Section 5.1 and 5.3). Apparently all three species can tolerate a wide range of habitat conditions; however, there appears to be optimal conditions which result in the highest growth rates and greatest survival.

Shrimp have a life cycle which requires a variety of habitats. The habitats can basically be divided into offshore and inshore (see Section 5.1.5). The high salinity, oceanic waters serve as habitat for the large mature shrimp which will spawn offshore. Brown and pink shrimp apparently move to relatively deep continental shelf water and white shrimp appear to remain nearshore in shallower water (see Section 5.1.4).

The relative abundance of the three shrimp species in the South Atlantic may be related to offshore bottom sediment composition. Kennedy and Barber (in press) suggest that spawning pink shrimp may be most abundant off Cape Canaveral and Cape Lookout because that species has an affinity for hard, coarse, and particularly calcareous bottom sediments which occur in those areas. They also note that the nearshore soft sediments correlate well with white and brown shrimp distributions from northern Florida to Pamlico Sound, North Carolina.

Offshore water also serves as habitat for larval and postlarval shrimp. These shrimp are planktonic and feed on zooplankton and phytoplankton in the water column. There is some evidence that postlarval brown shrimp may overwinter in nearshore bottom sediments (Temple and Fischer, 1967). Aldrich et al. (1968) demonstrated that brown shrimp postlarvae buried in laboratory experiments when water temperature was reduced to 12^{o}-$16.5^{o}C$ (54^{o}-$62^{o}F$). For their experiments, they used substrate material taken from Galveston Bay which was 75 percent clay, 22 percent silt, and 3 percent sand.

The inshore phase of the life cycle is perhaps the most critical because most of the rapid growth occurs here. This critical habitat is dominated on the Atlantic coast by smooth cordgrass (Spartina alterniflora) and Juncus (in North Carolina's Pamlico Sound) which produce most of the primary production. Schelske and Odum (1961) stated that up to 10 tons of Spartina plant tissues are produced per acre per year. Turner (1977) found a direct relationship between commercial shrimp landings to absolute area and type of estuarine-intertidal vegetation. He suggested that the "...measurements of intertidal areas are relative indicies of the amount of "edge" in an area and are thus indirect measurements of the habitat."

Shrimp enter the inshore habitat as postlarvae and maintain a benthic existence. The areas where juveniles appear most abundant have a mud-silt substrate and intermediate salinities. Gunter et al. (1964) found that juvenile white shrimp were most abundant in waters of salinities less than 10 ppt in Alabama and Texas bays. Truesdale (1970) presented somewhat contradictory information. He concluded that salinity, per se, had no effect on postlarval distribution and abundance in Trinity Bay, Texas except during periods of high river discharge. Zein-Eldin and Aldrich (1965) and Zein-Eldin and Griffith (1970) found that salinity, per se, did not affect the growth rate of postlarval shrimp.

Apparently white shrimp have a greater tolerance to low salinity than brown shrimp. Gunter (1961) attributes the predominance of white shrimp in Louisiana to the lower estuarine salinities. Conversely, brown shrimp dominate in the waters around the much drier Texas. Gunter points out that the connection between rainfall and Texas white shrimp production was dramatically illustrated in 1957 when a long drought was broken and landings jumped from 2,229,000 pounds in 1957 to 7,370,000 pounds in 1958. Parker (1970) reported brown shrimp in areas where bottom salinity ranged from 0.9 to 36.5 ppt. Gaidry and White (1973) reported that commercial catches of brown shrimp were poor in those years when salinities where less than 15 ppt at the time postlarvae were present in the estuaries. They also stated that years of low commercial landings of brown shrimp were associated with prolonged estuarine temperatures of less than 20°C (68°F) at the time of postlarval immigration into the estuary. Laboratory studies with juvenile and adult brown and white shrimp indicate that white shrimp are better adapted to tolerate low salinity, whereas, brown shrimp are better adapted to higher salinities (McFarland and Lee, 1963). Gunter et al. (1964), found that juvenile white shrimp were more abundant in areas with waters of salinities less than 10 ppt while brown shrimp juveniles were more abundant in salinities between 10.0 and 19.9 ppt.

Juvenile shrimp appear to be most abundant at the Spartina grass - water interface. This "estuarine edge" is the most productive zone in many estuaries. Because there is a minimum of wind generated turbulence and stabilization of sediments, rich bands are found along the edges of marshes (Odum, 1970). Furthermore, Odum (1970) found that the percentages of organic detritus in sediments along the shore in the Everglades estuary are several times greater than a few meters offshore. Mock (1967) examined two estuarine habitats, one natural and one altered by bulk-heading. He found a 0.6 m (2 ft) band of rich organic material along the natural shore and very little organic material along the bulk-headed shore. White shrimp were 12.5 times and brown shrimp 2.5 times more numerous in the natural area as in the altered area. Loesch (1965) found that juvenile white shrimp in Mobile Bay were most abundant nearshore in water less than 0.6 m (2 ft) deep containing large amounts of organic detritus. Brown shrimp were congregated in water 0.6 to 0.9 m (2-3 ft) deep where there was attached vegetation.

As shrimp increase in size, they begin migrating toward high salinity, oceanic waters. Parker (1970) observed that size of brown shrimp at the time of emigration is apparently related to density of individuals but smaller individuals tended to concentrate in the shallow peripheral zones. St. Amant et al. (1966) observed that as juveniles increased in size they moved into deeper, larger bays, through the lower bays and to offshore waters. Lindner and Anderson (1956) stated that shrimp size increased from inside to outside waters. The largest shrimp were in the outside waters where salinity values were highest.

6.2 Condition of the Habitat

There is little published information available concerning the present status of estuarine shrimp habitat in the South Atlantic relative to the past. Lindall and Saloman (1977) reviewed and summarized the known alteration and destruction of estuarine habitat affecting fishery resources of the Gulf of Mexico. They estimated that over 138,000 acres of marsh had been filled through 1977. Comparable data are not readily available for the South Atlantic but Spinner (1969) estimated wetland acres destroyed from 1954-1968 in the Atlantic coastal states. The South Atlantic lost an estimated 44,900 acres or 3.2 percent of coastal wetlands from 1954 to 1968 (Table 6-1).

Spinner's data indicate that 62.6 percent of all east coast United States' wetlands in 1968 were found from North Carolina to Florida with South Carolina having the most, 23.5 percent. Reimold (1977) found the South Atlantic to make-up 81.6 percent of the east coast's salt marshes and mangrove swamps. He found 33 percent of the marsh area in Georgia and 30 percent in South Carolina. Tiner (1977) examined South Carolina's coastal marshlands and estimated that less than 2 percent have been lost as diked dredge-spoil disposal areas. Many coastal marshlands, however, were altered by European settlers and their descendants for culture of crops, primarily rice. If the assumption is made that all these areas were once natural marshlands, then South Carolina has lost at least 15.8 percent of its original, natural marsh. State and federal legislation has significantly

Table 6-1. Summary of coastal wetlands acreage for the South Atlantic states. (Sources: a=Spiner, 1969; b=Wilson, 1975; c=Tiner, 1977, d=Reimold, 1977).

	Total Coastal Wetlands	Percent of South Atlantic Wetlands[a]	Estimated Wetlands Destroyed 1954-1968[a]
North Carolina	197,250[b]	15.2	14,700
South Carolina	504,445[c]	39.0	2,000
Georgia	475,687[d]	36.7	2,700
Florida (East coast)	117,696[d]	9.1	25,500
Total	1,295,078	100.1	44,900

slowed the destruction of coastal wetlands but physical alterations to subtidal and intertidal areas continue under pressure from an increasing population's demand for waterfront properties.

Pesticides pose a more insidious threat to shrimp as well as all aquatic and marine species. Freshwater runoff laden with pesticides and other chemicals from agriculture and other sources are removed and concentrated by filter feeding estuarine animals. Oysters, for example, are able to concentrate DDT from the water and incorporate it into their pseudofeces, making it available in a more concentrated form to deposit feeders (Odum, 1970). Odum et al. (1969) determined that detritus particles in estuarine sediments can concentrate DDT at levels 100,000 times higher than in estuarine waters.

The use of DDT has been outlawed in the United States but other pesticides are used domestically that can affect marine life. The pesticide malathion, used in combating mosquitoes along the South Atlantic coast, has been shown to cause mortalities of brown and white shrimp after aerial application (Conte and Parker, 1975). Conte and Parker (1975) recommended that the application of malathion be made on adult mosquitoes and marine waters should not be sprayed. A study done in Texas by Chin and Allen (1957) examined the effects of another insecticide used in mosquito control. This insecticide (active ingredient: benzene hexachloride) was determined to be extremely toxic to _P. setiferus_ and _P. a. aztecus_ in laboratory experiments. Harder et al. (1980) examined the rainfall input of the pesticide toxaphene into a South Carolina estuary. They reported toxaphene washout into the estuary at concentrations greater than those reported to produce harmful effects in several species of fish and crustaceans in laboratory studies. Courtenay and Roberts (1973) have shown that toxaphene is toxic to _P. d. duorarum_ larvae in laboratory tests. They found a "significant interaction" at the nauplius, protozoea and mysis stages in temperature - toxaphene tests. A significant synergism of salinity and toxaphene was observed in the mysid stage. Bioassay work with mullet (Mugil cephalus) and spot (Leiostomus xanthurus) indicates that an environmentally-altered form of toxaphene is apparently just as toxic as the parent compound (H. W. Harder, Univ. of S. C., Columbia, S.C., pers. comm).

More dramatic effects of pesticide poisoning have been observed in some South Carolina tidal creeks. Several large white shrimp kills occurred during the 1970's as a result of application of methyl parathion and toxaphene to adjacent soybean fields (C. M. Bearden, S.C. Wildl. Mar. Res. Dept.; Charleston, S.C., pers. comm). More recently, several localized fish kills have occurred presumably as a result of pesticide-laden rainfall runoff from adjacent tomato fields (C. R. Richter, S.C. Wildl. Mar. Res. Dept., Charleston, S. C.; pers. comm.). At present, one can only speculate as to the ultimate impact of pesticides on shrimp stocks and other marine organisms, but it is obvious that these chemicals should be closely monitored and controlled.

6.3 Habitat Areas of Particular Concern

Of the many habitats occupied by penaeid shrimp, the estuarine tidal creeks and salt marshes are perhaps the most important. These areas provide abundant food and shelter during a major growth phase of the shrimp's life cycle. As discussed in Section 5.1.5, size of shrimp upon reaching the commercial shrimping grounds appears to be dependent on density of individuals. It is likely then, that a major limiting factor in shrimp growth is the availability of nursery habitat. If this assumption is true, then during years of high shrimp abundance there is already not enough habitat for maximum shrimp production (biomass). To maintain present production levels and maximum future production, the remaining saltwater marsh habitat must be protected.

It is well known that shrimp are capable of occupying and flourishing in estuaries with a wide range of salinites. Optimal salinities for juvenile brown and white shrimp, however, seem to be from about 5 ppt to 20 ppt and and slightly higher for pink shrimp. With regard to these optimal conditions, man-made alterations in river discharge can have significant effects on shrimp production. Increases or decreases in freshwater flow into estuarine waters can result in changes in shrimp species composition and potentially retard growth rates. During the drought of 1980 along the eastern coast of the United States, salinities in coastal rivers and creeks were much higher than normal. As a result shrimp were found further inland than usual (J. D. Whitaker, S. C. Wildl. Mar. Res. Dept., Charleston, S.C., unpubl. data; S. Shipman, Ga. Dept. Nat. Res., Brunswick, GA.; pers. comm.; D. Spitzbergen, N.C. Dept. Nat. Res. and Comm. Dev., Morehead City, N.C., pers. comm.). With higher than normal salinities in "inside" waters, shrimp residency times may be lengthened and increased natural mortality may result in fewer shrimp moving to commercial trawling grounds. On the other hand, a large increase in freshwater flow into an estuarine system can reduce salinities to less than optimal levels resulting in less available nursery habitat and perhaps forcing shrimp offshore prematurely.

An example of man's altering of freshwater flow into an estuary is the Santee-Cooper rediversion project in South Carolina. Shealy and Bishop (1979) examined this project and speculated on the possible effects on shrimp. Water will be diverted from the Cooper River to the Santee River and salinity of Charleston Harbor water, which is fed in part by the Cooper River, may increase causing displacement of low-salinity nursery grounds. There may be a decrease in white shrimp production per unit area and an increase in brown shrimp production. Opposite trends in the Santee River estuaries may occur.

Trawling grounds where shrimp are seasonally abundant must also be protected. Open-ocean dumping of dredge spoil can result in shrimp gill erosion and should not be done in shrimp trawling grounds when shrimp are abundant. Dumping should also be avoided during the spawning season because the demersal eggs could be smoothered and destroyed by dredge spoil. Another consideration is the alteration of bottom contours and substrate composition by dredge spoil so as to make trawling hazardous or impossible.

Dredging of nearshore bottoms to provide deepwater port capabilities may also have a negative impact on shrimp. Channels dredged to 10.7-16.8 m (35-55 ft) or more from estuaries to equally deep ocean bottom can require channels extending more than 16.9 km (10 mi) from shore. These deep channels could direct shrimp further offshore than normal. A biological consequence, could be the displacement of white shrimp spawners with a resultant decrease in recruitment of postlarvae to the estuary. Impacts on the fishery may be higher fuel expenditures to reach trawling grounds and crowding of fishing trawlers and other commercial vessels in the ship channel.

6.4 Habitat Protection Programs

North Carolina, South Carolina, Georgia, and Florida have all adopted programs through legislation to protect the coastal marshes. Generally, all alterations of land or water at or below the mean high tide mark must be reviewed and approved before work can begin. Because the protection programs vary from state to state, each state is presented separately.

6.4.1 North Carolina

Department of Natural Resources and Community Development regulation defines and protects nursery areas in North Carolina. "Nursery areas are defined as those areas, in which for reasons such as food, cover, bottom types, salinity, temperature and other factors, young finfish and crustaceans spend the major portions of their initial growing season." Bottom disturbing fishing gears, trawls and dredges are prohibited in nursery areas and excavation and/or filling activities are "severely restricted or prohibited."

The North Carolina Coastal Area Management Act charges the Coastal Resources Commission (CRC) with the responsibility for identifying types of areas in which uncontrolled or incompatible development might result in irreversible damage to the water or land. The Act also directs the CRC to operate a permit program to control inappropriate or damaging development activities within areas of environmental concern. Individuals proposing "minor development" in an area of environmental concern are required to obtain a permit from a local permit officer, while individuals proposing "major development" activities must obtain a permit directly from the CRC. Use standards provide guidance for development in such a way as to avoid damaging sensitive areas such as primary nurseries.

6.4.2 South Carolina

Act 123 of 1977 was enacted by the General Assembly of South Carolina to provide for the protection and enchancement of the State's coastal resources (South Carolina Coastal Council, 1981). The Act created the South Carolina Coastal Council which has the duty of "encouraging the protection and sound development of coastal resources." The Act gives the Council the direct state authority to deny or issue permits in the critical areas defined in the Act. The South Carolina Wildlife and Marine Resources Department as well as all other state agencies submits comments and recommendations to the South Carolina Coastal Council which makes the State's official ruling.

6.4.3 Georgia

The Coastal Marshlands Protection Act of 1970 requires that anyone who seeks to remove, fill, dredge or drain or otherwise alter any marshlands within an estuarine area must obtain a permit from the Coastal Marshlands Protection Committee. The Coastal Management Act of 1978 created the Georgia Coastal Management Board which administers public and private funding to carry out provisions of the Act and the federal Coastal Zone Management Act, administer and enforce the provision of the Act, coordinate public participation in development of policies to be administered pursuant to the Act and perform any act necessary to carry out the provisions of the Act. The Act gives the CMB the duty of recommending, to local governments, standards and guidelines for wise use of land and water resources of the coastal zone. Also, the state's

Shore Assistance Act of 1979 is designated to conserve the dynamic dune fields, beaches, and offshore bars. These vital areas are subject to a state permit process for any alteration of the topography or vegetation.

The Coastal Fisheries, Coastal Protection and Coastal Management Sections of Georgia's Department of Natural Resources have several goals pursuant to conservation of Georgia's coastal zone. These goals include monitoring of coastal resources, performing research projects relative to the coastal zone, regulation of marshland and shoreland alteration and public education.

6.4.4 Florida

The Florida Department of Environmental Regulation (DER) has primary responsibility for protecting Florida's coastal zone. A permit from DER must be obtained before any non-exempt alterations can be made in coastal marshlands. Dredging and filling activities in "bays, bayous, sounds, estuaries, and natural tributaries thereto" require a DER permit. Before issuance of a permit, a biological survey, ecological survey, and hydrographic survey (if deemed necessary by DER) must be made with reference to the effects of the activity upon fish, wildlife and other natural resources. Less extensive surveys may be prepared in evaluating "minor" projects.

Each state in the South Atlantic has guidelines for evaluating proposed wetland alterations. These guidelines are similar for each state and some alteration activities addressed include docks and piers; bulkheads and seawalls; jetties and groins; cables, pipelines and transmission lines; marina location and design; transportation; dredging and filling; navigation channels and access channels; deposition of dredged materials; sewage lagoons and impoundments; marsh impoundments for recreational and/or commercial activities; development activities on barrier islands and coastal dunes and non-water dependent structures.

The Rivers and Harbors Act of 1899 and Section 404 of the Federal Water Pollution Control Act of 1977 give federal permitting responsibility to the United States Army Corps of Engineers. A permit from the Corps of Engineers is required for any type of construction or other alteration in navigable waters of the United States, including all coastal waters and contiguous or adjacent wetlands of the United States (Bara et al., 1977). The National Marine Fisheries Service and the United States Fish and Wildlife Service also review and comment on wetland alterations that may affect resources for which they have responsibility. The Environmental Protection Agency regulates discharge of effluents and the Federal Water Pollution Control Act and amendments of 1972 (33 U.S.C. 1251-1376) require states and regions to plan for land use to control location of new sources of pollution.

The National Ocean Pollution Research and Development and Monitoring Planning Act of 1978 (P.L. 95-273) designates NOAA as lead agency in developing a plan for a program relating to ocean pollution research, development, and monitoring.

7.0 FISHERY MANAGEMENT JURISDICTION, LAWS AND POLICIES

7.1 Management Institutions

Management of the shrimp fishery in the four Southeastern Atlantic States has traditionally been based on State and local laws and regulations. These laws and regulations are generally designed to control seasons, fishing areas, and the size of shrimp that can be caught. These regulations are based upon biological (protection of juveniles, nursery areas, spawners, etc.), economic (maximum returns to fishermen) and socio-political considerations. Specific regulations concerning seasons, areas, gear, methods, licenses and taxes, reciprocal agreements, and reporting requirements exhibit variation from state to state, as do law enforcement systems and penalties for violations (Table 7-1).

Although all four states have provisions for adoption of rules and regulations pertaining to the shrimp fishery, in many instances existing statues or legislative and administrative procedures impede short term decision-making in critical situations. Of the four states included in this study, North Carolina currently has perhaps the most flexible administrative and regulatory system pertaining to shrimp management. The states of South Carolina, Georgia, and Florida all have limited flexibility in various aspects of shrimp management due to existing state and local statutes. At present, only South Carolina does not have legislative authority to enter reciprocal shrimp management agreement with the other States.

Enforcement and monitoring programs related to shrimp regulations also differ significantly among the four states. In some cases, specific law enforcement units exist under the direct control of the coastal management unit or division, while in others law enforcement sections are responsible for enforcing game and freshwater fisheries as well as coastal fisheries laws. Manpower, equipment, and other coastal law enforcement capabilities and needs also vary widely among the four states.

Table 7-1 Summary of shrimp management laws and regulations, Southeastern Atlantic states.

LAWS OR REGULATORY MEASURE(S)	NORTH CAROLINA	SOUTH CAROLINA	GEORGIA	FLORIDA
I. Restrictions on Gear or Method				
A. General	Stop netting illegal.	Stop netting illegal.	Stop netting illegal.	Stop netting illegal.
B. Mesh Size, Minimum	Shrimp trawls - 1 1/2" stretched mesh. Channel nets and seines 1 1/4" stretched mesh.	Seines - 1" stretched Channel Nets - 1 1/2" stretched.	Seines under 12' 1" Stretched; up to 100 ft. - 1 1/4" stretched.	No statewide provisions. County laws vary.
C. Net Restrictions				
(1) Channel Nets	Legal most areas (120' max. width).	Legal, by permit (80' max. width).	No provisions - illegal, inside waters.	No provision, illegal in most inside waters.
(2) Seines	Legal, all waters (no max. size, commercial).	Legal, all waters year round (40' max. length).	Legal, inside waters; (>12')' ocean beaches (up to 100').	Legal only in certain areas with size restrictions.
(3) Cast Nets	Legal, all waters year round	Legal, all waters year round.	Legal, all waters year round.	Legal in most inside waters; size restrictions in some counties.
(4) Dip or drop nets, bridge nets.	Legal, all waters.	Legal all waters year round.	No provisions.	Legal in most areas.
(5) Butterfly, float nets.	Permit required.	Legal only in permitted areas.	No provisions.	No provisions.
(6) Shrimp Trawls	Legal in open areas (no restrictions, except mesh size).	Legal in open areas (no size restrictions).	Legal in open areas (size limit on bait trawls).	Legal in open areas (no size limits generally).
D. Catch Limits	None.	None.	Bait shrimp trawling, personal use.	Varies by County.

Table 7-1 (Continued)

LAWS OR REGULATORY MEASURE(S)	NORTH CAROLINA	SOUTH CAROLINA	GEORGIA	FLORIDA
II. Trawling Season(s)	Set by Department, and based on shrimp size.	Offshore - May 15 - Dec. 31, Sounds - Aug. 15 - Dec. 15 (Commission may open or close any area by discretion).	Offshore - June 1 - Dec. 31, provided count is 45 or above. Also may open in Jan., Feb. if count is below 50.	Set by Marine Resources Division based on shrimp count sampling.
III. Trawling Areas, Legal	Specified by regulation (legal in off-shore waters, most inside waters).	Six major sounds and bays, offshore waters only.	Offshore waters only in recent years.	Specific area designated as sanctuaries closed permanently to trawling.
IV. Shrimp Count Law (Minimum)	No provisions.	No provisions.	45/lb. heads-on (50/lb. Jan., Feb.)	70/lb. heads-off.
V. Bait Shrimp Trawling	No specific provisions for bait shrimping.	No specific provisions; trawling illegal in restricted areas.	Legal in most waters. Recreational - 10' trawl (max.). Commercial 20' trawl (Max.).	Legal in most waters, under restrictions and permit requirements. Push nets legal in some areas.
VI. Other	Trawling prohibited between one hour after sunset Sat. to one hour before sunset Sun.	Night trawling illegal 1/2 hr. after sunset to 1/2 hour before sunrise.	Night trawling illegal, 8 P.M. to 5 A.M. EST. (9 P.M. and 6 P.M., EDT).	Night shrimping unlawful except during June - August.

All four States have coastal zone management units concerned with the protection of estuarine and wetland habitat (shrimp nursery areas). In North Carolina, Georgia and Florida, the same natural resource agencies that have shrimp fishery management responsibilities also have coastal zone management (including permitting) authority.

The following is a summarization of existing shrimp management systems in each state.

7.1.1 North Carolina

The organizational unit responsible for management and regulation of marine and estuarine resources in North Carolina is the Department of Natural Resources and Community Development. The Department's Division of Marine Fisheries is the organizational unit charged with coastal fisheries management functions. This Division is governed by the North Carolina Marine Fisheries Commission, which is responsible for the promulgation of rules and regulations. A Commercial and Sports Fisheries Advisory Committee functions in an advisory capacity to the Commission and the Division. The staff prepares suggested regulations and submits them to the Commission. The specific authority of the Division with respect to regulation of coastal fisheries is provided under Title 15, Chapter 3 of the North Carolina Administrative Code.

The North Carolina coastal shrimp management system is quite flexible, and most of the regulatory authority is under the Division, its Director, and the Commission. General statutes themselves deal primarily with licenses, taxes, record keeping, enforcement, and leasing procedures. All other matters, including opening or closing of seasons and areas to shrimping gear and equipment restrictions, and other aspects of shrimp management are controlled through regulations promulgated by the Division. North Carolina G.S. 113-133 abolished local coastal fishing laws, although there are some regulations promulgated which deal with the restriction of shrimping in specific areas of coastal waters.

The Law Enforcement Section of the North Carolina Marine Fisheries Division has fisheries inspectors in the coastal area who are primarily concerned with the enforcement of fisheries, dredge and fill, and state health laws.

7.1.2 South Carolina

In South Carolina, the Wildlife and Marine Resources Department is the agency having coastal fisheries management responsibility. The Department is governed by a nine-man board, the South Carolina Wildlife and Marine Resources Commission. The Department's Division of Marine Resources has jurisdiction over all saltwater fish, fishing and fisheries.

Coastal fisheries laws for South Carolina are contained in Chapter 17, Title 50, South Carolina Code of Laws, 1976 as amended. The Division is authorized to promulgate 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 legal trawling areas, gear restrictions, licenses and taxes, etc. The Division does have considerable flexibility in shrimp management insofar as control of the season in coastal waters is concerned, and any area where legal trawling is permitted may be opened or closed at any time to any type of commercial fishing activity.

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

7.1.3 Georgia

The Coastal Resources Division, Georgia Department of Natural Resources is the organizational unit primarily responsible for coastal fisheries management and enforcement. The Department is headed by a Commissioner and a 15 person Board of Natural Resources. As in South Carolina, much of the regulatory authorization of the Division related to shrimp management is specified by state legislation.

Georgia statutes pertaining to shrimp allow some flexibility in the opening and closing of seasons, based on eleven criteria of wildlife research and management established under State law. Other aspects relating to vessel licenses, gear restrictions, etc. are specified by statute. The Board has the authority to promulgate regulations pertaining to coastal fisheries not contrary to existing statutes.

The Law Enforcement Section of the Department has enforcement powers pertaining to all game, freshwater fishing, coastal fishing, dredge and fill, boating, and water quality laws in the state.

7.1.4 Florida (East Coast)

In Florida, the Department of Natural Resources is charged with the administration, supervision, development, and conservation of all natural resources. The Marine Resources Division of the Department is specifically responsible for the management of coastal fisheries resources, including shrimp.

Legislation pertaining to the shrimp fishery is contained in Chapters 370 of the Florida Statutes Annotated, and in Chapter 16B of the Florida Administrative Code (Regulations). General statutes include provision for licenses and taxes, enforcement, gear restrictions, and the regulation of fisheries for various species such as shrimp. Administrative regulations may be promulgated by the Department to implement, interpret, or make specific the statutory requirements concerning various species. These regulations require review by a legislative committee. Generally, the shrimp management system in Florida, as set forth in the statutes, is relatively inflexible, and allows for limited regulatory authority through administrative discretion. The Florida Legislature has also adopted numerous local laws which regulate shrimping in various counties.

The Department's Bureau of Law Enforcement, the Marine Patrol, is the organizational unit responsible for the enforcement of saltwater fisheries laws and regulations. The Marine Patrol is also responsible for the enforcement of boating, dredge and fill, water quality, and shellfish sanitation laws and regulations.

7.2 Summary of State and Local Laws, Regulations and Policies

7.2.1 North Carolina

a. Licenses and Taxes

Commercial Fishing Vessels

Without motors - $1.00

With motors, less than 18 ft length - $3.00

With motors, 18-26 ft length - $0.50/ft

With motors, 26 ft + in length - $0.75/ft

Non-resident, any length - $200.00

Shrimp Dealer and Individual Licenses - $10.00/year (shrimp dealer) Bait dealers may operate under this license, or a finfish dealers license.

Taxes on Shrimp Caught - Green, heads off - $0.15/100 lb or 0.10/100 lb, heads on

Shrimp Gear Licenses - None

Annual Licensing Period - January 1 - December 1

Record Keeping Requirements - G.S. 113-157 (e), 113-163 (applies primarily to seafood dealers).

b. Reciprocal Agreements

Sections 113-223 and 113-181 (N.C.G.S.) contain general provisions whereby the State of North Carolina may enter into reciprocal agreement concerning coastal fisheries matters. Under these statutes, the state has reciprocal agreement authority which would include practically any aspect of shrimp management in territorial waters. Section 113-161 also provided that such states accord similar privileges to North Carolina license holders. (Refer to North Carolina Marine Fisheries Regulation 15 NCAC 38-204 for additional information).

c. Regulations

Restrictions on Gear and Fishing Methods

Non-commercial shrimp gear is defined as seines less than 12 ft in length and dip nets.

Channel or stationary nets may not be used in any location where they might constitute a hazard to navigation, and cannot block more than two-thirds of any natural or man-made waterway. Channel nets used in coastal fishing waters for taking shrimp may not exceed 40 yards in length and must be properly buoyed and marked.

Mesh Size of Shrimp Nets

Minimum mesh size for shrimp nets is 1 1/2 in stretched mesh. Hand seines and fixed (channel) nets, float nets, and butterfly nets may have a minimum mesh size of 1 1/4 in stretch (such nets may not have an inner or outer liner of any mesh size). There are no minimum mesh size restrictions on cast nets.

Seasons, Areas, Etc.

No person shall take, attempt to take or possess aboard a vessel, shrimp taken by any method other than by a cast or fixed net, from the coastal waters of North Carolina:

(1) Between one hour after sunset on any Saturday and one hour before sunset on the following Sunday, except in the Atlantic Ocean.

(2) Between January 1 and the date upon which the season shall be opened by the Secretary.

(3) In specified closed sanctuary areas. Primary nursery areas are defined by regulation and closed at all times. Secondary nursery areas are open only after they have ceased to be or ceased to serve as such.

Opening and Closing Season

The Secretary, acting upon the advice of the Director may open or close the shrimp season in various waters based upon reasonable and prudent management of marine and estuarine resources. The season may be closed at any time upon 48 hour notice for the protection of undersized shrimp (this regulation does not apply to channel or fixed nets).

Bait Shrimping

North Carolina has no specific regulations on bait shrimping. License requirements and general provisions for shrimping apply, however. There is a 100 shrimp per person limit for a cast net used in closed shrimping areas, which tends to limit such activity to catching bait.

Miscellaneous

Other general regulations apply to the restrictions of nets and seasons in specific areas of North Carolina coastal waters.

d. Scientific Permits

Section 113-261, N.C.G.S.

e. Limited Entry

No privisions for limited entry are contained in N.C. fisheries laws or regulations.

7.2.2 South Carolina

a. Licenses and Taxes

Commercial Fishing Vessels

Resident shrimp trawler - $75.00

Non-resident shrimp trawler - $200.00

Commercial vessels under 18 ft - $2.50 (except for trawlers)

Commercial vessels in excess of 18 ft - $10.00 (except for trawlers)

<u>Shrimp Dealers and Individual Licenses</u>

Individual Commercial Shrimp License (Required of trawler captain) - $5.00

Shrimp Dealer's License - $20.00

Shrimp Processor's License - $100.00

Bait Dealer's License - $5.00

<u>Taxes on Shrimp caught in South Carolina</u>

None

<u>Shrimp Gear Licenses</u>

Channel Net - $5.00

<u>Annual Licensing Period</u>

July 1 - June 30

Record Keeping Requirements - Sections 50-5-120, 50-17-530, 50-17-1310, 50-17-2310

b. <u>Reciprocal Agreement</u>

There is currently no authorization in the South Carolina Code of Laws for the Department or Division to enter into reciprocal agreement with other states pertaining to shrimp management or licensing.

c. <u>Regulations</u>

It is unlawful to place or set 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.

<u>Shrimp Seines (Section 50-17-1020)</u>

Such seines may be used for commercial or personal use and cannot exceed 40 ft in length. A minimum mesh requirement of 1/2 in (nylon) or 9/16 in (cotton), square mesh, is provided. No restrictions exist on cast nets, drop nets, or dip nets for personal shrimping.

Channel Nets (Section 50-17-1020)

Maximum mouth width allowable for channel nets is 80 ft, and a mesh size no smaller than 3/4 in square mesh, may be used.

Seasons, Areas, Etc.

Trawling Seasons and Areas* (Section 50-17-1510, 50-17-1520)

Shoreline to three-mile limit: May 15 - December 21. Sounds and Bays: August 15 - December 15, except for Calibogue Sound (September 1 - November 1).

Trawling is restricted within one-quarter or one-half mile of the shoreline along most inhabited beaches during May 15 - September 15. It is also unlawful to trawl within one-half mile of any fishing pier in Horry County. All internal estuarine areas, except six sounds and bays are considered nursery areas and are off-limits to shrimp trawling.

Trawling is unlawful from one-half hour after official sunset until one-half hour before official sunrise in any legal state waters.

Bait Shrimp Regulations

South Carolina has no provisions for bait shrimp operations, other than the requirements for bait dealer's licenses. Cast nets, seines, drop nets and dip nets may be used to take bait shrimp in tidal creeks, rivers, or streams.

Miscellaneous Provisions

Any vessel operating in areas where trawling is closed is required to have trawl nets on board at all times. This makes it obvious to law enforcement that nets are not in the water. Legal trawling boundaries are specified in Article 11, South Carolina Code of Laws, 1962 as amended. Requirements for

---

*Section 50-17-1590 provides that the Commission may open or close any of the listed areas at any time, if it believes such action should be taken in the best interest of the State.

shrimp channel net permits are specified by rule and regulation. Persons 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.

d. Scientific Collection Permits (Section 50-17-70)

South Carolina Code of Laws, as amended.

e. Limited Entry

A limit of 100 channel net licenses was imposed by 1980 legislation.

7.2.3 Georgia

a. Licenses and Taxes

Commercial Vessels

Trawlers 18 ft and under - $50.00

Trawlers over 18 ft - $50.00 + $3.00/ft over 18' ft

Non-residents are charged at the above rates plus $25.00 per vessel. If non-residents home State charges a fee in excess of this amount, the non-resident must pay the same amount which his State would charge a Georgia resident.

A $5,000.00 cash or forfeiture bond must be filed by each shrimp boat license applicant.

Individual and Dealer Licenses

Personal Commercial License (Resident) - $10.25

Personal Commercial License (Non-resident) - $100.25

Wholesale Fish Dealer - $50.00 (Dept. of Agriculture)

Sport Bait Shrimp Trawling - $5.00 resident, $75.00 non-resident

Commercial Bait Shrimp Trawling - $2.00 resident, $5.00 non-resident

Taxes on Shrimp Caught - None

Annual Licensing Period - April 1 - March 31

Shrimp Gear Licenses - None

Record Keeping Requirements - Sections 45-217; 45-218.1

b. Reciprocal Agreements - Section 45-114 (9) provides that the Board of Natural Resources may enter into cooperative agreements with educational institutions and federal, state and other agencies to promote wildlife management and conservation. This section apparently provides broad authority to enter into reciprocal agreement.

c. Regulations

Restrictions on Gear and Fishing Methods

Cast nets and bait shrimp trawls of less than 20' may be used for taking shrimp in tidal creeks, streams and rivers. Seines of twelve feet or less and a maximum mesh of 1-inch stretched may be used in any saltwaters. Seines up to 100 feet in length with a mesh of no less than 1 1/4 inches may be used on certain ocean beaches. No restrictions or catch limits on cast nets, but shrimping areas cannot be baited.

Seasons, Areas, Etc.

Trawling Season (Section 45-905)

The shrimp trawling season in Georgia may be opened by DNR from June 1 through December 31 provided the shrimp meet the eleven criteria of wildlife research and management which must be considered in making a decision to open or close the season. During January and February offshore waters may be opened based on the same criteria as above. Provision is also made that adequate sampling must be conducted to determine shrimp count sizes. Actions must be taken in accordance with current sound wildlife research and management principles, and 24 hour notice is required.

Trawling Hours

Commercial food shrimping legal only between 5 A.M. EST (6 A.M. EDT) and 8 P.M. EST (9 P.M. EDT).

Bait Shrimp Regulations (Section 45-935, 45-935.1)

Any person may at any time and in areas specified for such purpose use a power-drawn net not exceeding 10 ft across the mouth, for the purpose of taking shrimp to be used for live bait for personal use. Catch is limited to two quarts of shrimp per person, or four quarts per boat at any time (4 quarts per person and 8 quarts per any 24 hour period).

Any person engaged in commercial bait shrimping must own or be employed by an established bait dealership in Georgia, and must post a $1,000 bond and obtain the necessary licenses required by law. Qualified persons so licensed may use trawl nets not larger than 20 ft across the mouth for taking live bait for sale in state waters.

Miscellaneous (45-903(3))

The Department has the power to close any area in the tidal or saltwater areas of the state to commercial shrimping in the event of disaster or emergency situations.

d. Scientific Collection Permits (Georgia Statute 45.208)

e. Limited Entry

Sections 45-114(3) and 45-101.1 in the absence of any constitutional impediments, would apparently provide for the establishment of a system of limited entry.

7.2.4 Florida

a. Licenses and Taxes

Motor Boats (Includes shrimp vessels)

Class A-1 - (less than 12 ft) - $2.50

Class A-2 - 12-16 ft - $6.50

Class 1 - 16-26 ft - $11.50

Class 2 - 26-40 ft - $31.50

Class 3 - 40-65 ft - $51.50

Class 4 - 65-110 ft - $61.50

Class 5 - 110' + - $76.00

(Non resident fee - $50.00 in addition to above).

Individual and Dealer Licenses

Resident Wholesale - $100.00

Non-resident Wholesale - $150.00

Alien Wholesale - $500.00

Resident Retail - $10.00

Non-resident Retail - $25.00

Alien Retail - $50.00

Alien and Non-resident Commercial Fisherman's Licenses - $25.00

Shrimp fishery permits are required by the Director which specify the type of gear to be used in different sections of open areas.

Taxes on Shrimp Caught - None

Annual Licensing Period - July 1 - June 30

Shrimp Gear License - None

Record Keeping Requirements - Section 370.061(5)

b. Reciprocal Agreements

Section 370.18 pertains to access to fishery resources, specifically shrimp and prawn. Provision is made whereby the citizens of Florida may be permitted to catch shrimp or prawn from the waters under the jurisdiction of other states upon similar agreements to allow non-residents to fish or catch seafood in Florida.

c. Regulations

Restrictions on Gear and Fishing Methods

Florida has numerous county (local) laws pertaining to area and type of gear which can be used for taking shrimp. Statewide, it is unlawful to obstruct any tidal waterway with a seine, net, or other device except gill nets, to prevent the free passage of fish (370.08). Shrimp traps are restricted as to size and construction (370.08(2)).

Seasons, Areas, Etc.

Trawling Season and Areas

Generally, the shrimping season is controlled by the Department under the provisions of Sections 370.15, 370.151, 370.153, and 370.156. No specific dates are set for statewide seasons, with areas being opened or closed according to shrimp count size, as determined by sampling by the Marine Resources Division. Certain areas are closed to commercial trawling at all times.

Night Shrimping

It is unlawful to catch or attempt to catch shrimp or prawn in any county bordering on the Atlantic Ocean of Florida at night by trawling, except during the months of June, July and August.

Bait Shrimping

Live bait shrimping, including trawling, is legal in most of the territorial waters of Florida's east coast. Permits are required for bait shrimping from the Division which may specify the type of equipment necessary to catch and maintain shrimp alive after capture, as well as requirements for handling, transporting and marketing. In some counties, a license fee is required and size of trawls, restricted areas, etc. are defined. Bait shrimp permits for pleasure fishermen are specified by regulation on a county basis.

Specific areas in coastal waters are designated as sanctuaries or nursery areas and are closed permanently to shrimp trawling. In most inland waters (tidal creeks, estuaries), only cast nets or bait shrimping is allowed.

Shrimp Catch Regulations

It is illegal to have in possession on board any vessel or in any place of business small shrimp in excess of 5 percent of the total poundage. Small shrimp or prawn are defined as those requiring more than 47 heads-on

(70 count, heads-off) to make one pound. Random sampling is done to determine the percentage of small shrimp in the catch (Section 380.15(2)).

d. Scientific Collection Permits (G.S. 380.10)

e. Limited Entry

No precedents for limited entry have been established and there are no specific legislative provisions for same in Florida saltwater fisheries laws.

7.3 International Treaties and Agreements

Currently there is no foreign fishery for shrimp in State waters or in the U.S. Fishery Conservation Zone of the Southeastern Atlantic region. In the future, any shrimp management plan developed by the South Atlantic Fishery Management Council would probably consider access to foreign fishing only if an available surplus of shrimp in excess of U.S. harvesting capacity existed and a GIFA were in effect with the respective country involved.

7.4 Federal Laws, Regulations and Policies

The Magnuson Fishery Conservation and Management Act of 1976 (PL 94-265) as amended, defines specific procedures for the management of fisheries within the FCZ. Prior to the enactment of this law, there was no legal mechanism for the management of shrimp stocks in waters beyond the States' territorial seas.

The MFCMA provides for exclusive United States management authority over the fishery resources within a Fishery Conservation Zone extending from the seaward boundary of the States' territorial sea (three nautical miles) to a point 200 miles from shore. Responsibility for developing fishery management plans for the South Atlantic is vested in the South Atlantic Fishery Managment Council; implementation and enforcement of any regulations pertinent to the management of fisheries within the Fisheries Conservation Zone are the responsibility of the Secretary of Commerce and Secretary of the Department wherein the U.S. Coast Guard is located.

Successful implementation of any future shrimp management plan will require unity of purpose between Federal regulations and those of the four Southeastern Atlantic states.

In addition to the FCMA, the following Federal legislation would be applicable to a shrimp management plan for the Southeastern Atlantic:

1) The Coastal Zone Management Act of 1972, as amended, provides for planning and management of coastal areas.

2) National Wildlife Refuges and National Seashores are regulated by the National Park Service, Department of the Interior.

3) The Marine Protection, Research and Sanctuaries Act of 1972 provides the authority to regulate dumping of all types of materials into ocean waters.

4) The Outer Continental Shelf Lands Act (OCS Lands Act) allows the exploration and development of mineral resources located on the shelf. Shrimping under a FMP could be affected due to the loss of trawlable areas resulting from structures necessary for petroleum development.

5) Amendments to the OCS Lands Act created an offshore Oil Spill Pollution Fund. Owners and operators of offshore facilities and of vessels transporting oil from such facilities will be required to comply with and maintain evidence of financial responsibility and to pay for damages caused by them up to certain limits.

6) The Federal Water Pollution Control Act as amended by the Clean Water Act of 1977 represents a significant increase in the Federal regulatory effort to prevent discharges of pollutants into the nation's waters. The Corps of Engineers is authorized to issue general permits for dredge and fill discharges which will have only minimal cumulative adverse effects on the environment. The Environmental Protection Agency has supervisory authority over states' dredge and fill permit programs under the National Pollutant Discharge Elimination System.

7) The Marine Mammal Protection Act of 1972 provides for the conservation and protection of marine mammals.

8) The Endangered Species Act of 1973 provides for the conservation of endangered and threatened species, including sea turtles, which may be caught in shrimp otter trawls.

8.0 DESCRIPTION OF FISHING ACTIVITIES AFFECTING THE STOCK COMPRISING THE MANAGEMENT UNIT

8.1 History of Exploitation

Although extensive commercial use of the shrimp resource was not made until after the first quarter of this century, it had been exploited to lesser degrees for many years prior. Unquestionably, coastal Indians caught shrimp as part of their food. Such subsistence shrimping activities were apparently learned through observation and experience and continued by European settlers. Records indicate the use of bow nets in the estuaries of North Carolina as early as 1709 (Maiolo and Still, 1981). During Colonial years, through the first half of the nineteenth century, and up through the War for Southern Independence, coastal residents were familiar with the fine taste of shrimp; however, due to limited transportation and little practical means of preservation, distribution of shrimp was restricted to local markets during limited seasons.

Although shrimp first became important commercially in the United States in California during 1869 (Maiolo and Still, 1981), it was not long thereafter that the fishery in the South Atlantic states reached commercial proportions. When the U.S. Bureau of Fisheries began compiling shrimp landings data in 1880, the four South Atlantic states produced 821,000 lb for market (Table 8-1). South Carolina was the leading producer in 1880, landing 630,000 lb. From its early beginning, the South Atlantic fishery has grown, as part of the most valuable fishery in the United States, to be valued at over 50 million dollars to fishermen annually and employing several thousand people.

The primary method of capture by the commercial industry, beginning in 1872 and lasting through the first decade of the twentieth century, was use of haul seines. Reaching up to 549 m (1,800 ft) in length and 4.3 m (14 ft) in depth with 12.7-292.1 mm (0.5-11.5 in) mesh, haul seines were labor intensive and inefficient and were limited as to the areas in which they could be worked. Cast nets up to 4.3 m

Table 8-1. Recorded commercial production of shrimp (thousands of pounds, heads-on) landed in each South Atlantic State, during 1880 through 1980. (Sources: 1880-1976 - Fishery Statistics of the U.S., 1965-1976; 1977-1978 Shrimp Landings, Annual Summary 1977,1978; 1979-1980 South Atlantic State/Federal Statistics Program.

	North Carolina	South Carolina	Georgia	Florida (East Coast)	Total
1880	63	630	56	72	821
1887	120	338	185	1	1
1888	124	359	191	2	1
1889	135	380	150	78	743
1890	144	372	162	66	744
1897	146	374	68	39	627
1902	84	370	344	3,013	3,811
1908	371	452	528	4,346	5,697
1918	940	55	5,793	8,868	15,656
1923	1,658	355	10,668	11,024	23,705
1927	1,276	1,657	12,280	14,779	29,992
1928	845	431	9,526	22,507	33,309
1929	897	288	12,378	17,266	30,829
1930	1,299	793	8,853	15,260	26,205
1931	338	2,635	5,471	17,050	25,494
1932	292	1,501	3,602	17,068	22,463
1934	2,564	1,801	6,843	14,753	25,961
1936	3,815	1,101	9,715	18,946	33,567
1937	4,184	1,201	9,504	12,547	27,436
1938	4,569	3,723	10,426	8,847	27,565
1939	4,811	4,090	10,802	7,982	27,685
1940	4,156	1,784	9,336	7,426	22,702
1945	10,614	4,696	16,392	11,879	43,581
1950	8,311	7,746	11,157	9,267	36,481
1951	8,200	3,730	7,608	8,233	27,771
1952	8,713	4,072	5,991	6,895	25,671
1953	14,645	5,086	7,535	5,667	32,933
1954	9,182	6,644	7,742	5,078	28,646
1955	10,324	6,918	7,161	4,136	28,539
1956	6,243	5,589	7,991	5,695	25,518
1957	7,933	6,690	8,788	5,179	28,590
1958	2,519	5,815	8,746	5,504	22,584
1959	6,378	7,515	7,602	4,511	26,006
1960	5,988	8,030	10,403	6,793	31,214
1961	3,016	3,907	6,810	6,016	19,749
1962	5,805	6,474	8,610	5,189	26,078
1963	3,374	2,201	5,448	4,506	15,529
1964	4,279	2,632	5,939	4,491	17,341
1965	5,416	6,795	8,585	5,395	26,191
1966	5,697	4,263	6,476	5,039	21,475
1967	4,919	4,088	6,657	4,933	20,597
1968*	4,616	6,333	8,536	4,800(4,793)	24,285(24,278)
1969	7,854	5,817	8,447	5,188	27,306
1970	5,054	4,951	5,996	4,606	20,607
1971	7,615	10,753	8,862	3,970	31,200
1972	5,563	8,085	7,258	4,341	25,247
1973	5,003	8,256	8,248	3,061	24,568

Table 8-1 (Continued)

	North Carolina	South Carolina	Georgia	Florida (East Coast)	Total
1974	8,440	7,429	7,230	3,992	27,091
1975	5,164	8,866	8,090	2,806	24,926
1976	6,643	8,653	7,772	3,040	26,108
1977*	5,600	4,338(4,283)	4,595	3,546	18,079(18,024)
1978*	2,961	5,083	5,517(5,671)	4,206	17,767(17,921)
1979	4,941	8,240	9,713	6,724	29,618
1980	9,823	7,214	8,394	7,638	33,069

Note - Rock shrimp and royal red shrimp poundages are included
*Disparity exists in Shrimp Landings data.

(14 ft) in diameter supplied a small portion of the commercial catch during that period.

In the 1890's, the otter trawl which had been developed from the beam trawl in England was introduced in New England. Along with newly developed power boats of the time it was a very effective fishing gear. While in use at Beaufort, North Carolina around 1912 to 1914 by the U.S. Bureau of Fisheries, the otter trawl's effectiveness was recognized by fishermen of the area. In 1913, apparently independently of the activities at Beaufort, Portuguese immigrants in Fernandina, Florida began using otter trawls to catch shrimp. By 1917, trawl nets revolutionized the shrimping industry and replaced haul seines as the standard shrimping gear for a number of reasons. Trawls required a lower initial cost and required fewer operators which increased catches and profits. Trawls could be utilized in a greater variety of areas, and time was not lost due to sets on low concentrations of shrimp. By 1940, seines were no longer of commercial significance, but were used in smaller versions to catch bait. Modified otter trawls known as set or channel nets were developed in North Carolina in the late 1930's.

Shrimp catches in the Gulf and South Atlantic States increased dramatically after introduction of the trawl. Production steadily rose from 18 million lb in 1908 to 48 million lb in 1918 of which the South Atlantic region produced over 15 million lb. The South Atlantic catch was 33 million lb in 1928 and during the period of 1923 to 1928, production probably reached a level which approximated maximum sustained yield of the resource. Economic conditions may have contributed to decreased landings through the early 1930's (Johnson and Lindner, 1934) but there were no subsequent periods of large increases in landings. Neither the geographic range of the fishery nor the efficiency of vessels and gear had reached their maximum by 1928, yet production has not substantially increased since. It would appear that the fishery's potential was reached by the late 1920's.

In 1931, the shrimp fishery was geographically continuous from Cape Canaveral, Florida to Charleston, South Carolina. Wilmington, North Carolina was the northernmost extent of commercial activity in 1880, and the fishery had reached Pamlico Sound by the 1920's. Nevertheless, North Carolina was considered the extreme extent of commercial abundance in 1931 and not of great importance (Johnson and Lindner, 1934). In South Carolina, the grounds were from Bulls Island to Tybee Roads and included the State's southern sounds. Fishing activity was fairly uniform along the entire coast of Georgia and was scattered between Fernandina and Cape Canaveral, Florida. It was estimated that the fishery in 1931 was composed of 95 percent common shrimp, later to be known as white shrimp, and 2.5 percent grooved (brown and pink) shrimp which were not distinguished as two species at the time. Employing 14,000 people, the Gulf and South Atlantic States shrimp fishery was the most important fishery in volume and value in the region and was sixth in volume and seventh in value nationally.

Most commercial shrimpers on the Atlantic coast in the early 1930's were natives of or recent emigrants from European maritime countries. From Cape Canaveral to Charleston many Portuguese and some Scandinavians and Italians traveled the coast following shrimp concentrations. From Georgetown, South Carolina northward local fishermen were dominant (Johnson and Lindner, 1934).

The 1931 fleet in the four Atlantic states and the Gulf coast of Florida consisted of 647 craft, most of which were less than five net tons (boats) and carried two-man crews. Those over five net tons (vessels) were known as the Florida-type, with decked over cabins forward and holds aft. Most were 12.1 to 18.3 m (40-60 ft) in length with bow peaks higher than the remaining deck which was a wide, flat work area aft of the cabin. All were rigged with a single trawl and either a mast and boom or an "A" frame and boom. Trawls were from 6.7-30.5 m (22-100 ft) wide at the mouth. Winches for net retrieval were powered by deck engines and were relatively common during the 1920's. Most were powered by gasoline; however, some operators had switched to diesel to cut fuel costs, but diesels were not common until after World War II. The trawlers carried ice unless they fished very close to port. The inshore fishery was executed for the most part by open skiffs pulling a single net retrieved either by hand or winch. Shrimp trawlers in the South Atlantic states were owned by individuals or by packing plants.

Monthly landings data in 1931 reveal that the peak shrimping season in North Carlina was August and September, when 88 percent of the catch was made. South Carolina's season was September through November with 85 percent taken, while shrimpers in Georgia took 61 percent during those months. No monthly data were recorded in Florida. Summer and fall catches consisted of immature shrimp spawned the preceding spring. Preparation of shrimp products for market employed about 2,755 people in the four states including the west coast of Florida. Of those, 89 were proprietors, 38 were salaried, and 2,628 received wages (Johnson and Lindner, 1934). The largest portion of the shrimp catch reached canneries during the 1920's and early 1930's. The number of shrimp canneries on the Atlantic coast reached a maximum of 27 in 1925 when 5.7 million lb (whole weight) were processed. Maximum canning production, however, was reached in 1930 by only 20 canneries processing 12.9 million lb. In 1930, there were one, four, six and nine canneries in North Carolina, South Carolina, Georgia and Florida (whole state), respectively. Cannery operators required large and steady supplies of shrimp and were, therefore, forced to move operations to areas of greatest abundance (Johnson and Lindner, 1934).

Trawler operators working for canneries supplied iced shrimp daily in baskets at the docks. In many cases heading (or de-heading) of shrimp was performed on board, thus resulting in the use of less ice and a higher price paid per pound. Shrimp were washed, weighed and if necessary headed upon reaching the dock. Dock headers received one-half to one cent per pound. At times of high abundance excess shrimp were retained overnight on ice, and it was learned that such shrimp were more easily peeled for the canning process. Only one dealer in 1931 had electric refrigeration (Johnson and Lindner, 1934).

The market for fresh headless shrimp was second to canning during the canneries' heyday. By procedures very similar to those followed today, fresh shrimp were headed, washed, chilled and packed into barrels with ice. Packers received 10 to 15 cents per hour, while more skilled laborers were paid 10-25 cents per hour. Hand grading by size was performed, but uncommonly. A portion of the catch was packaged in either fresh or frozen convenience packs. Fresh-cooked shrimp were prepared as for canning, hermetically sealed but not cooked further, and kept on ice. Use of shrimp waste products was minimal; relatively small amounts were utilized as fertilizer, fish bait, and shrimp meal. About 2.6 million lb of meal were sold in 1931, mostly to Germany as a feed mixture.

During the early 1930's, shrimp canning disappeared from North Carolina which had seen its first cannery in 1915. Virtually all of the State's landings reached the fresh shrimp market. During that time, South Carolina produced canned and fresh shrimp. Portions of landings made in Georgia and Florida were canned, sold fresh, pickeled, and packaged as fresh-cooked (Table 8-2). Lack of efficient transportation and preservation techniques were apparently responsible for the slow commercial growth of the shrimp fishery. One record reveals that shrimp were shipped out of North Carolina in 1878 (Maiolo and Still, 1981). About that time ice was being used for packing seafood but was scarce. Ice was at times shipped to southern States from frozen streams and stored for later use. During the early 1930's, comparable amounts of processed shrimp were shipped by rail and by water. Where available, railroads were utilized to transport fresh headless shrimp to northern markets and considerable quantities left Jacksonville, Florida by steamer. Refrigeration was not in use on board trawlers, transport vessels, railroads or trucks at that time. Refrigeration of shrimp holds on trawl-

Table 8-2. Types and amounts of shrimp products produced in the Southeastern States during 1931, with original whole weights shown as pounds and as percentages of the region's landings (weights are in thousands of lb). (Source: Johnson and Lindner, 1934).

Type Product	Whole Weight	Percent	Product Weight
Canned	47,400	49	12,324
Fresh Headless	32,900	34	20,000
Sundried	11,200	12	1,344
Fresh/Frozen Packaged	3,500	5	2,085
Fresh Cooked	1,500	2	379

ers were introduced in the late 1940's in the Gulf. However, this has never been common on South Atlantic trawlers since they usually return to port each day.

By 1949, only two types of primary processing remained: canning and packing of fresh-headless shrimp for the fresh retail trade or further processing. The center of the canning operations was Georgia and northeastern Florida then; they had been operating intermittently for several years. Producers of fresh-headless shrimp, known as raw shrimp houses, received the major part of fishery production. A typical raw shrimp house of the day was a larger, unpartitioned structure over or near water with heading tables, washing vats, scales, ice crusher, and space for gear storage. These houses ranged from New Smyrna, Florida to Atlantic, North Carolina.

During the depression, low prices caused a general decrease in landings of shrimp, but otherwise there had been a general increase of landings from 1913 to 1928 and a leveling off thereafter (Johnson and Lindner, 1934). World War II had negative effects on fisheries in general because fishermen and vessels were removed from productive operation; personnel and material which otherwise would have been utilized in seafood processing industries were diverted to the war effort (Maiolo and Still, 1981). Conversely, the war had positive effects on the industry; the demand for seafood increased as it was one of the few food types which was not rationed. In 1943, a ceiling price was placed temporarily on shrimp by the Office of Price Administration (Maiolo and Still, 1981). There were downward fluctuations in shrimp landings during the war, though they are not well documented in the landings statistics. The shrimp fishery emerged from World War II over five times as valuable as it was at the War's beginning. The value to fishermen in the South Atlantic States increased from $754,000 in 1940 to nearly $4 million in 1945. After the war, interstate shipments of shrimp and shrimp products increased greatly. The use of frozen and other convenience products increased. As a result, shrimp and shrimp products became more available, and the markets became more stable and expansive. The fresh, raw, headless shrimp market, which supplied retailers and processors, continued to be a major primary outlet for shrimp. The ex-vessel value of the South Atlantic States' shrimp fishery continued to rise sharply; value increased from nearly $4 million in 1945 to over $10 million in 1950 (Anderson et al, 1949b). The combined fishery of the South Atlantic and Gulf of Mexico became the most valuable domestic U.S. fishery in 1952.

The fishery in the late 1940's as described by Anderson et al. (1949b) shows many similarities to the fishery of the early 1930's (Johnson and Lindner, 1934) but also reveals how little change has occurred in certain aspects of the fishery. In 1949, there were still no shrimp species composition data being collected. Many data for the east and the west coasts of Florida were not being reported separately, and no double rigged trawlers had been utilized by that time. Generally speaking, the operations of otter trawls, vessel types, and unloading and packing procedures at shrimp houses have changed little since 1949.

The geographic range of shrimping activities (Figure 8-1) increased during the years prior to 1949, particularly in North Carolina where expansion of the brown and pink shrimp fisheries had occurred. The northern-most extent of the fishery was at Beaufort/Morehead City with effort concentrated near the mouths of the Neuse and Newport Rivers, in Core and Pamlico Sounds, and disjunctly in coastal waters from Beaufort Inlet to Southport. In 1945 North Carolina unsuccessfully attempted to locate offshore shrimping grounds. A significant commercial shrimp fishery was developed in Pamlico Sound in 1948. North Carolina's peak season was August to November when 84 percent of the year's catch was made (Table 8-3). Fishing areas in South Carolina changed very little over the years. The coastal area from Little River to Cape Romain was generally not productive except for a small fleet from Georgetown working the Winyah Bay Entrance. Prin-

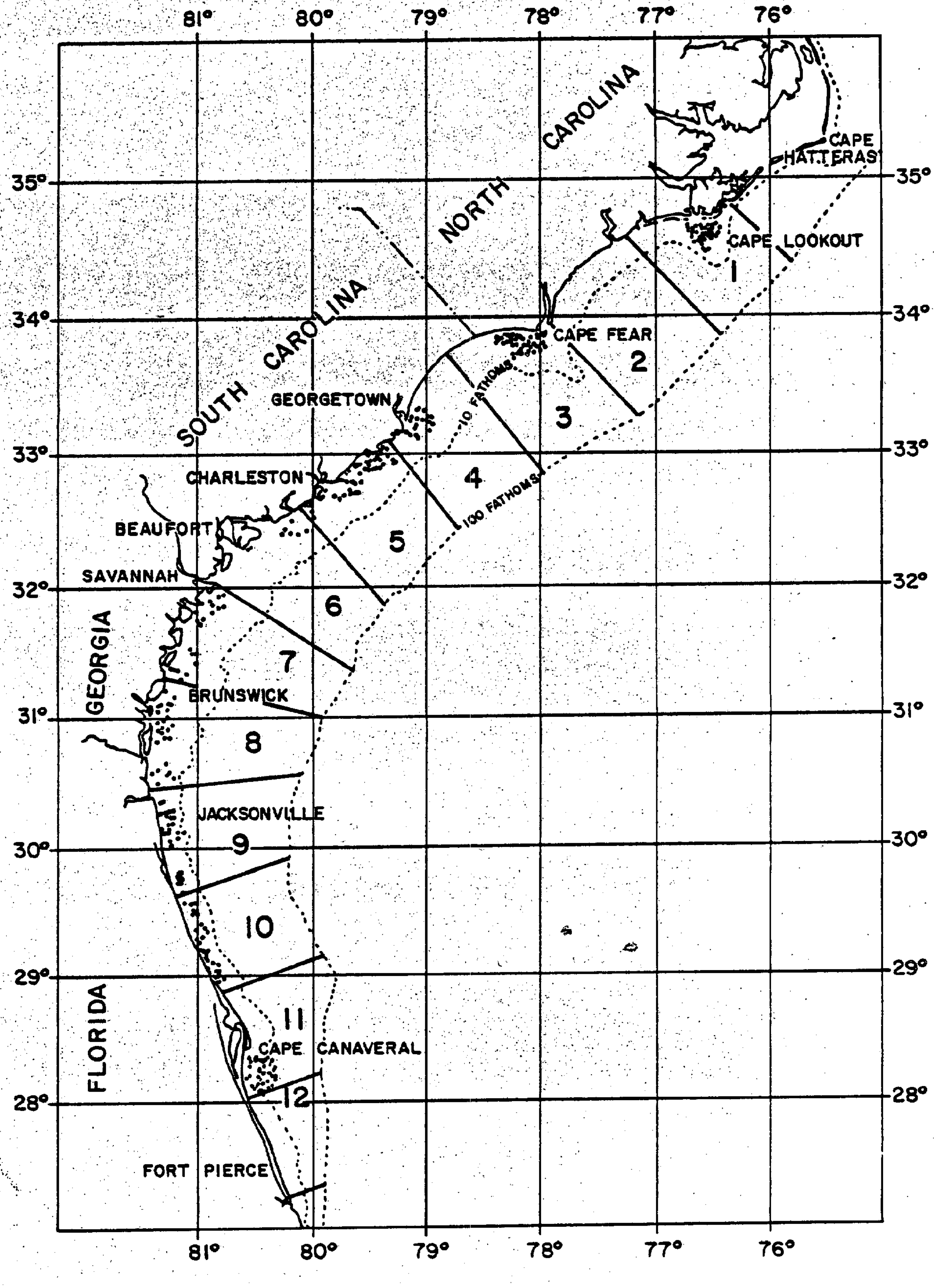


Figure 8-1. Geographic range of shrimp activities.

Table 8-3. Percentages of shrimp landings of each southern Atlantic state made during each month averaged from designated seasons. (Source: From Anderson, et al., 1949b).

Month	North Carolina (1941-1945)	South Carolina (1941-1944)	Georgia (1931-1935)	Florida* (1933-1934)
January	3.3	0.0	2.2	18.8
February	0.0	0.0	2.5	11.2
March	0.3	0.0	2.8	10.4
April	0.5	0.1	3.6	8.2
May	1.2	1.9	6.1	4.7
June	0.7	2.9	8.0	6.2
July	7.9	9.5	5.5	2.5
August	19.2	16.8	16.8	5.8
September	19.9	24.9	19.7	5.9
October	29.5	28.5	17.2	5.0
November	15.8	14.1	12.2	6.7
December	1.7	1.3	3.4	14.6

*Both Coasts of Florida combined.

cipal areas were from Bulls Bay to Tybee Roads at the Georgia State line. The most productive area was from Stono Inlet to Tybee Roads. The State's southern sounds were closed to shrimp trawling by State regulation. Eighty-four percent of the annual catch was made during August through November. The fishery in Georgia was more uniform geographically than in the other three states. Georgia's peak season also was August through November, when 66 percent of the catch was made. There was additional shrimping effort in the spring for adult spawners which did not occur in North or South Carolina. In Florida, trawling areas were continuous from Georgia to the St. Johns River and scattered to Ft. Pierce. South of that point, coral bottom prevented trawling. On the northeast coast of Florida, August through November is most productive for shrimp, whereas the peak season between St. Augustine and Cape Canaveral was December through March.

No species data were collected until 1957 and as a result no significant statement regarding the composition of prior catches can be made. Anderson et al, (1949b) stated that catches made in the Gulf and South Atlantic states probably were 96 percent common or white shrimp. The remainder were grooved shrimp, taken in late spring and early summer on the inside grounds. Burkenroad (1939) showed that grooved shrimp were actually three species, two of which (brown and pink) existed in commercial quantities along the southern coasts of North America (see Chapter 5.0). Collection of shrimp species data, beginning in 1957, revealed that white shrimp did not dominate the catch to such a great extent. The lack of species data prior to 1957 and paucity of landings data during the 1940's leave unanswered questions concerning the apparent significant decreases of white shrimp and concurrent increases of brown and pink shrimp, particularly in North Carolina waters. Partial explanation may be that brown and pink shrimp were not accepted by the market prior to 1946 when, with a decline in abundance of white shrimp, a market was developed (W. Anderson, Ga. Dept. Nat. Res., Brunswick, GA; pers. comm., in Calder et al., 1974). During the first five years of such detailed data collection, the species' average percentage of the catch in the South Atlantic states were as follows: white - 61 percent, brown - 32 percent, pink - 7 percent. White shrimp predominated until 1962 but were equaled by brown shrimp in 1962 through 1964. These variations in abundance can probably be attributed to the severe winters of those years.

Trawling vessels in the late 1940's were of two types. There were the small 9.1 to 13.7 m (30-45 ft) long vessels in nearshore coastal use. They were for the most part gasoline powered with a power winch and rope towline from an outrigger, an "A" frame, or a boom. The larger vessels were of the "Florida-type", 15.2 to 19.8 m (50-65 ft) long, and diesel powered. They had steel cables, drum hoists and single nets up to 36.6 m (120 ft) across the mouth which was pulled from an outrigger. Power-take-offs in the 1940's had largely replaced the separate deck engines used to retrieve trawl gear. The operation of the gear was nearly identical in offshore and inshore waters. The incorporation of try nets to locate concentrations of shrimp was made by offshore fishermen, but they were seldom used inshore. Today's fleet consists of trawlers which are quite mobile and distinctively designed relative to the various types of fishing (see Section 8.2.4).

8.2 Domestic Commercial and Recreational Fishing Activities

8.2.1 Participating User Groups

People participate in the shrimp fishery for subsistance, recreation, and income production. Portions of catches made by virtually any participant could be consumed by him or his family, but few fishermen shrimp solely for subsistance. The recreational shrimper may have consumption and income as well as sport for motivation, but motivation of the true commercial shrimper is income production.

Disregarding motivation, management agencies generally categorize participants as licensed commercial or non-licensed recreational depending upon the type gear used. This is with the exception of licensed sport bait trawl shrimpers in Georgia (Section 8.2.5.3) and the St. Johns River in Florida (Section 8.2.1.2). Table 8-4 shows the numbers of commercial fishermen in each southeastern Atlantic

Table 8-4. Number of commercial fishermen employing shrimp otter trawls in each South Atlantic State during each year, 1950 through 1978, with totals exclusive of duplication. (Source: 1950-1976 Fishery Statistics of the United States and 1977, 1978 - NMFS, Wash., D.C.).

Year	North Carolina	South Carolina	Georgia	Florida (east coast)	South Atlantic
1950	2,201	453	613	516	NP
1951	1,942	977	660	418	NP
1952	1,938	694	563	573	NP
1953	2,136	718	502	744	NP
1954	1,963	575	506	587	NP
1955	1,766	730	587	508	NP
1956	1,824	826	713	783	NP
1957	1,817	989	793	907	3,807
1958	1,380	951	1,096	1,080	3,723
1959	1,509	812	1,106	1,034	3,821
1960	1,575	819	953	982	3,667
1961	1,407	702	1,092	1,000	3,534
1962	1,410	740	1,177	889	3,569
1963	1,349	665	1,156	813	3,368
1964	1,361	503	1,104	676	3,119
1965	1,314	489	1,095	661	3,075
1966	1,313	442	1,079	697	3,099
1967	1,241	476	1,076	633	2,904
1968	1,126	633	1,139	612	2,957
1969	1,171	718	1,219	543	3,048
1970	1,326	642	1,003	527	3,004
1971	1,500	874	1,277	559	3,731
1972	1,638	938	1,231	491	2,988
1973	1,856	993	1,218	465	3,811
1974	1,878	1,164	1,406	392	3,283
1975	2,032	1,218	1,530	349	4,340
1976	2,011	1,162	1,562	429	4,456
1977	1,649	921	896	454	3,549
1978	1,345	1,221	1,005	549*	3,389*

*Florida and therefore South Atlantic figures are estimated

NP - not published

state for each year (1950-1978) employing otter trawls which were the only significant commercial gear. These figures are minimum since recreational and commercial harvestors, who did not sell to established dealers, are not included.

8.2.1.1 Commercial

In North Carolina, vessels are licensed as commercial because of the fisherman's intention to utilize a commercial gear regardless of his motivation. In 1978, 15,888 fishing craft were licensed to catch shrimp. Of those, 5,574 fishermen identified themselves as part-time commercial and 2,941 as full-time commercial.

Maiolo (1981) found that full-time and part-time commercial shrimp captains in North Carolina ranged from 18 to 80 years old with a mean age of 49. Fifty-four percent had 12 or more years of education, but the average was just under 11 years. Nearly 90 percent were married. Eighty-one percent were born and raised in coastal North Carolina, and 65 percent had fathers with fishing experience. Eighty-nine percent are sole owners of their primary craft. Maiolo (1981) compiled additional detailed data on both full-time and part-time shrimpers. In his sampling of crew members in North Carolina he observed that 83 percent of crew members considered themselves full-time. Their average age was 27, and their average education was 11 years. Fifty-two percent were married, and 90 percent were native North Carolinians. Fifty-three percent had fathers who were or had been involved in fishing; ninety-five percent owned a boat.

Theiling (1977) found that of the 833 licensed resident trawler owners during 1976 in South Carolina, 63 (8 percent) were both commercial and recreational shrimpers and that 366 (44 percent) were strictly commercial. Ninety (11 percent) did not shrimp (although they were licensed) and 64 (8 percent) license holders did not respond to the survey. Six hundred and twenty-two (75 percent) resident trawlers were owner-operated and 211 (25 percent) were non-owner-operated. Twenty-six South Carolina counties were represented by trawler owners.

Of 1,263 licensed, resident captains that year, 178 were Negro, 1,068 were Caucasian and 16 were of other or undetermined race. Overall average age was 36 years.

In the 1979-80 season, 1,240 licenses to trawl for shrimp for food were listed in Georgia to residents and non-residents, while 1,360 were issued in 1980-81. It was not determined how many of those were actually recreational shrimpers. Also, an undetermined number of shrimpers, who fish outside territorial waters, did not purchase licenses. Of 426 resident captains on Coast Guard documented trawlers, 343 (80.5 percent) were full time and 83 (19.5 percent) were part time. There are no data on the number of cast netters and seiners who sell their catches (S. Shipman, Ga. Dept. of Nat. Res., Coastal Res. Div., Brunswick, GA; pers. comm.). The designation of commercial bait shrimper was used by the Georgia Department of Natural Resources to identify 74 shrimpers allowed to trawl inshore for bait shrimp for sale during the 1980 season.

8.2.1.2 Recreational

Because recreational shrimpers are not licensed unless they utilize commercial gear it is very difficult to determine how many people are involved. The states have attempted a variety of methods to estimate their numbers. Cupka and McKenzie (1974) determined that 43.7 percent (16,780) of boat owners registered in eleven eastern counties of South Carolina had shrimped for recreational purposes during 1973 with non-licensed gear. Roughly two-thirds utilized cast nets primarily, and one-third used seines or drop nets. The sample consisted only of non-licensed shrimpers. Recreational trawlers, which required a license, were not considered. Theiling (1977) estimated that 250 (30 percent) of South Carolina's 833 licensed resident trawler owners in 1976 considered themselves to be strictly recreational and 63 (8 percent) were both commercial and recreational shrimpers. Recreational use of trawls and non-licensed gear has increased considerably since those surveys (D. Theiling, S.C. Mar. Res. Center., Chas., SC; pers. observ.).

When given the choice of designating themselves as pleasure, part-time commercial, or full-time commercial fishermen 7,373 (46 percent) of the 15,888 shrimping craft owners licensed in North Carolina during 1978 chose the pleasure category. It is assumed that virtually all utilized trawls (D. Spitsbergen, N.C. Div. of Nat. Res. and Comm. Devl., Div. of Marine Fisheries, Morehead City, NC; pers. comm.).

The 1,455 non-commercial recreational bait shrimpers licensed in Georgia during 1980 season were considered recreational (See Section 8.2.5). There are no estimates of the number of shrimpers utilizing either non-licensed recreational gear or licensed trawls in offshore waters (S. Shipman, Ga. Dept. Nat. Res., Coastal Res. Div., Brunswick, GA; pers. comm.).

The only quantitative data for the northeast coast of Florida on recreational participants is the number of non-commercial licenses allowed for trawlers in the St. Johns's River, 127 in 1980-81. It was expected that some of these licenses were being used illegally for commercial purposes (F. Kennedy, Fl. Dept. Nat. Res., Marine Res. Lab., St. Petersburg, FL; pers. comm.). In the six county area of northeast Florida, recreational trawl fishermen are allowed to trawl in offshore waters on the week-ends and take up to 50 lb per day. There are no available estimates of the number of weekend trawl fishermen or the number of recreational gear users which include cast netters, pushnetters and seiners.

8.2.2 Catches and Landings

8.2.2.1 Seasons

Availability of shrimp and effort to catch them is seasonal in the four state area. Seasonality is governed by the inherent life cycles of the species and by environmental influences on reproduction, growth, and migration. Fishing effort is also dependent on economics, weather, and conservation laws. In conformity with biological patterns, the shrimping season generally begins in spring and ends in December. May is usually the first month shrimp begin to appear offshore in commercial sizes and/or quantities. The peak shrimping season occurs

July through October after which activity and catch sizes drop off until the season ends. The various states have enacted statutes establishing or authorizing seasonal regulations to protect spawning stocks and small shrimp. Many times restraints are enacted which prevent, postpone or halt shrimping effort while commercial quantities or sizes are available.

Commercial quantities of shrimp appear in early spring in North Carolina when the overwintering populations (mostly pink shrimp begin a seaward migration). Pink shrimp constitute the first catches of the year and are usually available in late March or early April, although peak catches do not occur until mid-May. Opening dates for the shrimp seasons in North Carolina have varied, but since 1974, the season has been opened on January 1 to take advantage of the overwintering pink shrimp in Pamlico and Core Sounds. Purvis and McCoy (1972) indicated that late openings restrict utilization in North Carolina of the overwintering pink shrimp populations which migrate during early spring when water temperatures exceed 13°C (55°F). If these shrimp are not harvested before reaching the ocean they are possibly lost to the fishery.

The intensity of trawler activity in North Carolina during spring is largely dependent on size of the shrimp population. By mid-July, the season for brown shrimp is at a peak and continues until late fall, when the shrimp leave coastal waters. White shrimp occur in the fall harvest in the Southport/Cape Fear area but have not recently been significant elsewhere in North Carolina. During spring and summer, brown and pink shrimp are caught mostly at night; whites are taken during daylight in autumn. Core Sound is an exception in that all three species are caught only at night.

Commercial size shrimp usually first appear during April or May off the South Carolina coast. These are primarily overwintered white "roe" shrimp, congregating along the central coast and southward. The season usually opens in late spring on these adult shrimp, with the trawler fleet fishing them through June or early July. During mid-June, brown shrimp begin to occur in offshore waters, and support the fishery into early autumn. During the latter part of July or early August, the major sounds and bays have occasionally been opened to allow shrimping on large brown shrimp unless excessive numbers of small white shrimp are present. The white shrimp population begins to appear in offshore waters during late August and constitutes the bulk of the fishery through December. The greatest part of South Carolina's recreational effort (78 percent) and catch (86 percent) occurs during July through October (Cupka and McKenzie, 1974). Sounds and bays are normally opened in September through mid-December to allow harvest of white shrimp. Overall the annual statewide harvest of white shrimp exceeds that of brown shrimp. Pink shrimp occur in the catches but comprise a relatively insignificant part of the commercial catch.

The Georgia fishery also gets underway in the spring, usually late May or early June, when overwintering white shrimp move toward offshore waters. A relatively small brown shrimp population appears in July and August which trawlers harvest near the beaches. During late August a new crop of white shrimp enters the fishery and provides a major portion of Georgia's shrimp. Georgia's sounds have not been opened since 1977, but prior to that year they were opened during the fall white shrimp period.

In effect, the brown shrimp season in east Florida begins with the opening of legal night shrimping on June 1. As in Georgia and South Carolina, browns emigrated into the estuaries during the early spring.. During late August, brown shrimp catches are much reduced, and white shrimp, which account for the majority of east Florida landings, enter the fishery. They are available through December in northern Florida and as late as March in central Florida.

8.2.2.2 Commercial Catches and Landings

Although the terms catch and landings are often used interchangeably, there are specific differences. Catches are measurements of fishery production which may be related to qualitative data such as effort, fishing location, gear, price, species composition, and fishing capabilities information. Landings refer to measurements of fishery production associated with areas such as ports, counties, states, or regions and periods of time such as months, seasons, or years. Landings may be assigned values but normally are not assigned prices unless related to gear or effort information. Catches can be thought of as fishery products leaving the resource and landings as fishery products entering the market.

Commercial landings statistics apparently were not collected and published for the shrimp fishery until 1880 and then only sporadically until 1950. Species composition data were not collected until 1957 (Table 8-5). Detailed regional catch data were not collected until 1978 (Theiling, 1981).

North Carolina did not contribute greatly to the landings until 1934, (Table 8-1). Landings increased until 1940 and in 1945 over 10 million lb were taken. Unfortunately, the lack of landings data for the rest of the 1940's makes it impossible to document production for that period. This is particularly unfortunate because the abundance of white shrimp in North Carolina prior to 1940 appears to have been much greater than that reported for the period since 1957 (Table 8-6).

The apparent change in abundance of white shrimp in North Carolina is interesting because it suggests that competition may exist between brown and white shrimp in this area (W. Anderson, Ga. Dept. Nat. Res., Brunswick, GA; pers. comm., in Calder et al., 1974). Anderson's hypothesis is supported by the fact that although a severe cold spell in the 1939-40 winter decimated white shrimp in North Carolina, landings of shrimp in North Carolina during 1940 were almost normal. However, the catch consisted of "brownies" instead of white shrimp (Lindner and Anderson, 1956).

Shrimp catches peaked in North Carolina between 1950 and 1955. Apparently most landings during this period were brown and pink shrimp, although this is not known with certainty. Since 1956, landings have fluctuated about a mean level of roughly 4.8 million lb, with brown and pink shrimp predominating. With exception

Table 8-5. South Atlantic shrimp landings, (X 1000), of Penaeus species, 1957-1980. (Source: 1957 through 1978 - Shrimp Landings NMFS, NOAA; 1979 - South Atlantic State/Federal Statistics Program and TIMS, NMFS; 1980 - South Atlantic State/Federal Statistics Program).

	Heads-Off Total	(Heads-Off) Brown	(Heads-Off) Pink	(Heads-Off) White	Heads-On Totals
1957	16,952	6,050	1,348	9,554	26,611
1958	13,426	5,708	515	7,203	21,107
1959	15,476	5,860	1,289	8,327	24,321
1960	18,581	5,614	767	12,200	29,054
1961	11,755	1,550	1,092	9,113	18,277
1962	16,446	7,163	1,404	7,879	25,912
1963	9,816	4,749	346	4,720	15,469
1964	10,893	4,403	1,218	5,272	17,155
1965	16,689	5,047	1,055	10,587	26,118
1966	13,489	7,208	332	5,949	21,297
1967	13,023	4,956	987	7,079	20,460
1968	15,517	3,677	836	11,004	24,204
1969	17,368	5,323	1,061	10,984	27,183
1970	13,079	4,431	538	8,111	20,486
1971*	19,610(19,476)	6,065	1,197	12,348(12,214)	30,696(30,490
1972	16,093	4,798	493	10,802	25,149
1973	15,591	2,797	949	11,845	24,262
1974	16,897	6,887	1,324	8,685	26,581
1975	15,767	4,170	1,265	10,332	24,649
1976	16,460	5,995	1,134	9,331	25,836
1977	10,309	6,587	501	3,222	16,369
1978	10,127	4,101	340	5,686	15,903
1979	16,769	4,138	1,112	11,519	26,180
1980	18,548	8,306	984	9,258	29,204

*Disparity exists in 1971 Shrimp Landings data

Table 8-6. Penaeid shrimp landings (heads-off) by state and species, 1957-1980. (Source: 1957 through 1978 - Fishery Statistics of the U.S. and Shrimp Landings NMFS, NOAA; 1979 Florida - TIMS, NMFS; 1979 S.C., N.C., Ga., - South Atlantic State/Federal Statistics Program; 1980 - South Atlantic State/Federal Statistics Program).

		North Carolina	South Carolina	Georgia	Florida (East Coast)
1957	brown	2,976,628	1,443,133	912,094	717,936
	pink	1,324,201	5,700	15,481	2,895
	white	421,158	2,533,074	4,270,689	2,328,625
1958	brown	941,859	2,000,466	2,110,880	654,623
	pink	508,171	0	6,496	0
	white	50,959	1,461,032	3,069,618	2,621,568
1959	brown	2,435,350	1,813,631	1,133,204	477,947
	pink	1,288,110	0	475	0
	white	72,962	2,659,317	3,387,159	2,207,326
1960	brown	2,564,394	1,430,690	1,274,330	344,397
	pink	766,560	0	0	0
	white	233,601	3,349,393	4,917,880	3,699,046
1961	brown	601,419	526,869	347,816	73,967
	pink	1,092,389	0	0	0
	white	101,525	1,798,603	3,705,799	3,506,656
1962	brown	2,180,044	2,243,892	1,837,501	901,727
	pink	1,402,714	0	0	1,355
	white	32,743	1,858,097	3,586,488	2,401,789
1963	brown	1,751,336	1,191,204	1,175,602	631,107
	pink	346,462	0	0	0
	white	0	183,675	2,269,950	2,266,457
1964	brown	1,444,942	1,139,318	1,221,485	597,743
	pink	1,210,430	0	7,100	0
	white	10,248	516,011	2,541,272	2,204,688
1965	brown	1,774,880	1,554,428	1,203,379	514,732
	pink	1,054,523	0	0	0
	white	565,844	2,787,023	4,315,722	2,918,427
1966	brown	2,955,446	2,151,235	1,377,787	723,265
	pink	330,870	0	1,149	0
	white	265,997	519,423	2,763,460	2,400,217
1967	brown	1,951,916	1,463,377	1,126,382	414,125
	pink	986,974	0	0	525
	white	127,977	1,124,753	3,132,982	2,693,576
1968	brown	1,963,982	963,093	453,064	296,575
	pink	827,905	3,800	0	4,501
	white	83,809	3,102,002	5,068,825	2,749,187

continued
Table 8-6

		North Carolina	South Carolina	Georgia	Florida (East Coast)
1969	brown	3,656,663	765,226	559,454	341,743
	pink	1,060,627	0	0	636
	white	175,316	2,977,273	4,900,279	2,930,734
1970	brown	2,379,976	1,160,420	633,802	256,314
	pink	534,235	0	775	2,855
	white	238,844	2,001,730	3,230,167	2,640,380
1971	brown	3,175,038	1,710,094	716,047	463,702
	pink	1,196,660	0	0	0
	white	381,994	5,194,397	5,006,227	1,631,865
1972	brown	1,989,967	1,395,522	1,058,507	354,403
	pink	492,673	0	0	0
	white	1,020,220	3,790,630	3,606,302	2,385,160
1973	brown	1,053,826	1,067,868	377,737	297,401
	pink	944,574	0	0	4,423
	white	1,166,497	4,244,722	4,960,773	1,473,138
1974	brown	3,809,124	1,290,669	878,823	908,748
	pink	1,320,070	0	0	3,843
	white	126,890	3,474,689	3,774,285	1,309,425
1975	brown	1,601,266	1,478,843	804,964	284,709
	pink	1,223,385	7,161	5,520	29,375
	white	407,900	4,203,717	4,380,028	1,340,167
1976	brown	2,788,670	1,716,151	1,169,670	320,187
	pink	1,105,887	19,742	0	8,776
	white	249,069	3,804,334	3,823,681	1,454,290
1977	brown	3,105,088	2,037,451	991,171	453,413
	pink	370,170	29,621	4,196	96,780
	white	5,759	434,472	1,942,718	838,554
1978	brown	1,540,574	1,503,314	771,167	285,742
	pink	264,360	7,327	15,936	52,167
	white	37,316	1,650,258	2,730,674	1,267,819
1979	brown	1,952,612	1,169,234	718,673	297,730
	pink	975,859	2,774	8,335	124,682
	white	153,351	3,622,783	5,143,307	2,599,270
1980	brown	4,894,312	1,728,844	1,126,303	556,790
	pink	857,075	6,219	11,384	109,171
	white	368,499	2,854,057	4,041,371	1,993,677

of the 1972 and 1973 seasons, white shrimp have been particularly scarce. Maximum and minimum production levels of each species in North Carolina since 1957 are shown in Table 8-7. Total production of 9.8 million lb in North Carolina during 1980 was the highest since 1955 (Table 8-1).

Production in South Carolina increased with fluctuations until sometime during the 1940's (Table 8-1). Again the lack of landings data during that decade preclude comments other than general statements. Since 1950, landings have fluctuated around a mean of 5.6 million lb and have ranged from 2.2 to 10.8 million. Species composition data (Table 8-6) show the importance of white shrimp, the insignificance of pink shrimp, and fluctuations of white and brown shrimp. No salient peak in total production can be identified for South Carolina. A moderate peak of possible importance occurred in 1971-1973, but because shrimp produce annual crops such peaks are due more to climate and effort, to a lesser extent, than to progressive increases in population size as in perennial species. Extremes of annual brown and white shrimp landings in South Carolina since 1957 are large.

Several very high levels of landings have been recorded for Georgia (Table 8-1). The 10 million lb level (heads-off) was attained in 1923 and during at least seven years since, but landings have not surpassed 8.9 million lb since 1960. Significant peaks occurred during the 1920's and late 1930's. Missing data during the 1940's confuse the importance of record production in 1945. Although production has not regained the levels of earlier years, it has fluctuated around a mean of 7.1 million lb since 1950 (range=2.9-11.1 million lb). Since species data were first collected in 1957, white shrimp have been the most important species by far (Table 8-6). The years 1968 through 1971 were especially productive white shrimp years as compared to apparent declines in brown shrimp.

The most striking aspect of Florida's east coast landings is the drastic decline in production between the years just after the otter trawl's introduction

Table 8-7. Range of shrimp landings (in millions of pounds, heads-on) of each species in each South Atlantic State during 1957 through 1980. (Source: Fishery Statistics of the U.S. and South Atlantic State/Federal Statistics Program).

State	White	Brown	Pink
North Carolina	0–1.8	1.0–7.9	.4–2.2
South Carolina	.3–8.0	.8–3.6	*
Georgia	3.0–7.9	.6–3.4	*
Florida, East Coast	1.3–5.7	.1–1.5	0–.2

*Never over 50 thousand pounds recorded.

(1913) at Fernandina and 1950 (Table 8-1). During that period there was a steady increase in the combined production of the three states to the north. This suggests that as effort increased smaller percentages of southward migrating populations reached Florida waters until in early 1950's when some degree of equilibrium was reached. Since 1950, the mean annual catch on Florida's east coast has been 4.6 million lb, but there appears to have been a slight decline since then. Landings of penaeid shrimp have not reached 6 million lb since 1961, but surpassed that level 5 times between 1950 and 1961.

8.2.2.3 Discards and Landings of Commercially Caught Incidental Species

In addition to catching shrimp, otter trawls are very effective in capturing other marine and estuarine species. Some portions of the incidental catch or by-catch are of value, while the bulk is considered trash. Marketable fish are kept for the market place, while trash is swept overboard. Several researchers have investigated these incidental catches quantitatively and qualitatively in the southeastern Atlantic states (Cornell, 1948; Baughman, 1950; Roelfs, 1950; Latham, 1951; Lunz et al., 1951; Tiller, 1951; Siebenaler, 1952; Lunz, 1955, 1960; Jones, 1960; Fahy, 1965a,b; 1966; Anderson, 1968; Beaumariage, 1968; Brown and McCoy, 1969; Knowlton, 1972; Wolff, 1972; Keiser, 1976, 1977). Keiser (1977) recorded that the fish-shrimp ratio ranged from a low of 1.2:1 during part of South Carolina's season to a high of 4.0:1 in North Carolina. He estimated that an annual average of 69.5 million lb of fish was caught during 1973 through 1975 by trawlers working in the four state area. That figure equaled 24 times the average annual reported fish landings made by trawlers during that period. Beaumariage (1968) estimated that 1.3 million lb of fish were discarded annually along the northeast coast of Florida.

Uses exist for fishery by-products as can be seen by the presence of U.S. industrial fisheries in California, New England, the Gulf States, and North Carolina. In general, the production from those fisheries is utilized for canned pet food or frozen for mink food and crab trap bait. Although North Carolina has facilities to process industrial fish (menhaden in this case) incidental catches of shrimp trawlers are not normally utilized. The incidental fish catch of shrimp trawlers is of a quality high enough to be processed as fish-meal or minced fish, but there are several suggested reasons why it is not used. Shrimpers state the following as reasons: (1) few dealers are prepared to handle and ship incidentally caught fish, (2) the expected price would not be worth the additional effort, (3) additional ice which increased operating costs would be required, (4) additional space below deck for boxes on deck would be needed, and (5) culling for fish may delay icing of perishable shrimp (D. Theiling, S.C. Mar. Res. Center, Chas., SC; pers. comm.).

Keiser (1977) noted that trawls made during the off-season for shrimp, which is basically mid-winter to early spring in several areas of the Southeastern states, did not yield volumes of fish comparable to those taken during the shrimping seasons. Consequently, a year-round supply of fish probably would not be available for processing. Pointing out that many shrimp trawling areas overlap with nursery areas of many important fish species, Keiser (1977) suggested that development of an industrial fishery would not be wise at present effort. He also stated that there is no evidence that shrimp trawling activities are depleting stocks of commercial fish.

Upon being discarded, refuse of dead fish, crabs and other marine forms is at times a problem when washed up on beaches. Their appearance and smell as well as the perceived threat of feeding sharks are often disquieting to users of beach and surf.

During the spring of some seasons, large catches of jellyfish (Stomolophis meleagris) known by the fishermen as jellyballs, become serious impediments to normal shrimp trawling. By quickly filling net bags, jellyballs reduce drag time drastically as well as damage shrimp by mashing. No commercial use for them has been found. Slits or deflectors called "shooters" in nets have proven helpful in reducing jellyball catches, as has use of the Turtle Excluder Device (TED) (U.S. Dept. Comm., NMFS, 1981).

Incidentally taken fish not discarded are used for human consumption. Depending on the quantity of marketable fish and other factors, fish may reach the consumer through any of several channels. They may be sold to the shrimp packing house, carried by the trawler crew as part share or gratis, or given to family or friends of the Captain.

Fish of edible size and quality generally represent only a small portion of a trawlers incidental catch, but total catches among all trawlers are significant. Their magnitude is not known fully because many catches go unreported. Important species in the four states are whiting, flounder, croaker and spot. Also landed in considerable quantities are weakfish and bluefish in North Carolina, sharks in South Carolina and spotted sea trout in Georgia.

Other incidental catches of commercial value include blue crabs, whelks, horseshoe crabs, and at times items of esthetic interest such as mollusc shells and sand dollars. Although blue crabs comprise a major portion of incidental catches, they are seldom retained. Reasons given for not retaining crabs include: (1) crabs must be kept alive which is difficult during warm weather, (2) the value of blue crabs during the shrimp trawling season, which corresponds to that of the crab trap fishery, is low particularly for female crabs which are most abundant in trawl catches, (3) many crabs are dead or adulterated with sand after a period in the net, and (4) the lack of deck and hold space, the costs of additional ice, and the bother associated with any incidental catch are drawbacks. Another deterrant to handling large numbers of blue crabs is their ability to inflict painful pinches (D. Theiling, S.C. Mar. Res. Center, Chas., SC; pers. observ.).

Incidental catches of very small penaeid shrimp and of marine turtles are discussed in Section 8.2.6.2.

8.2.2.4 Recreational Catches

Magnitude of the recreational shrimp harvest has not been determined in the South Atlantic region. Therefore, data are scarce concerning this most important aspect of the fishery.

In questioning a segment of coastal county boat owners in South Carolina, Cupka and McKenzie (1974) found that the average non-trawl recreational catch during 1973 was 5.26 lb per trip and that a projected 155,000 trips were made. The resulting estimate of 816,000 lb (heads-on) equaled 9.9 percent of the recorded 1973 commercial production for South Carolina. No estimate of the sport trawl-caught portion of total landings is available. Pate (1977) estimated non-reported catches made by recreational and part-time shrimpers in North Carolina during 1973 to be 524,000 lb, which equalled 10.9 percent of that year's recorded commercial production. However, a more recent survey by Maiolo and Faison (1980) indicates that recreational shrimpers sold 12,200 lb and caught but did not sell 78,620 lb. This amounts to less than 3 percent of the total reported commercial catch.

No estimates of the recreational shrimp catch of Florida and Georgia are available (F. Kennedy, Fl. Dept. Nat. Res., Marine Res. Lab., St. Petersburg, FL.; pers. comm.; S. Shipman, GA Dept. Nat. Res., Coastal Res. Dev., Brunswick, GA; pers. comm.), but those catches constitute significant portions of the State's production.

8.2.3 Fishing and Landing Areas

8.2.3.1 Commercial Fishing Areas

The known geographic range on the Atlantic coast of the three commercially important species combined is from Cape Cod, Massachusetts to the Atlantic's interface with the Gulf of Mexico off southern Florida. In commercial quantities and over bottom suitable for trawling that range is smaller, yet still quite wide

(Figure 8-1). During at least a portion of the year, the commercially important area stretches from Fort Pierce, Florida to Pamlico Sound and Ocracoke Inlet, North Carolina.

Data collected by the South Atlantic State/Federal Fisheries Management Program reveal catch totals by shrimping area during 1980 as shown on Tables 8-8 and 8-9. These data represent catches made in the listed sub-areas and are different from the landings which may have been made at ports in those sub-areas. Landings made in Florida are not included, although catches made off Florida and landed elsewhere are tallied. There are virtually no offshore areas where shrimp were not taken during 1980. Even those areas on the coasts of North Carolina and northern South Carolina, which were not shrimped in earlier days of the fishery, are exploited, though not as heavily as is the coast from Winyah Bay entrance, South Carolina to Cumberland Island, Georgia. Florida's important fishing area is off Fernandina to Melbourne where effort is concentrated around inlets.

Portions of the four state's annual shrimp production are taken within internal waters, from territorial seas, and from the Fishery Conservation Zone (FCZ). The life cycles of the three penaeid species are such that postlarval and juvenile shrimp rely on marshes and tidal creeks as nursery areas (See Section 6.0). They are, therefore, first available to fishermen in internal waters when they reach commercial sizes. During 1980, each state allowed commercial activity in a portion or portions of its internal waters during at least part of the season. Management actions of opening, closing, and keeping closed internal waters have been based on protection of pre-commercial size shrimp, protection of potential or actual overwintering stocks, and on maximizing economic yields. Those internal areas identified as nursery areas are never opened to commercial activity.

The general management policy of the North Carolina Division of Marine Fisheries concerning internal waters is to leave shrimp migration routes open

Table 8-8. Estimated totals of catches of penaeid shrimp made in inshore areas of North Carolina and South Carolina during 1980. A dash denotes an area with no defined sub-areas. (Source: Data collected under the South Atlantic State/Federal Fisheries Statistics Program).

State	Area	Sub-Area	Pounds Heads-Off (X1000)
North Carolina	Croatan Sound	-	1
	Pamlico Sound	Undesignated	2,230
		East of Bluff Shoal	7
		West of Bluff Shoal	150
		Bay River	40
	Pamlico River	Goose Creek	3
	Neuse River	Below U.S. 17	204
		Adams Creek	91
		Lower Broad Creek	1
	Core Sound	Undesignated	986
		Black Sound	9
	North River (Carteret)	-	133
	Newport River	-	258
	Bogue Sound (East)	-	27
	Bogue Sound (West)	-	222
	White Oak River	-	50
	New River	Undesignated	288
	Stump Sound	-	8
	Topsail Sound	-	131
	Masonboro Sound	-	73
	Cape Fear River	Below Wilmington	98
	AICWW (White Oak-C.Fear)	Undesignated	92
	AICWW (South Port-Little R.)	-	15
	Shallotte River	-	2
	Lockwood Folly	-	1
South Carolina	Winyah Bay	-	51
	Santee Bay	-	9
	Bulls Bay	-	54
	St. Helena Sound	-	224
	Port Royal Sound	-	186
	Calibogue Sound	-	116

Note- No Georgia inshore areas were opened to power drawn commercial shrimping during 1980.

Table 8-9. Estimated totals of catches of penaeid shrimp made in offshore areas of North Carolina, South Carolina, and Georgia during 1980. A dash denotes an area with no defined sub-areas. (Source: Data collected under the South Atlantic State/Federal Fisheries Statistics Program).

State	Area	Sub-Area	Pounds Heads-Off (X1000)
North Carolina	Bogue Inlet to Ocracoke	-	208
	Kure Beach to Bogue Inlet	-	317
	Cape Fear R. to Kure Beach	-	50
N.C./S.C.	Garden City to Cape Fear	- Undesignated	12
North Carolina		- S. C. line to C. Fear R.	375
South Carolina		- Grand Strand	17
	Cape Romain to Garden City	- Undesignated	2
		- DeBidue to Garden City	32
		- North Island	398
		- Cape Romain to Winyah Bay	291
	Folly Is. to Cape Romain	- Bulls Is. to Cape Romain	376
		- N. Jetty to Capers Is.	215
		- Morris Is. to S. Jetty	731
		- Folly Island	119
S.C./Ga.	Tybee Is. to Kiawah Is.	- Undesignated	3
South Carolina		- Botany Is. to Kiawah Is.	374
		- Hunting is. to Edisto Is.	726
		- Bay Point to Fripp Inlet	325
		- Hilton Head Beach	340
Georgia		- Savannah River	248
	St. Andrews So. to Tybee	- Undesignated	30
		- Tybee	551
		- Wassaw	457
	St. Andrews So. to Wassaw	- Undesignated	5
		- Ossabaw and St. Catherine	425
		- Sapelo	1,662
		- Altamaha	225
		- St. Simons	993
	St. Augustine to St. Andrews So.	- Undesignated	65
		- Cumberland	206
Florida	(Caught in Florida but landed out of state)	-	223

to shrimping activity all year. Those routes include the large sounds, major rivers, smaller sounds adjacent to the inlets, and a major portion of the Intracoastal Waterway (ICWW). Designated primary nursery areas are kept closed, and tributaries adjacent to migration routes can be closed when small brown shrimp appear in them.

South Carolina's internal legal trawling areas are Winyah Bay, North Santee Bay, and Bulls Bay in the northern coastal area and St. Helena Sound, Port Royal Sound, and Calibogue Sound in the southern area. They are opened September through December, generally. The bays are small and except on opening day are worked mostly by trawlers of less than 10.7 m (35 ft). The sounds are quite large and are utilized by a major portion of the southern fleet when opened. Although vessels of 19.8 m (65 ft) and over are able to shrimp there, they tend to work offshore except during the first several days after the sounds are opened.

Georgia last allowed commercial shrimp trawling in internal waters in 1976 when Wassaw, Ossabaw, Sapelo, St. Simons, St. Andrews and Cumberland Sounds were opened during the fall. State managers have determined that significant economic benefit has resulted, either directly or indirectly, during the seasons that the sounds were held closed (R. Reimold, Ga. Dept. Nat. Res., Brunswick, GA; pers. comm.) Trawler activity in the sounds when they were opened was similar to that in South Carolina. Designated areas above or upstream of the sounds have been opened for sport bait and commercial bait trawling activity during designated periods since 1978 (Ga. Dept. Nat. Res., 1981). These areas account for less than 30 percent of all inshore waters; thus, 70 percent of all inshore areas are closed to power drawn nets.

Florida's only internal area open to shrimping has been the deeper portions of the St. John's River and Nassau River estuary. There is no detailed information on catches from internal and offshore territorial waters (F. Kennedy, Fl. Dept. Nat. Res., Marine Res. Lab., St. Petersburg, FL; pers. comm.).

The proportion of total catch made in internal waters, the territorial sea and the FCZ varies spatially and temporally. Tables 8-8 and 8-9 which reveal totals of catches made by trawlers unloading in Georgia, South Carolina, and North Carolina during 1980, delineate catches made in internal waters and those made in ocean waters. Detailed data concerning distance from shore of catches are not available but generalizations concerning each state can be made (Tables 8-10 and 8-11). All but 0.8 percent of North Carolina's catches were made in internal waters. For practical purposes it can be assumed that all of the catches made in ocean waters of North Carolina were made within the three-mile boundary (D. Spitsbergen, N.C. Div. Nat. Res. and Comm. Devl., Div. of Marine Fisheries, Morehead City, NC; pers. comm.). The portion of catch taken in the FCZ is estimated to be about 5 to 10 percent annually off South Carolina where trawling effort beyond three-miles occurs in limited areas and during limited times (D. Theiling, S.C. Div. of Marine Res., Charleston, SC; pers. observ.). Man-made jetties at Charleston Harbor and shoals at North Edisto Inlet apparently force shrimp and therefore trawlers beyond the three mile boundary. The estimated percentage for Georgia in 1980 was 59 percent (R. Essig, Ga. Dept. of Nat. Res., Brunswick, GA; pers. comm). Significant trawling effort is expended in the FCZ out as far as seven miles from shore due to extensive shoaling in nearshore waters. Approximately 12-15 percent of Florida's non-rock shrimp catches are made in the FCZ (F. Kennedy, Fl. Dept. of Nat. Res., Marine Res. Lab., St. Petersburg, FL; pers. comm.). Although coastal shoaling is not as extensive in Florida as in Georgia, effort is expended as far offshore as eight miles.

Bottom type and depth in nearshore ocean waters are apparently major determinants of shrimp occurrence and accessibility and of shrimping effort. The breadth of the area within the six fathom curve is greatest in northern and central Georgia waters. It is greatly reduced in northeast Florida and central North Carolina waters but not so greatly in South Carolina waters. In the broad shallow

Table 8-10. Percent of the South Atlantic shrimp catch (heads-on) by State from the FCZ versus territorial seas, 1980. (Source: McCoy, pers. comm).

	0 to 3 miles (lb)	% of Years Catch	3 miles Seaward	% of Years Catch	Total Landings
Florida(E. Coast)	3,494,000	47.0	4,009,000*	53.0	7,503,000
Georgia	3,476,128	41.0	4,998,804	59.0	8,474,932
South Carolina	6,999,992	97,0	194,367**	3.0	7,194,359
North Carolina	9,741,322	99.2	82,168	0.8	9,823,490

*Figures include Rock Shrimp; Florida officials estimate that 12-15% of the non-rock shrimp catch was made in the FCZ (F. Kennedy, FL DNR, St. Pete., FL., pers. comm.).

**These figures are believed to underestimate the actual percent of the catch which originated in the FCZ for S. C. according to Theiling (S. C. Marine Res. Center., Chas., SC), about 5 to 10% of the catch in 1980 occurred in the FCZ.

Table 8-11. Percentage of the South Atlantic shrimp catch from the FCZ versus territorial seas, 1973-1980* (Source: Fishery Statistics of the U.S., NOAA/NMFS, various years; Fisheries of the U.S., NOAA/NMFS, various years).

Year	0 to 3 Miles (lb)	% of Years Catch	3 Miles Seaward	% of Years Catch
1973	22,141,000	88.0	2,921,000	12.0
1974	23,256,000	87.0	3,628,000	13.0
1975	22,192,000	89.0	2,724,000	11.0
1976	23,125,000	89.0	2,996,000	11.0
1977	15,092,000	84.0	2,905,000	16.0
1978	13,675,000	68.0	6,463,000	32.0
1979	15,640,000	48.0	16,655,000	52.0
1980	23,712,000	72.0	9,284,000	28.0

*Management personnel from state agencies in the Region question the accuracy of these figures due to differences in collection techniques and the inclusion of rock shrimp data.

areas, particularly off southern Georgia, trawlers are unable to work over wide areas near shore. Beyond the narrow shallow areas, trawling is confounded by rough bottom and sparse concentrations of shrimp. Hazards to trawling including stumps, wrecks, rocks and dumpsites are numerous throughout the shrimping areas of the four states. A Hang Log (McGee et al., 1975) shows 1,100 known hangs in the region. Theoretically, all catches made during closed seasons are made outside of the three-mile boundary.

State enforcement efforts, particularly in the FCZ have historically been hampered by inadequate man-power and physical resources, insufficient penalties, conflicting provisions of the law, and the uncertainty of the authority to enforce their laws in the FCZ. The extent of a state's jurisdiction beyond its territorial waters in terms of jurisdiction over citizens of its own state and citizens of other states was discussed at the June 30, 1981 South Atlantic Fishery Managment Council meeting in Charleston, South Carolina. It was concluded that the states have very limited jurisdiction beyond their territorial waters. A vessel registered in one state (e.g. Georgia) engaged exclusively in fishing in the FCZ off another state (e.g. Florida) could not be regulated by that state (e.g. Florida). Based on this information, state management in the FCZ would not appear to be adequate under present circumstances.

8.2.3.2 Commercial Landing Areas

The vast majority of commercially landed shrimp are unloaded at waterfront shrimp packing houses which provide docking, unloading, heading, packing, refrigeration and shipping facilities necessary for fishermen's catches to reach secondary markets. In many cases, operators of packing houses own singularly or in partnership one or more vessels at their docks. They also contract verbally with other shrimpers for use of the docks' facilities in exchange for having those shrimpers' catches unloaded at their docks. Some packing houses are run basically for and by family groups while others have no ownership ties to trawlers or family ties with trawler owners. Some docks operate solely to handle shrimp, but the trend in the past half decade has been to diversify into other activities. Other fishery activities, including crab processing, oyster shucking and the handling or processing of finfish to one extent or another, are important ones at many shrimp dealers. Fishery-related services such as fuel and ice sales, net and gear repair and storage, and railways are either directly or indirectly related to many docks and concentrations of docks. Public sales of seafood, bait, nets, traps, tackle, and ice occur at some docks. There is no shrimp processing at the docks of landing other than heading (head removal) and, in limited quantities, freezing for later retail sale.

In North Carolina during 1980, about 262 dealers in 19 counties were licensed to handle shrimp. About 48 of those license holders were not licensed to handle other fishery landings. Theiling (1977) found that in 1976, 62 dealers were licensed in shrimp buying and shipping in South Carolina but that only 37 in five counties were considered to be major commercial establishments. The remainder were either small, low volume license holders or did not utilize their licenses at all. Though ownership of some houses has changed, the number of dealers has not changed significantly in South Carolina since 1976. Most are located in Beaufort (14) and Charleston (16) counties. In 1976, about 22 dealers handled shrimp only, but that number has decreased to about five in 1981 due to diversification into other fisheries (D. Theiling, S.C. Marine Res. Center, Charleston, SC; pers. observ.). Nix et al. (1975) located 32 active shrimp packing houses in six Georgia counties during 1974. That number has risen to 34 in 1981, and most are located in Glynn (8), McIntosh (13) and Chatham (7) counties (S. Shipman, Ga. Dept. of Nat. Res., Coastal Res. Dev., Brunswick, GA; pers. comm.). Twenty dealers were active on the east coast of Florida during 1980. They were located in Cape Canaveral (2), New Smyrna (3), St. Augustine (2), Mayport (7), and Fernandina (6) (J. E. Snell, NMFS, Miami, FL; pers. comm.).

In recent years there has been an important movement in the United States and other major marine fishery nations toward concentrating fishery-related facilities into seafood industrial parks. The major purpose is to increase the efficiency of operations related to harvesting, processing and marketing of fishery resources. Several ambitious endeavors of this type have been proposed and/or planned in the South Atlantic Region (McKenzie et al., 1976). At present, the Wanchese Seafood Industrial Park on Roanoke Island, North Carolina is the only such facility constructed and in operation.

8.2.3.3 Recreational Fishing and Landing Areas

In general the tidal creeks and rivers which are so extensive in the four state area are quite accessible and productive for recreational shrimpers using a wide variety of gear types. When in internal waters, shrimp can be located over nearly any bottom type and in any depth of water, but tend to concentrate in the more favorable habitats (See Section 5.0). Cast netters are able to take shrimp in areas as small as a few feet wide and only inches deep. Seiners shrimp in moderately to very broad creeks, up to 1.8-2.4 m (6-8 ft) deep, and push netters can work in creeks or open waters up to 1.2 m (4 ft) deep. Drop nets are effective in waters over about 0.6 m (2 ft) deep.

Major geographic areas of recreational shrimping activity in North Carolina are in Carteret County south to the state line and to a lesser extent the tributaries of Pamlico Sound (D. Spitsbergen, N.C. Div. of Nat. Res., and Comm. Devl., Div. of Marine Fisheries, Morehead City, NC; pers. comm.). In South Carolina recreational effort is coast-wide with cast netting predominant in the southern area. Cupka and McKenzie (1974) reported that non-trawl sport shrimpers worked from boats (66.5 percent), shore (20.8 percent), piers (10.6 percent), and bridges (2.1 percent). Georgia's designated sport bait trawling zones occur throughout the coastal area as does non-commercial gear usage (Georgia DNR, 1978). Recreational beach seining is concentrated on Tybee, Sapelo, St. Simons, Jekyll and Cumberland Islands. Florida's major sport shrimping areas are the St. John's River area and the area around Ponce De Leon Inlet (F. Kennedy, Fl. Dept. of Nat.

Res., Marine Res. Lab., St. Petersburg, FL: pers. comm.). Recreational catches of shrimp are landed at a wide variety of places including public and private boat landings, personal and commercial docks, marinas and onshore at the shrimping site.

8.2.4 Craft and Gear

8.2.4.1 Trawling Craft

The historical documentation of the numbers of boats and vessels involved in the shrimp fishery of the four states is shown in Tables 8-12 through 8-16. Also shown are the gross tonnages of vessels and measurements of nets in the fishery. Generally speaking there have been steady increases in all states in all categories through 1978. Published data are not available after that time but state management data for 1979 and 1980 are shown in Table 8-17.

Today's shrimp trawling fleet consists of trawlers which are quite mobile and distinctively designed relative to the various types of fishing. Offshore trawlers have undergone significant design changes making them larger and more versatile (Captiva, 1966). Most newer offshore vessels, the so-called Florida trawlers, are 22.9-24.4 m (75-80 ft) or more in length and are double-rigged for towing two nets simultaneously. Double-rig fishing has been estimated to increase the catch by 15 to 30 percent as well as reduce fuel costs and repair and labor time (Klima and Ford, 1970). Details of Georgia and South Carolina trawlers in 1980 are shown in Table 8-18.

Juhl (1961) demonstrated a fairly close relationship between the gross and net tonnage and the lengths of vessels in the shrimp fleet. Such correlation is probably due to the uniform hull design of the "Florida-type" vessels which have a round bottom, flare bow and a broad, square transom stern. The deckhouse is forward with the clear fishing decks aft. Double-rig nets are towed from outriggers (Figure 8-2). The engine room is below the deckhouse with

Table 8-12. Numbers of vessels and boats utilized in the South Atlantic shrimp otter trawl fishery each year, 1957 through 1978, with related tonnage and gear data. (Sources: 1957-76 Fishery Statistics of the U.S.; 1977-1978 NMFS Data Management, Wash., D.C.).

Year	Vessels		Boats	All Craft	
	Number	Tonnage	Number	Number	Gear (meters)
1957	1095	15,329 N	835	1930	34,041
1958	1065	14,980 N	833	1898	32,785
1959	1098	15,978 N	888	1986	34,815
1960	1090	30,103 G	814	1904	34,576
1961	1071	29,449 G	747	1818	33,388
1962	1021	28,770 G	863	1884	34,269
1963	1023	28,501 G	736	1759	34,785
1964	954	26,277 G	641	1595	31,834
1965	958	27,273 G	691	1649	33,576
1966	903	28,132 G	910	1813	34,700
1967	889	28,880 G	755	1644	32,543
1968	911	32,652 G	746	1657	34,647
1969	919	35,644 G	806	1725	35,115
1970	949	35,959 G	727	1676	35,315
1971	1024	39,624 G	825	1849	NP
1972	1040	40,618 G	980	2020	NP
1973	1088	44,174 G	1087	2175	NP
1974	1157	48,965 G	1172	2329	NP
1975	1200	51,703 G	1259	2459	NP
1976	1170	49,359 G	1374	2544	NP
1977	1160	50,670 G	1365	2525	49,479
1978	1212	55,738 G	1013	2225	50,347

N - net tonnage
G - gross tonnage
NP- not published
Note - duplication of craft among States has been excluded.

Table 8-13. Numbers of vessels and boats utilized in the North Carolina shrimp otter trawl fishery each year, 1950-1978, with related tonnage and gear data. (Sources: 1950-1976 Fishery Statistics of the U.S.; 1977-1978 NMFS Data Management, Wash., D.C.).

Year	Vessels Number	Vessels Tonnage	Boats Number	All Craft Number	All Craft Gear (meters)
1950	402	3,115 N	677	1,079	19,646
1951	401	3,285 N	544	945	17,835
1952	383	3,352 N	573	956	16,508
1953	395	3,655 N	666	1,061	18,320
1954	397	3,966 N	575	972	16,865
1955	389	4,241 N	521	910	16,034
1956	389	4,669 N	556	945	15,777
1957	399	4,948 N	561	960	15,843
1958	325	4,184 N	405	730	12,078
1959	362	4,898 N	426	788	13,893
1960	389	8,533 G	427	816	14,347
1961	407	8,686 G	321	728	13,183
1962	371	8,343 G	379	750	13,311
1963	383	8,181 G	319	702	12,683
1964	371	7,832 G	349	720	12,828
1965	370	8,112 G	356	726	13,208
1966	301	7,136 G	564	865	13,237
1967	305	7,549 G	460	765	12,295
1968	277	7,313 G	402	679	11,439
1969	266	7,876 G	462	728	11,236
1970	360	10,794 G	430	790	13,777
1971	407	12,701 G	477	884	15,671
1972	425	13,578 G	538	963	17,113
1973	472	16,433 G	638	1,110	19,764
1974	447	15,373 G	719	1,166	20,098
1975	488	17,749 G	791	1,279	21,964
1976	451	16,175 G	841	1,292	21,611
1977	495	18,237 G	858	1,353	22,879
1978	542	20,109 G	586	1,128	22,087

N - net tonnage
G - gross tonnage

Table 8-14. Numbers of vessels and boats utilized in the South Carolina shrimp otter trawl fishery each year, 1950-1978, with related tonnage and gear data. (Source: 1950-1976 Fishery Statistics of the U.S.; 1977-1978 NMFS Data Management, Wash., D.C.).

	Vessels		Boats	Total Craft	
Year	Number	Tonnage	Number	Number	Gear (meters)
1950	164	1,690 N	61	225	4,089
1951	364	3,937 N	117	481	9,002
1952	251	2,525 N	94	345	6,390
1953	253	2,695 N	104	357	6,488
1954	148	1,489 N	134	282	5,166
1955	295	3,648 N	68	363	6,621
1956	310	4,159 N	90	400	7,107
1957	380	5,445 N	97	477	8,860
1958	316	4,406 N	149	465	9,068
1959	264	3,433 N	167	431	8,502
1960	273	7,368 G	167	440	9,037
1961	224	5,972 G	133	357	7,919
1962	242	6,229 G	141	383	8,825
1963	221	5,762 G	106	327	8,510
1964	183	4,677 G	63	246	6,654
1965	203	5,318 G	36	239	7,046
1966	187	5,018 G	29	216	7,064
1967	217	6,218 G	16	233	7,331
1968	280	8,514 G	23	303	9,361
1969	316	10,967 G	30	346	10,455
1970	288	10,697 G	26	314	9,688
1971	372	15,133 G	54	426	12,508
1972	370	15,223 G	153	523	13,108
1973	386	16,183 G	152	538	13,727
1974	447	19,437 G	144	591	16,132
1975	450	19,725 G	162	612	16,545
1976	410	17,091 G	199	609	15,435
1977	315	13,790 G	253	568	13,254
1978	459	22,034 G	170	629	17,947

N - net tonnage
G - gross tonnage

Table 8-15. Numbers of vessels and boats utilized in the Georgia shrimp otter trawl fishery each year, 1950-1978, with related tonnage and gear data. (Source: 1957-1976 Fishery Statistics of the U.S.; 1977-1978 NMFS Data Management, Wash., D.C.).

	Vessels		Boats	Total Craft	
Year	Number	Tonnage	Number	Number	Gear (meters)
1950	220	2,392 N	84	304	5,595
1951	268	3,151 N	55	323	6,003
1952	229	2,797 N	48	277	5,157
1953	204	2,469 N	45	249	4,493
1954	204	3,006 N	49	253	4,365
1955	216	2,748 N	70	286	4,805
1956	290	4,129 N	77	367	6,573
1957	284	3,596 N	143	427	6,928
1958	346	4,575 N	234	580	9,225
1959	328	4,618 N	266	594	9,213
1960	307	8,433 G	195	502	8,154
1961	312	9,027 G	270	582	8,715
1962	324	9,421 G	308	632	9,132
1963	363	10,523 G	264	627	11,221
1964	333	10,343 G	213	546	10,044
1965	325	10,570 G	282	607	11,290
1966	314	10,430 G	296	610	11,224
1967	332	11,812 G	270	602	11,840
1968	347	14,286 G	303	650	13,243
1969	388	17,196 G	300	688	14,724
1970	307	12,744 G	267	574	11,958
1971	416	18,840 G	283	699	15,805
1972	387	17,370 G	270	657	14,882
1973	363	16,884 G	291	654	14,844
1974	426	21,521 G	296	722	17,115
1975	471	23,763 G	295	766	18,674
1976	468	23,162 G	302	770	18,553
1977	338	15,976 G	223	561	13,115
1978	347	17,394 G	172	519	13,585

N - net tonnage
G - gross tonnage

Table 8-16. Numbers of vessels and boats utilized in the Florida, east coast shrimp otter trawl fishery each year, 1957 through 1978, with related tonnage and gear data. (Sources: 1957-1976 Fishery Statistics of the U.S.; 1977-1978 NMFS Data Management, Wash., D.C.

	Vessels		Boats	Total Craft	
Year	Number	Tonnage	Number	Number	Gear (meters)
1950	158	2,232 N	25	183	3,671
1951	121	1,622 N	33	154	2,967
1952	178	2,952 N	23	201	4,141
1953	233	3,512 N	22	255	5,454
1954	221	3,600 N	3	224	4,910
1955	228	3,753 N	16	244	5,245
1956	332	5,733 N	35	367	8,037
1957	375	6,469 N	34	409	9,025
1958	428	7,942 N	45	473	10,641
1959	431	7,802 N	29	460	10,699
1960	431	16,020 G	25	456	11,055
1961	442	16,623 G	23	465	11,420
1962	393	14,975 G	35	428	10,364
1963	350	13,811 G	47	397	9,347
1964	307	12,004 G	16	323	8,353
1965	293	11,864 G	17	310	7,951
1966	305	13,399 G	21	326	8,453
1967	290	13,201 G	9	299	7,960
1968	275	14,504 G	18	293	7,974
1969	241	13,525 G	14	255	6,995
1970	238	13,380 G	4	242	6,998
1971	248	14,200 G	11	259	7,655
1972	212	12,204 G	19	231	6,880
1973	207	12,539 G	6	213	6,449
1974	173	10,672 G	13	186	5,378
1975	148	9,513 G	11	159	4,641
1976	156	9,988 G	32	188	4,743
1977	177	11,658 G	31	196	5,526
1978	201	13,480 G	NA	NA	7,257

N - net tonnage
G - gross tonnage

Table 8-17. Numbers of vessels and boats employed in the commercial shrimp otter trawl fishery in each South Atlantic state during 1979 and 1980. Non-resident craft are included. (Sources: N.C. - estimates based on 1968-1978 period; S.C. and Ga. - State vessel files; Florida - NMFS/TIMS).

	North Carolina		South Carolina		Georgia		Florida(E.Coast)	
	Vessels	Boats	Vessels	Boats	Vessels	Boats	Vessels	Boats
1979	(562)	(860)	595	705	647	824	326	75
1980	(585)	(901)	619	883	652	708	440	75

Table 8-18. Specifications of 1980 licensed shrimp trawlers whose owners resided in either Georgia or South Carolina. (Source: Georgia DNR vessel file and South Carolina MRD vessel file).

		Georgia	South Carolina
Total number		1,128	1,088
Length Frequency	10-19 feet	452	498
	20-29 feet	215	192
	30-39 feet	52	59
	40-49 feet	68	75
	50-59 feet	86	98
	60-69 feet	135	97
	70-79 feet	77	51
	80 + feet	6	13
	Unknown	37	5
Length each net	Unknown and less than 10'	195	7
	10-19 feet	24	21
	20-29 feet	121	106
	30-39 feet	267	353
	40-49 feet	196	284
	50-59 feet	118	127
	60-69 feet	80	75
	70-79 feet	84	55
	80-89 feet	24	39
	90-99 feet	19	12
	100 + feet	0	9
Gear Type	Single rig	610	732
	Double rig	358	349
	Twin Trawl	44	3
	Unknown	116	4
Number in crew	1	142	128
	2	567	553
	3	296	315
	4	49	23
	5+	14	5
	Unknown	60	64
Horsepower	9-49	27	65
	50-99	205	306
	100-149	266	241
	150-199	168	168
	200-249	112	113
	250-299	42	49
	300-349	50	64
	350-399	106	60
	400-449	12	5
	450-499	10	4
	500-549	8	2
	550+ and unknown	122	11

Table 8-18 (Continued)

		Georgia	South Carolina
Tonnage	LT 1- 9	135	129
	10-19	71	73
	20-29	67	67
	30-39	69	40
	40-49	60	52
	50-59	30	36
	60-69	26	23
	70-79	19	10
	80-89	8	3
	90+	14	6
	Unknown and boats	629	649
Year Built	1900-1949	30	49
	1950-1959	72	85
	1960-1969	226	234
	1970-1979	587	512
	1980	60	54
	Unknown	153	154
Hull Material	Wood	352	434
	Aluminum	15	31
	Steel	21	18
	Fiberglass	697	579
	Other	2	4
	Unknown	41	22
Fish other than Shrimp	Yes	202	192
	No	853	871
	Unknown	73	25

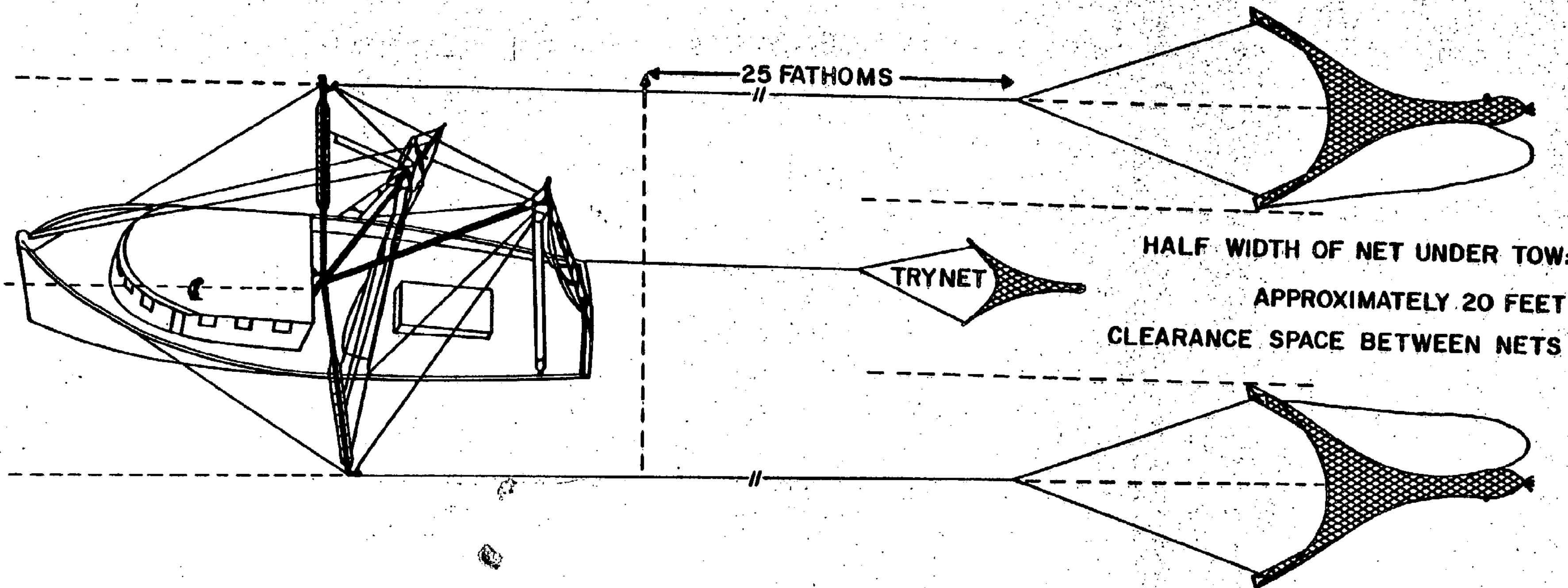


Figure 8-2. A diagrammatic representation of double-rig shrimp trawling (Adapted from Kristjonsson, 1968).

the fishholds aft. Typically, the vessels are diesel powered with pronounced variations of length and horsepower between single and double-rigged vessels. Generally, the vessels in the 15.2-21.3 m (50-70 ft) class are powered by 100-200 hp diesels. Cable rigs with drum hoists are powered from the main engine. A large portion of the vessels are equipped with electronic navigational aids and have the capacity for wide-ranging fishing operations.

The double-rigged shrimp trawler has two outrigger booms mounted one each on the port and starboard sides of the mast some distance above the deck (Figure 8-3). The booms are stayed fore, aft, and vertically. Stabilizer planes, suspended from the outriggers during moderate and rough seas when fishing and while at anchor, are utilized by many trawlers to dampen the roll. The use of permanently attached tag lines on trawl doors to facilitate handling has been a popular development.

The vessels used in inshore shrimping are generally smaller than those which work strictly offshore. There are, in addition, many smaller gas powered boats of 5 net tons or less, displaying quite a variety of designs and individual styles of construction working the inshore waters. These boats are usually equipped with power winches and rope towlines and rigged for towing a single trawl from the stern. The use of commercial skiff-type vessels operated by one man on the inshore grounds has become a major operation in certain local bays and sounds in North Carolina and South Carolina.

Expansion of the present day shrimp fishery is due to acceptance and use of diesel engine power. All offshore vessels in the South Atlantic states are equipped with diesel engines with reduction gears. Main engines are equipped with power takeoffs to run the winch through a system of chains, shafts, and sprockets. Main engine installation for most vessels is accomplished conveniently with maintenance kept as simple as possible. Most experienced boat captains and crew members can make minor repairs at dockside.

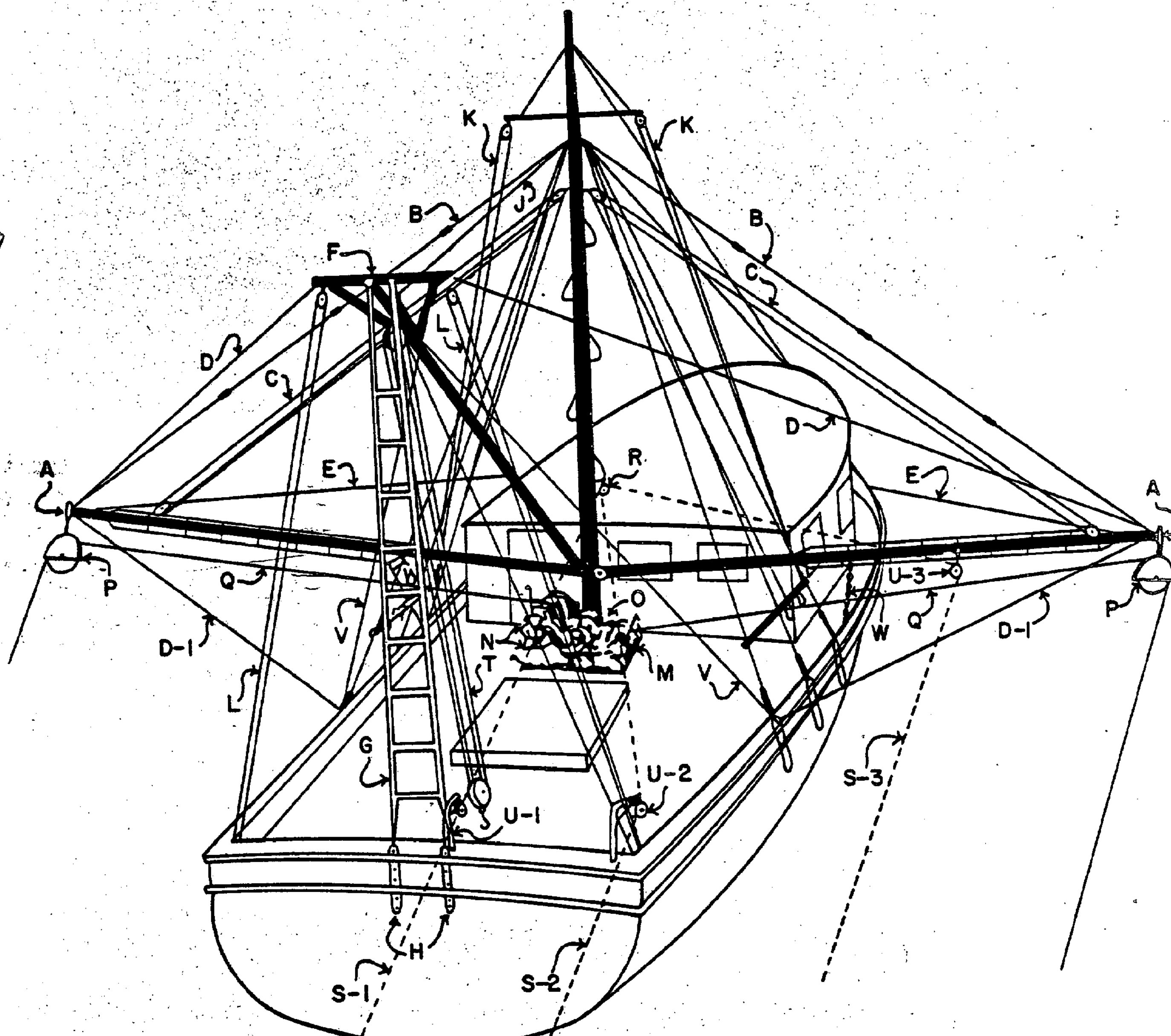


Figure 8-3. Rigging arrangements for double-rig Shrimp Trawling
A-Towing boom or outrigger; B-towing boom topping stay; C-topping lift tackles; D or D-1 - towing boom outrigger back stay; E-towing boom outrigger bow stay; F-modified boom; G-boom back stays - ratline structure; H-boom back stay plate on transom; J-boom topping lift stay; K-single block tackle; L-single block tackle; M-trawl winch; N-heads, two on trawl winch; O-center drum for try net warp; Q-warp; R-leading block for trynet; S-1, S-2, S-3-trynet lead block; T-main fish tackle tail block; U-1, U-2, U-3 - trynet lead block; any one may be used to accord with selection of S-1, S-2 or S-3; V-boom shrouds; W-chain stoppers for outriggers (Adapted from Kristjonsson, 1968).

Electronic instruments aboard shrimp trawlers serve both as navigational and fishing aids. They guide the fisherman to and from shrimping grounds and also provide information about the bottom. Principal items of equipment found on shrimp vessels are automatic pilots, depth recorders, radar, and VHF radios. Liao (1979) documented the use of electronic gear by Atlantic shrimpers. All vessels have a compass for basic navigation and many are equipped with LORAN.

Automatic pilots were introduced into the shrimp fleets to relieve the chores of steering, which on long runs presents a considerable fatigue problem. Since a course steered electronically is more accurate than one steered by hand, both running time and fuel consumption are reduced by the use of automatic pilots.

Depth recording equipment is used for navigation and fishing. When used for navigation, depth of water and bottom contours are determined to obtain vessel position. When used for fishing, good bottom (smooth and muddy) is distinguished from bad bottom (rock or coral) by appearance of the graph or recording paper. A depth sounder with a cathode ray tube, designed to function as a fish finder, is commonly found aboard the large vessels, but its practical value as applied to locating shrimp is questionable.

Radar equipment, quite common aboard large and intermediate vessels today, affords protection for the fishermen especially during fishing operations at night or in fog. LORAN equipment has enabled fishermen to accurately fix their locations and return to the same area repeatedly for successful catches. However, it is probably insignificant when dragging close to the beach.

8.2.4.2 Fishing Gear and Operation

There are three basic trawl designs employed in the South Atlantic shrimp fishery: flat, semi-balloon, and balloon (Figures 8-4 through 8-6). A survey of double-rigged trawlers in South Carolina revealed that the balloon and semi-balloon nets are generally preferred by vessel operators (Rhodes, 1974). These basic designs have been described by Bullis (1951), Fuss (1963), Marinovich and Whiteleather (1968), and Kristjonsson (1968).

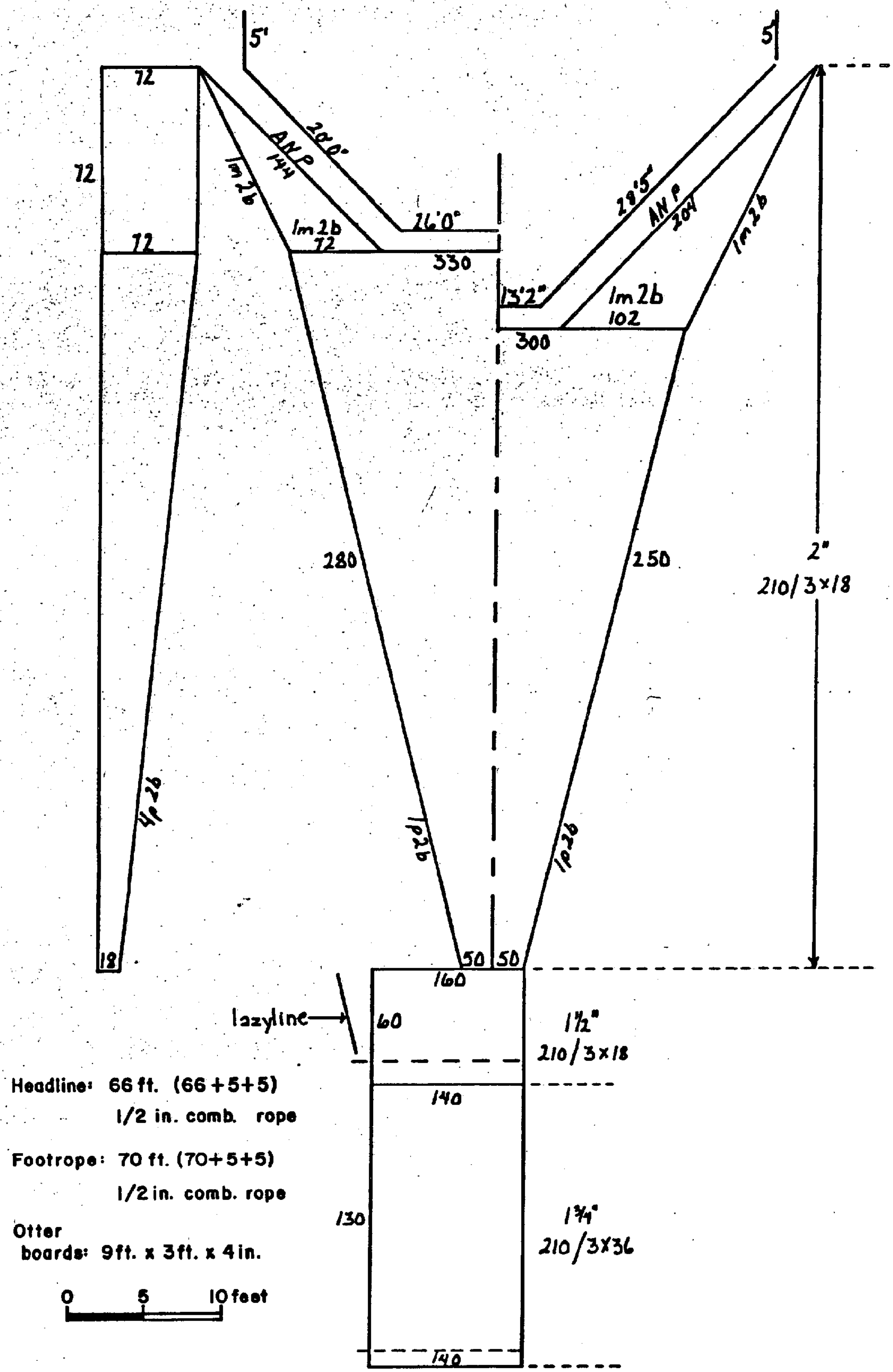


Figure 8-4. Diagrammatic representation of a 20 m (66 ft) flat trawl.

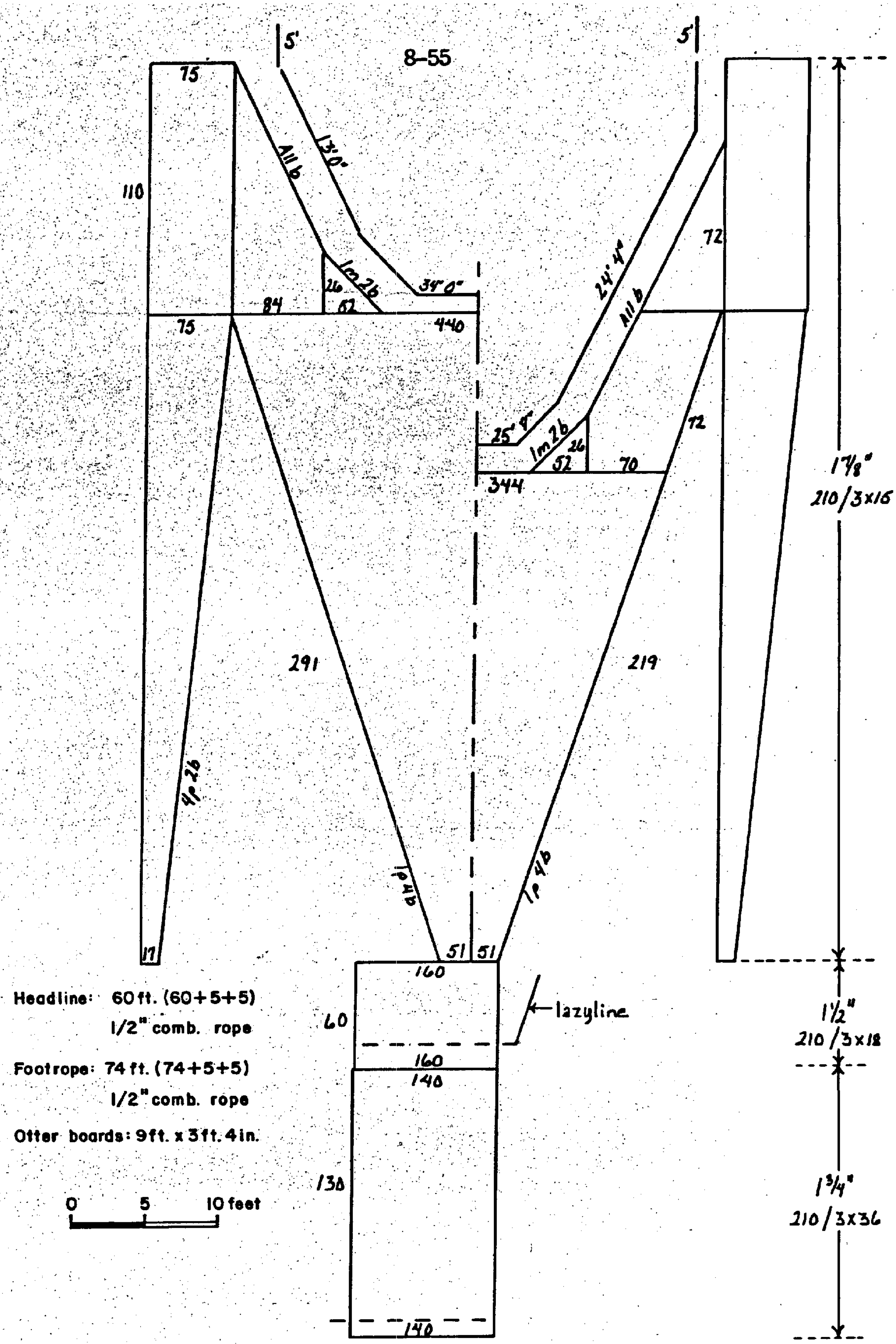


Figure 8-5. Diagrammatic representation of a 18 m (60 ft) semi-balloon trawl.

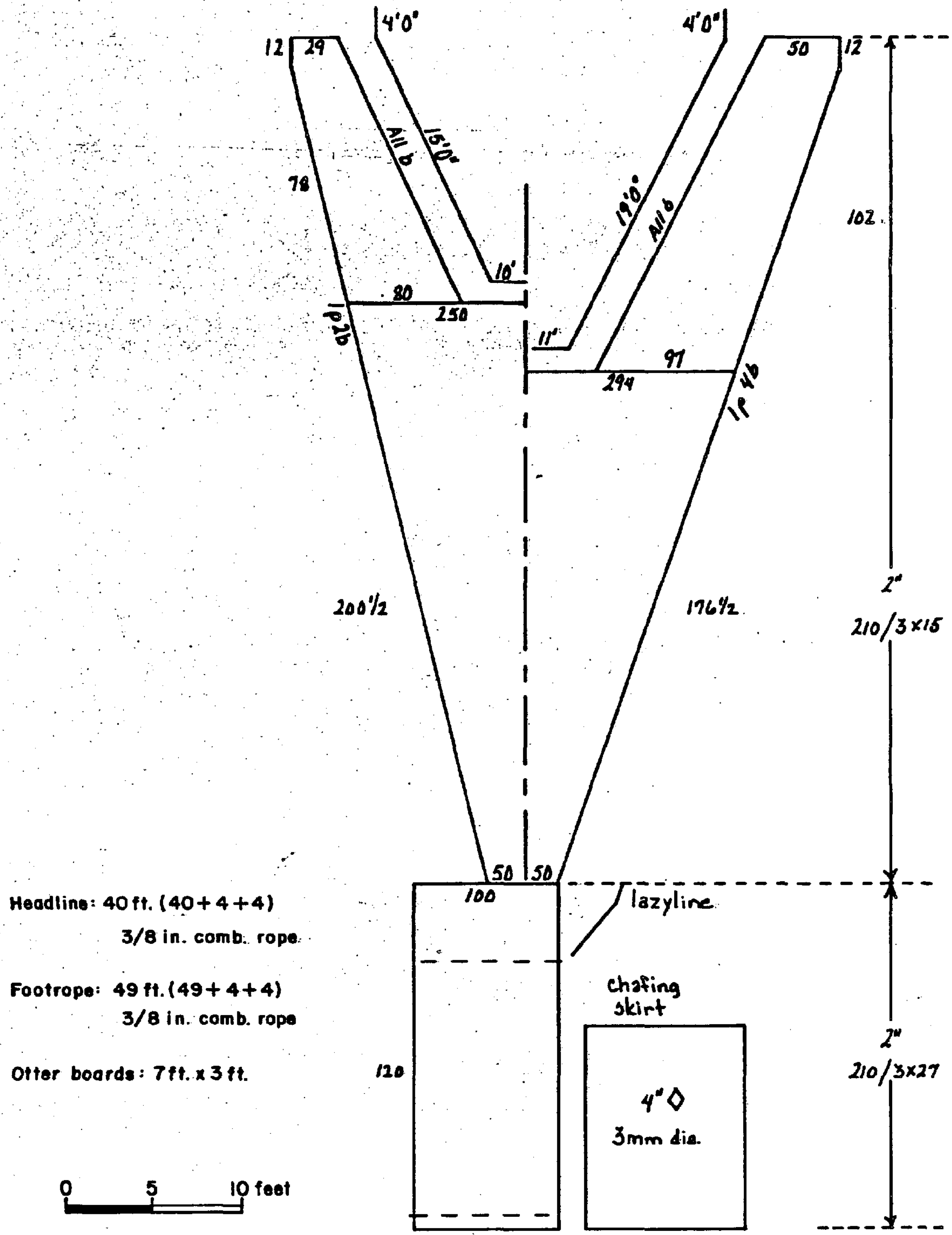


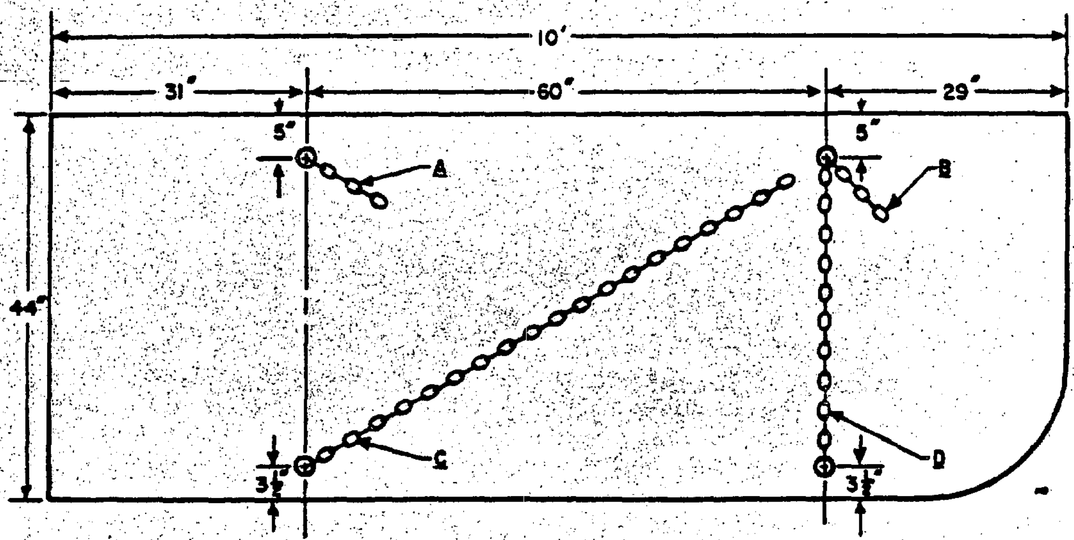
Figure 8-6. Diagrammatic representation of a 12 m (40 ft) two-seam balloon trawl.

The otter trawl generally consists of : (1) a cone-shaped bag in which the shrimp catch is gathered into the tail or cod end; (2) wings on each side of the bag for herding the shrimp into the bag; (3) trawl doors at the extreme end of each wing for holding the wings apart and holding the mouth of the net open; and (4) two lines attached to the trawl doors and fastened to the vessel. A lead, bottom, foot or ground line extends from door to door on the bottom of the wings and mouth of the net while a head, float or cork line is similarly extended at the top of the wings and mouth of the net. The size of the net is measured by the width of the mouth. Floats of hollow plastic and styrofoam are employed; the number of floats varies considerably. Generally, only about half as many floats are used on sandy bottoms as on muddy bottoms. With flat nets, the mouths of shrimp trawls are rectangular, the lead or bottom line and float or cork line being more or less straight horizontally. However, with the balloon net, the float line forms a pronounced arc when the trawl is being towed. The type of net design used by shrimpers appears to vary with species sought. Generally, it has been found that brown shrimp burrow into the bottom to escape the trawl and white shrimp try to escape by jumping off the bottom. Therefore, when fishing for brown shrimp, a flat net with two or three floats is often used since this design gives a wider horizontal spread than the other designs and supposedly facilitates the catching of burrowing shrimp. In contrast, four-seam, semi-balloon or two-seam balloon nets are fished for white shrimp since these nets have more vertical webbing than a flat net. Additional floats are used to increase the height of the trawl when needed.

Juhl (1961) reported that foot ropes differ only in the amount of weight attached to them. Loop chain is commonly attached to the foot rope at about 0.3 m (1 ft) intervals to add weight to the net. A chain may also be attached to the trawl doors, resulting in a "tickler" chain, which tows ahead of and separate from the net to frighten shrimp off the bottom into the oncoming trawl. Another common foot rope arrangement known as the "Texas drop down" is the attachment of the tickler chain to the foot rope chain (not looped) at about 0.9 m (3 ft) intervals using a short chain extension. It is generally believed by commercial fishermen that the Texas chain lifts the foot rope further off the bottom, resulting in catches with less mud and debris, and fewer undesirable organisms. The tickler/loop chain arrangement may not be effective in reducing "trash" caught by the net, but the effectiveness of the Texas chain can be reduced by a small change in its alignment.

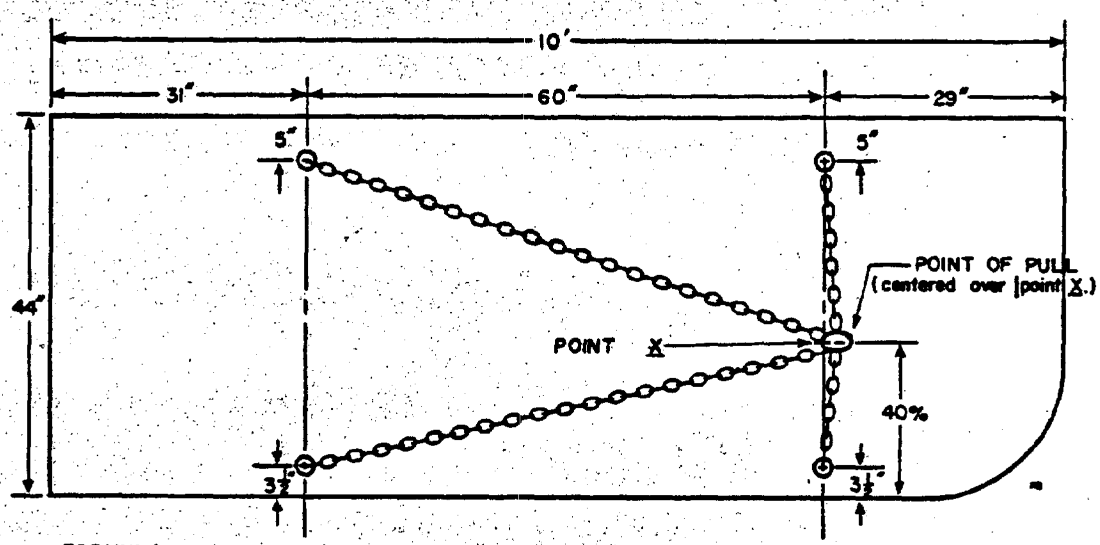
Most larger nets are constructed of synthetic webbing including various synthetic blends, i.e., nylon, nycot, marlon, and nylon rayon combination. The most common mesh size (stretch) in the nets ranges from 2.5-3.8 cm (1 1/2-2 in). For protection, the tail-bag is covered by a hula skirt or chafing gear of polyethylene strands tied into the bag or by a false bag of large mesh webbing.

The length of the dragging warp or tow line carried by shrimp vessels depends on the depth of water being fished; within the South Atlantic states this cable may vary from 137 to 1,372 m (75-750 fm). Single-rig vessels may carry from 137 to 366 m (75-200 fm) of warp while double-rig vessels carry from 137 to 1,372 m (75-750 fm). The cable used varies from 0.6 to 1.6 cm (1/4-5/8 in) diameter in multiples of 0.2 cm (1/16 in). The towlines are secured to the trawl doors using bridles (consisting of four chains) fastened to the doors. The front chains and the top chains are longer than the bottom chains (Figure 8-7). Thus, the doors have an outward, downward thrust while being towed. The shearing power necessary to offset the drag of the trawl and create the desired wing spread is directly related to the area of the doors and the speed of the vessel. Ideally, the door-net relationship should be such as to obtain the greatest possible wing spread without deforming the net opening or causing excessive drag. Trawl doors of 1.2-1.5 m (4-5 ft) length are used on trawl nets up to 15.2 m (50 ft) in width, 1.8-2.4 m (6-8 ft) doors on 24.4 m (80 ft) nets and 2.7-4.3 m (9-14 ft) doors on nets up to 36.6 m (120 ft) wide. The doors are constructed so that the length is slightly more than twice as long as the height. There appears to be



A. — TOP AFT CHAIN ONE LINK LONGER THAN BOTTOM AFT CHAIN.
B. — TOP FWD CHAIN ONE LINK LONGER THAN BOTTOM FWD CHAIN.
C. — BOTTOM AFT CHAIN TO WITHIN 2"-4" OF TOP FWD HOLE.
D. — BOTTOM FWD CHAIN TO CENTER OF TOP FWD HOLE.

Part 1



FORMULA:

AFT TOP AND BOTTOM CHAINS ARE EXTENDED TO POINT X, WHICH IS 40% OF DOOR HEIGHT FROM SHOE AND ON A LINE DRAWN BETWEEN ℄ OF FWD CHAIN HOLES. FWD CHAIN LENGTH IS DETERMINED BY RAISING BRIDLE SO THAT POINT OF PULL IS DIRECTLY OVER VERTICAL LINE.

Figure 8-7. Two methods of attaching chains to conventional wooden trawl doors (modified from Klima and Ford, 1970).

a lack of uniformity in the angle of trawl-door set but there is a tendency for setting lower chains from one to two links shorter than the upper chains. The dragging warp ratio commonly used for determining the required length of cable is five or six fathoms of line to each fathom of water. Occasionally, this ratio varies when fishing in deeper water.

During the mid-1970's twin trawls were introduced into the South Atlantic region. An investigation and demonstration of twin trawling in South Carolina was performed by the Clemson Marine Extension Program (Roberts and Rhodes, 1976). The twin trawl is used more in North Carolina but also has significance elsewhere in the region (D. Spitsbergen, N.C. Dept. of Nat. Res. and Comm. Devl., Div. of Marine Fisheries, Morehead City, NC; pers. comm.). An estimated 20 percent of Georgia's commercial trawlers used twin trawls during at least part of the 1980 season (D. Harrington, UGA Extension Service, Brunswick, GA; pers. comm.). The principle 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 (Figure 8-8). The reported advantages of this rig over the conventional double rig include: (1) the increase in fishing efficiency (25 percent increase in some cases); (2) the light weight and ease of handling two 10.7 m (35 ft) trawls as opposed to a single 21.3 m (70 ft) trawl; and (3) the nets can be towed slower and the vessel can make sharper turns with fewer incidents of tangling.

New net designs are continually being developed. At present, a modified tongue trawl or "three-winger" (also called the Mongoose trawl) is gaining acceptance in the region. This trawl has a triangular tongue or wing attached along the midsection of the corkline and connected to a center towing cable (Figure 8-9). The Mongoose spreads an average of 80-83 percent while conventional trawls spread from 50-65 percent. The height obtained is 40-50 percent greater than other trawls (B. Burbank, Burbank Trawl Makers, Inc.; pers. comm.). The increase

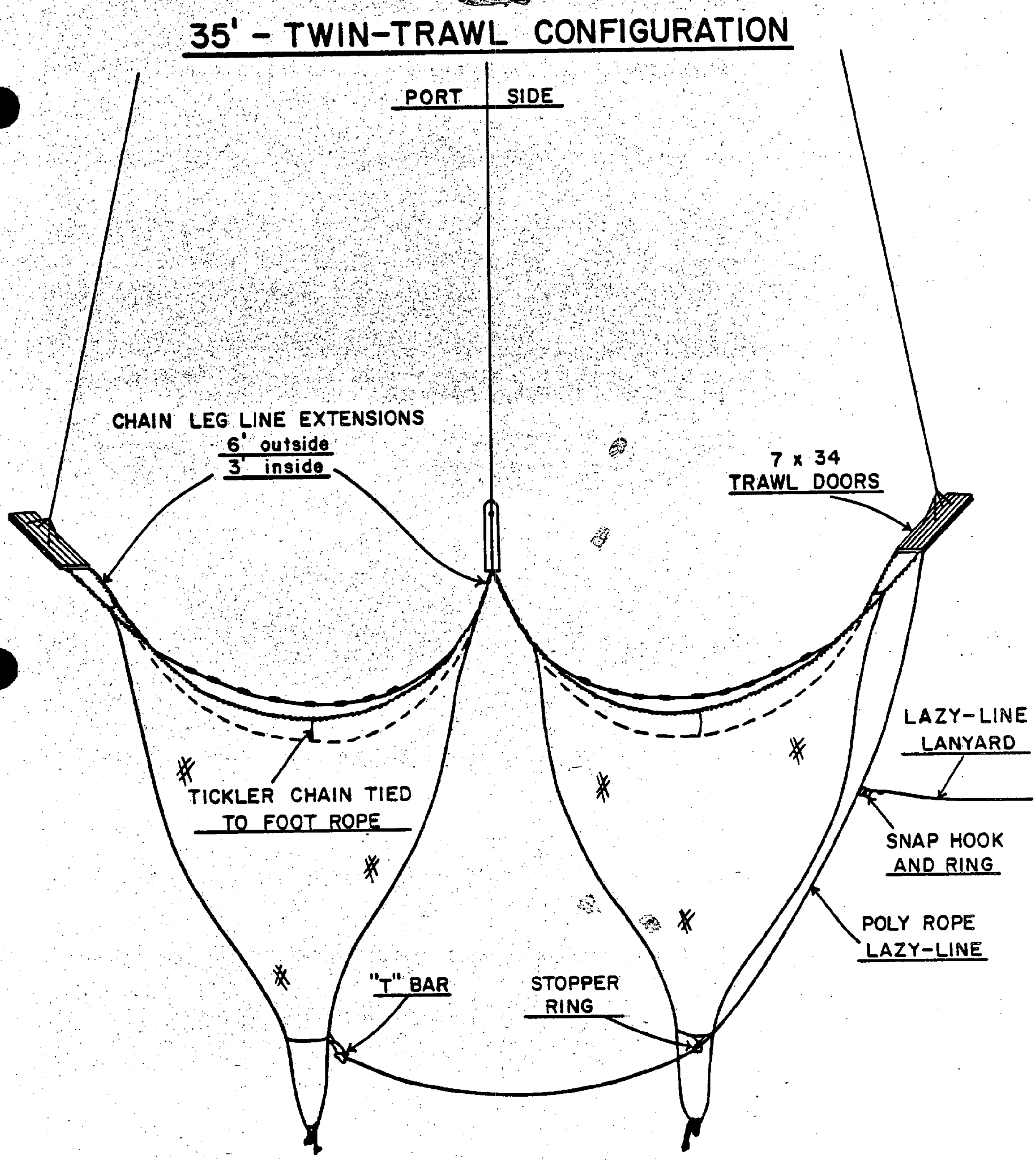


Figure 8-8. The Twin-trawl design as reported by Bullis and Floyd (1973).

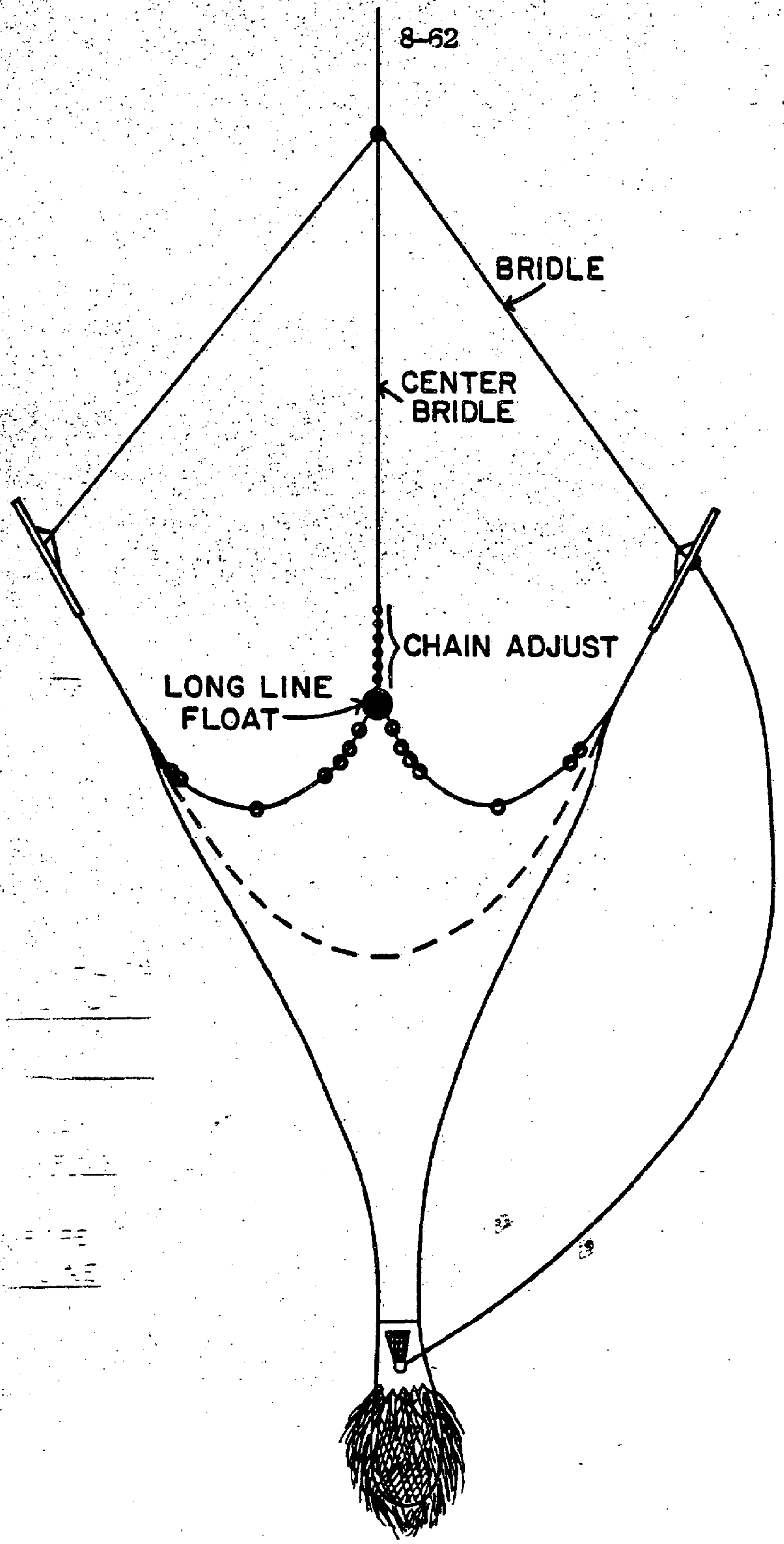


Figure 8-9. The "Mongoose" trawl designed by Billy Burbank, III (Courtesy of Burbank Trawl Makers, Inc.).

in vertical height results in greater catches of high moving white shrimp. Also, there appears to be energy saving capabilities associated with the use of smaller doors and decreased engine speed.

Trawling vessels are stocked for nearshore trips of short duration, generally not exceeding 24 hours. Weekly, they are fueled at the dock or where they are berthed at a nearby fuel dock for six or seven one day trips.

Upon arrival at the fishing grounds, doors are swung out to hang from outriggers by towing cables and nets are lowered to the bottom. The length of the drag varies with fishing conditions, most frequently ranging from one to over five hours. Usually, long hauls are made when shrimp are scarce and when the possibilities of catching large quantities of trash fish are small. During night-time fishing operations, two or three drags are usually made by the larger vessels. Smaller boats fishing inside grounds make much shorter drags. Those inshore shrimpers catching shrimp for live bait may haul in their nets as often as every five minutes.

During the drag on larger vessels, frequent tries are made with the try-net, a miniature of the larger otter trawl. Frequently, one or two try-net drags are made before the large nets are set to determine the bottom type and to estimate the abundance of shrimp in a particular area. The 3.7 to 4.9 m (12-16 ft) try net is pulled in frequently. Where shrimp appear in sufficient abundance to indicate grounds worth exploiting, the large nets are put over. By consistently checking the try-net ahead of the big nets, fishermen can tell whether or not they are still trawling through the concentration. In cases where the shrimper passes the concentrations, he changes course and resumes trawling through the area where the try-net showed good signs.

To retrieve, the speed of the vessel is decreased and the doors are cleared for hauling. The cables are brought in by winch until the two doors are blocked at the outrigger. Once the doors are up, the lazy line, attached around the mouth of the bag, is led through the block of the running whip which is then hoisted to the boom's end (Figure 8-3). The lazy line is led to the winch and heaved in until the neck of the bag is above the bulwark rail. The block and fall at the end of the boom is secured around the neck of the bag with a sling. The bitter end of this tackle is led to the winch and the bag of the net is raised out of the water and brought aboard and held suspended over the deck for emptying through its distal or cod end. The catch is then culled and iced down.

Shrimp trawl gear is operated essentially the same by both offshore and inshore fleets. However, there are differences in methods of locating shrimp and use of the try-net for such purposes is not as widespread among inshore vessels as among the offshore fleet.

The seine or haul seine utilized to catch shrimp is rectangular in shape and constructed of nylon webbing having a stretched mesh of 1.3-3.8 cm (1/2 to 1 1/2 in). This net varies in length and depth, with a lead line running along the bottom and a cork or float line along the top. Many seines have bags or pockets into which the shrimp are directed. Most seining operations are carried out in waters of less than 1.8 m (6 ft) in depth near the shore where the net is pulled by hand and hauled out to a bank where the catch is culled. Though previously a major commercial gear, seines are now used by bait and sport shrimpers. To a small extent seine-caught shrimp reach various types of markets. Laws dealing with minimum mesh sizes and maximum lengths of seines vary among the southern Atlantic states (Section 7.2). A variety of boat types are used in seine shrimping, but most are small or of shallow draft and are left at anchor or on a bank during shrimping operations. Many seiners, rather than using boats, take advantage of bridge and road access to tidal creeks.

Cast nets vary considerably in size, and their use is fairly widespread throughout the South Atlantic region, particularly in South Carolina, Georgia, and Florida. Cast nets are circular, usually having a spread of 1.8-6.2 m (6 to 20 ft) with a lead line running around the outside edge. A cord line extends through a ring or horn in the center of the net, and from this end there radiates numerous smaller cords (tuck lines) fastened at regular intervals to the lead lines. Mesh sizes vary from 0.6 cm (1/4 in) square mesh to 1.9 cm (3/4 in) 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 rim of the net has 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 casting for bait shrimp and for home consumption and by commercial fishermen fishing for live bait shrimp. Sales of cast net caught shrimp are widespread but small in volume. 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 shorelines adjacent to channels. Since most cast netting is done in shallow water, small, shallow draft boats are used. Cast nets may also be used from docks, bridges or banks. Recent activity of casting over bait in Georgia has been blocked by legislation in March 1981 (S. Shipman, Ga. Dept. Nat. Res., Coastal Res. Div., Brunswick, GA; pers. comm.).

Though the present day channel net is essentially a shrimp trawl, the history of its development is not directly related to that of the trawl. Maiolo and Still (1981) trace the development of the channel net in North Carolina where it is used most. The commercial use of channel nets in South Carolina has increased during recent years. Channel nets are anchored shrimp trawls which fish at or near the surface, being held open by currents which transport shrimp into the bag. Instead of otter boards to spread the net, a pole is secured to the lead line and the float line at each outer end of the net's wings. An anchor line is run upcurrent from each pole to prevent movement of the net. The catch is emptied by opening the tail bag into a boat. Channel nets are fished mostly in North and South Carolina in bays and sounds on ebb tides at night. The mesh sizes and widths of channel nets vary in the different states.

Employment of channel nets in North Carolina is most productive for pink, brown and white shrimp and in South Carolina for brown and white shrimp as they move seaward high in the water column. Most use of channel nets is commercial. Production as related to South Carolina's annual production is quite small but in North Carolina channel net catches reached six percent of that state's recorded shrimp production in 1980 (D. Spitsbergen, N.C. Dept. Nat. Res. and Comm. Devl., Div. of Marine Fisheries, Morehead City, NC; pers. comm.). Boats associated with the fishery range from about 4.6 to 7.6 m (15 - 25 ft).

Butterfly nets are hung on rectangular pipe frames and attached to the sides of boats. Similar to trawls, these nets vary considerably in size and are used only in areas where strong tidal currents exist. When in operation, the boat is anchored heading against the tidal flow and the nets lowered at right angles from the sides of the boat so that the current sweeps into the mouth of the net. The nets are lifted from the water, without lifting the frame, through the use of a tail bag line which facilitates emptying the catch. The very limited use in the South Atlantic States of these nets is largely a commercial operation, although bait shrimpers and sportsmen do employ this type of gear infrequently in bays and sounds. North Carolina allows the use of butterfly nets in designated areas by permit.

Drop nets consist of a large hoop up to 0.9 to 1.2 m (3-4 ft) in diameter to which a cone-shaped net is attached. The hoop or frame is attached to the main line by a bridle. The main line is tied to a bridge, boat, or pier and the net is dropped into the water. The nets are baited with smoked herring, cut fish, canned dog food or other local varieties of bait which attract shrimp. This method is strictly recreational, used for catching bait shrimp or shrimp for home consumption. Baited drop nets for shrimp were made illegal in Georgia in March 1981 (S. Shipman, Ga. Dept. Nat. Res., Coastal Res. Div., Brunswick, GA; pers. comm.).

Push nets are usually rectangular frames varying from 0.9 to 3.0 m (3-10 ft) in width and from 0.6 to 1.2 m (2-4 ft) in height. A bag of small mesh (1.3 cm; 1/2 in) nylon webbing is hung to the frame. A handle, 1.8 to 2.4 m (6-8 ft) long, is attached to the frame at the midpoint of the long side. A cross piece 1.8 to 3.0 m (6-10 ft) length is fastened perpendicular to the handle so that the fisherman can push against the handle with his chest. This gear is operated mostly in Florida. Fishermen push the net in shallow water areas; the length of push time depends on the quantities of shrimp in the area. The catch is usually emptied into the bow of the skiff which the fisherman drags behind and is sorted by someone in the boat. This gear is most productive on grassy and muddy bottoms.

South of Daytona, Florida brown and pink shrimp are taken at night under lights on ebb tides by dip nets, but commercial use of dip nets is negligible.

8.2.4.3 Participation in other Fisheries

Fishermen and craft of the shrimp fishery are involved in a wide variety of other fisheries; some are secondary and supplemental, and some are equal in importance to shrimping. For portions of the fleet, particularly in North Carolina, switching gear is an historic fact of fisheries life (D. Spitzbergen, N.C. Dept. of Nat. Res. and Comm. Devl., Div. of Marine Fisheries, Morehead City, NC; pers. comm.). For other segments, such as the medium size trawlers of South Carolina and Georgia, the need to supplement income by entering other fisheries is a recent economic fact of life. Although shrimping is the major fishery in which the vast majority of "shrimpers" participate, many of North Carolina's larger commercial vessels have taken the multi-fishery approach and are engaged in other activities of equal or greater importance. Those trawlers are engaged year round in trawl fisheries from Texas to Canada for flounder, other fish, sea scallops, and calico scallops. Some shrimp in only the good seasons. Small and medium sized trawlers and their captains in North Carolina are easily converted to any of several inshore activities including crab trawling, sink net fishing, clamming operations and channel netting (D. Spitzbergen, N.C. Dept. Nat. Res. and Comm. Devl., Div. of Marine Fisheries, Morehead City, NC; pers. comm.).

Small boats in South Carolina historically have been used with a variety of gears, the otter trawl being only one. Others are gill nets for sturgeon and shad, crab traps, shellfish gears, and stop nets. The Florida-type trawlers, while of limited use in inshore areas for purposes other than trawling for shrimp or crabs, are quite versatile in the application of near-shore and off-shore gear types. South Carolina vessels have become involved in the following activities: trawling for whelks, rock shrimp, calico scallops and reef fishes; hook and line fishing for bottom reef fishes and pelagic fishes; sea bass trapping and swordfish longlining.

As in the other states, small boats in Georgia are quite versatile and are utilized in fisheries other than shrimping. In-shore uses include gathering shellfish, trawling for crabs, setting shad gill nets, and setting crab traps. Larger trawlers are used off-shore in the harvesting of rock shrimp, calico scallops, and bottom reef fish by trawl gear. An estimated eight trawlers trawled for scallops and an estimated 25 percent of the Georgia fleet trawled for rock shrimp during the 1980 season (D. Harrington, UGS Marine Ext. Program, Brunswick, GA; pers. comm.). Offshore fishing activity other than trawling is limited to a few vessels fishing hook and line on reels for bottom fishes.

Commercial use of shrimp trawlers on the east coast of Florida is limited to only a few other fisheries. Trawling for rock shrimp and calico scallops is important to many large trawler fishermen, and the use of crab traps and, to a lesser extent, shad nets is made on smaller inshore trawlers. Table 8-18 shows that at least 80 percent of South Carolina, and 78 percent of Georgia resident trawlers did not function in a second fishery in 1980. (R. Essig, Ga. Dept. Nat. Res., Coastal Res. Div., Brunswick, GA; pers. comm.). The trend is however, that shrimp trawlers are engaging in other fisheries. An important undetermined fact is the extent to which other fisheries can withstand increasing participation.

It is important to note that many trawlers, while not active in other fisheries, are quite mobile within the penaeid shrimp fishery. This mobility includes movement between the southern Atlantic shrimp states as well as southward to the southeastern and northern Gulf of Mexico fisheries (Liao, 1979). Such mobility is, in effect, the same as participation in additional fisheries.

The fishing effort mentioned above for rock shrimp and for royal red shrimp while sporadic may suggest significant future fisheries. The trawl fishery for rock shrimp became commercially important during the 1970's. Table 8-19 reveals how landings have increased sharply and that it is most important on the northeast coast of Florida where the fishery is a primary one during late winter and fall. The activity in Georgia and South Carolina is secondary and is executed during periods of low catches or closed seasons in the penaeid fishery. The tremendous increase in fuel costs has reduced the profit margin in rock shrimp; the same is true for the even smaller royal red fishery. Though commercial landings have been small (Table 8-19) the potential does exist for expanded harvesting of royal reds, particularly between Cape Canaveral and St. Augustine, Florida (Cummins and Rivers, 1962). The shrimp industry has been slow to utilize the royal red resource due to several factors which are true for rock shrimp as well (Klima and Ford, 1970): (1) increased outfitting costs for deepwater trawling; (2) initial problems of fishing trawls in deep water; (3) reduced yield compared to penaeid shrimp; (4) no price advantage over penaeid shrimp; (5) lack of adequate market and (6) reluctance on the part of processors to handle products due to processing problems.

Table 8-19. Landings of rock shrimp and royal red shrimp in each South Atlantic state during 1971 through 1980 in thousands of pounds, heads-off. (Sources: 1971-1978 Shrimp Landings. 1979-1980 NMFS and State files.)

	Rock Shrimp				Royal Red Shrimp			
	N.C.	S.C.	GA.	FLA.	N.C.	S.C.	GA.	FLA.
1971	0	0	0	0	0	0	0	87
1972	0	0	0	53	0	0	0	15
1973	0	0	0	177	0	0	0	6
1974	0	0	0	303	0	0	0	1
1975	0	0	0	135	0	0	20	6
1976	0	0	0	1511	0	0	0	11
1977	0	204	0	799	0	0	0	20
1978	0	66	27	1,024	0	0	0	<1
1979	0	463	372	2,981	0	0	0	0
1980	3	16	203	2,094	0	0	8	6

8.2.5 Bait Shrimp Fishing

The utilization of shrimp, both alive and dead, as a hook and line fish bait occurs throughout the South Atlantic states. A large number of carnivorous fish species eat shrimp and are therefore attracted to baited hooks. Important marine and estuarine species taken by anglers on shrimp include spotted sea trout, weakfish, flounders, red drum, black drum, croakers, whiting, striped bass, spot, and mackerels. Shrimp are utilized extensively in both flat and bottom fishing inshore, but marine use is limited to pier and surf angling. Because shrimp are recognized as an excellent fish bait, the live and dead bait business is widespread and plays an important service role in the saltwater recreational fishing industry. As part of the commercial shrimp fishery, the bait business, except in Florida, is less important.

The bait shrimp fishery consists of all three *Penaeus* species, the predominant one being determined by season and locality. The fishery depends upon pink and brown shrimp on the northern and central coasts of North Carolina and on white shrimp in the southern area. The South Carolina fishery is for predominantly white shrimp, but brown shrimp are taken in the late spring and early summer. In South Carolina and Georgia the fall sport angling season peaks coincident with the peak availability of white shrimp in inshore waters. North of New Smyrna on the Florida coast white shrimp make up the bait fishery while it consists of brown and predominantly pink shrimp southward to Fort Pierce. *Penaeus brasiliensis*, a grooved shrimp closely related to pink shrimp, finds some importance as a bait species in Biscayne Bay, Florida during the summer.

Pink and brown shrimp are more viable in captivity than are white shrimp and are therefore more useful in the live bait business. In Florida white shrimp are less desirable also because they reach a size in the nursery areas too large for most live bait usage.

With increasing demand for shrimp in recent years, competition between bait and commercial shrimping has presented some problems. Commercial shrimpers are generally against most shrimping activities involving large catches of small creek shrimp; their feelings are based on the proposition that such inside shrimping is deleterious to their welfare from the standpoint of lost future income and habitat destruction.

8.2.5.1 North Carolina Bait Shrimp Fishery

Shrimp is the most important natural bait in North Carolina and is used for catching mainly flounder, spot, croaker and trout on the bottom inshore waters. Its use is mainly in the summer tourist season but stretches from spring through fall. Most bait shrimp in North Carolina are caught in the smaller sounds and in the tributaries of Pamlico Sound. All three species are utilized. Seines and cast nets are the major gears for taking shrimp for personal bait use.

There is very little commercial effort toward shrimping specifically for bait in the State. The primary source of dead shrimp for bait is the commercial catch for food by trawl and channel net. Fishermen utilizing those gears and packers who buy from those fishermen sell much of their small shrimp to bait dealers. Most bait shop and pier owners buy in bulk and repackage in small amounts as either fresh or frozen for resale. The few live-bait shrimp retailers supply some commercial fishermen with holding tanks to transport live shrimp. Problems which have limited the live-bait industry include a limited number of areas opened specifically for bait shrimping, difficulties in keeping and holding live shrimp, and angler resistance to high live bait prices.

No gear laws or regulations apply specifically to bait shrimp activity in North Carolina. The minimum trawl mesh measurement is 2.0 cm (3/4 in) (bar) and that for channel nets and seines is 1.6 cm (5/8 in). Cast nets and seines of less than 5.91 m (20 ft) with smaller mesh have been permitted in both open and closed shrimping areas by administrative policy for bait shrimping. Effective October 1, 1981 there is no restriction on cast net mesh size, and bait shrimpers may harvest 100 shrimp per person per day from otherwise closed areas. Use of cast nets is allowed in open shrimping areas anytime including during the period of one hour after sundown Saturday night to one hour before sundown Sunday night, which is when other shrimping activities are prohibited (D. Spitsbergen, N.C. Dept. Nat. Res. and Comm. Devl., Div. of Marine Fisheries, Morehead City, NC; pers. comm.).

8.2.5.2 South Carolina Bait Shrimp Fishery

Live shrimp is one of the most popular inshore recreational baits in South Carolina, but few bait dealers carry them due to the difficulties of holding them for sale. Of 72 bait dealers interviewed in 1981, only seven maintained live shrimp for sale during a portion of the year (C. Moore, S.C. Marine Res. Center, Charleston, SC; pers. comm.). Most anglers catch their own live bait as needed by baited drop nets, seines, and cast nets. Most live shrimp sold in South Carolina are caught there, but a portion is trucked in from Florida. The same recreational gears utilized by individuals for personal use are used by those catching shrimp for sale. A bait shrimp law allowing dealers to catch up to 100 pounds of live shrimp per trip in otherwise closed areas and periods in Beaufort County was in effect from 1974 through 1979. At present no regulations are specific to bait shrimping in South Carolina (C. Bearden, S.C. Mar. Res. Center, Charleston, SC; pers. comm).

Fresh and frozen dead shrimp is the most popular and available natural marine bait utilized for inshore fishing in South Carolina. It is available at any marine bait shop or retail seafood market virtually year around. Most of those shrimp are taken from local waters by commercial shrimp trawlers and packaged by dealers for resale. Of 92 dealers contacted in South Carolina during 1981, 66 sold fresh or frozen bait shrimp. Three reported annual sales exceeding 10,000 lb, and another nine reported selling over 5,000 lb. In addition, 21 had sold over 1,000 lb each and the remaining 33 dealers sold less than 1,000 lb annually. Ten indicated they had obtained shrimp from another state, eight from Florida and one each from Georgia and North Carolina (C. Moore, S.C. Marine Res. Center, Charleston, SC, pers. comm.).

8.2.5.3 Georgia Bait Shrimp Fishery

During 1956 through 1976, sport bait shrimpers in Georgia were allowed to employ up to a 3 m (10 ft) wide otter trawl with no license required and no restrictions as to trawling areas. Each fisherman was limited to two quarts per trip. Commercial bait shrimpers were limited to 6.1 m (20 ft) nets but could fish anywhere and were not limited as to the amount of catch allowed per day. With the full-year closure of inshore shrimping areas beginning in 1977, such bait shrimping activity halted. Subsequently, restrictions and allowances were placed on those fishing in the internal waters of the State, and currently the Department of Natural Resources recognizes two types of licensed bait shrimpers. The most numerous (1,455 in 1980-81) are the sport bait shrimpers, who are allowed to trawl year round in designated inshore zones with nets of 3 m (10 ft) or less during daylight hours. It is unlawful for shrimp taken under a sport bait shrimping license to be sold or consumed by humans, and there are limits on how much shrimp may be caught and how much dead shrimp may be held. The second group is the commercial bait shrimpers who are licensed to sell their live shrimp after posting a $1,000 forfeiture bond. The 74 licensed during 1980-81 were allowed to trawl at any time of day from May 15 to August 31 in the same areas as sport bait shrimpers but with nets of up to 6.1 m (20 ft) in width. They could possess on board no more than 50 quarts of shrimp, no more than 10 percent of which could be dead. There were also regulations concerning identification boards, record keeping, and the sale of shrimp between dealers.

There was a two boat limit on the number of trawlers working for one dealer. Regulations concerning holding facilities stated that they must be non-toxic and either floating bait containers or tanks with circulating or recirculating saltwater (Georgia DNR, 1981).

Of 49 marinas in Georgia in 1980, 25 carried live shrimp which are sold in quart, pint, and infrequently, dozen measurements. The retail price of live, locally caught shrimp during summer and fall has been $4.50 per quart. Shrimp brought into Georgia from Florida and sold by wholesalers to dealers in Georgia during the spring of 1981 cost an average of $52 per thousand shrimp. Retail prices ranged between $7 and $8 per quart which contained an average of about 125 shrimp (S.C. Sea Grant Consortium, 1981).

A Georgia bait dealer may own and operate his own boats, own a boat and hire an operator, or buy bait from a local or out-of-state source. His shrimp are held in holding tanks ranging from simple float-supported pontoons to elaborate aeration and water exchange systems capable of holding tens of thousands of live shrimp. Dead shrimp are removed daily and packaged as dead bait.

Dead bait shrimp are retailed in frozen containers up to one quart in size and marked "Sold for Bait Only". Spoiled shrimp remaining from food shrimp activities are often sold as frozen bait. Dead, fresh frozen shrimp with heads-on retail for $3 to $4 per quart, and spoiled, heads-off shrimp bring $2 to $2.25 per frozen half-pound box.

During 1980, the 74 live shrimp dealers operating in Georgia were supplied by 47 commercial bait boats. Those dealers consisted of marinas, private docks, houseboats, food stores, and bait shops. Most dealers who carried live shrimp did so mainly to attract customers to other commodities (S.C. Sea Grant Consortium, 1981).

The use of live shrimp as bait in Georgia is directed at primarily spotted sea trout and secondarily at red drum, flounder, black drum, croaker and whiting.

Live shrimp are available from late spring through fall and dead shrimp are used year round, particularly when live shrimp are not available. Dead shrimp as a bottom bait are attractive to a host of game and non-game species. Fresh and frozen shrimp heads are used as bait in commercial traps for eels and catfish in coastal areas. Normally the transfer of shrimp heads from shrimpers and dealers to fishermen who work traps is gratis.

8.2.5.4 Florida Bait Shrimp Fishery

In Florida waters, a variety of gears are utilized in capturing shrimp for bait with a major portion of the catch made by trawls. Also used are roller frame trawls, known as beam trawls, in commercial and recreational fisheries, and cast nets, dip nets and push nets in the sport bait fishery.

The commercial bait shrimp fishery of Florida is much larger and economically more important than those of the three other South Atlantic states. Table 8-20 presents the recorded landings of live shrimp (numbers) and of dead shrimp (lb) made on the east coast of Florida including Dade County each year since 1972. The average annual number of live shrimp taken during that period was 22.3 million. The 1980 production of dead shrimp was unusually high and may be an indication of unlawful use (human consumption) of shrimp taken under bait permits (F. Kennedy, Fl. Dept. Nat. Res., Marine Res. Lab., St. Petersburg, FL; pers. comm.). Excluding 1980, the average annual dead shrimp production was 108 thousand lb heads-on. The numbers of bait shrimp production licenses issued for the six county area around the St. John's River (Clay, Duval, Nassau, Putnam, Flagler, and St. John's) have been 96 in 1976-77, 52 in 1977-78, 58 in 1978-79, 90 in 1979-80, and 110 in 1980-81 (Fl. Dept. Nat. Res., unpubl. data). Considerable competition exists between bait, commercial, and recreational shrimpers in the St. John's River estuary particularly near Jacksonville. Each claims a right to the shrimp resource often to the point of preferring exclusion of other groups. Apparently abuse of shrimping regulations in that area exists, in that licensed bait and recreational fishermen are exceeding catch

Table 8-20. Florida wholesale bait shrimp landings and value for 1972 through 1980. (Source: J. E. Snell, NMFS, Miami, Florida; Pers. Comm.).

Year	Live Shrimp Number	Value $	Dead Shrimp Lbs. (heads-on)	Value $
1972	25,788,268	630,401	152,876	87,800
1973	24,000,520	673,697	132,636	105,911
1974	25,016,656	762,289	118,976	71,795
1975	25,292,145	754,073	79,357	76,029
1976	23,371,805	762,501	50,408	54,570
1977	22,935,328	862,334	65,781	69,909
1978	17,743,032	604,606	56,656	56,864
1979	16,734,629	553,437	51,389	68,755
1980	19,602,806	769,241	909,993	1,324,429

limits and/or selling their catches for human consumption. Actual or, at least, perceived competition results on the fishing grounds as well as in the market place (F. Kennedy, Fl. Dept. Nat. Res., Marine Res. Lab., St. Petersburg, FL; pers. comm.).

Live bait businesses are mostly small family operations employing 2 to 5 persons. Holding systems are usually rectangular wood or concrete tanks with 15.2 to 30.5 cm (6-12 in) of water and an open saltwater pumping system. Aeration is by spraying incoming saltwater on the surface in the tank (F. Kennedy, Fl. Dept. Nat. Res., Marine Res. Lab., St. Petersburg, FL; pers. comm.). Similar set-ups but with closed, or recirculating, water systems are utilized for transporting live shrimp. Refrigeration of sea water to transport shrimp has recently been effected in the northern Gulf of Mexico bait business and may be attempted in Florida (F. Kennedy, Fl. Dept. Nat. Res., Marine Res. Lab., St. Petersburg, FL; pers. comm.). Detailed descriptions of Florida's bait shrimp industry are in de Sylva (1954) and Woodburn et al. (1957).

8.2.6 Competition and Conflict

8.2.6.1 Among Shrimpers

As long as two or more people are attempting independently to obtain the greatest portion possible of a limited resource, there will be competition. When the activities of one person affect negatively the ability of another to harvest the resource, other than by affecting the amount available for him to harvest, there is conflict. In the shrimp fishery a good example of competition is the relationship between an inshore commercial channel netter and an offshore trawler operator; they affect only the amount of shrimp the other can catch. A conflict exists between a channel net operator and a trawler operator who attempt simultaneously to fish in the same river channel. They affect not only how much the other catches but also the ability to catch shrimp in the future by negatively affecting gear. Though competition is very great among shrimpers, conflicts are generally less common and isolated. This is the case due to management of shrimping methods, gears, areas, and times by regulatory state agencies with the prevention of conflict as a major objective. Without such management controls, conflicts would be inevitable.

Several specific forms of competition among shrimpers involve wastes, or perceived wastes, of portions of the shared resource. The problem of discards of pre-commercial size shrimp taken along with commercial size shrimp exists primarily in the inshore North Carolina waters but occurs occasionally in South Carolina as well. In North Carolina's sounds during fall of some years major migrations of brown shrimp enter sandy bottom, high salinity pink shrimp nursery grounds near inlets. To continue working on the brown shrimp, a shrimper is actually competing with himself as he is destroying a portion of the source of his future earnings, the spring pink shrimp stock. A similar situation occurs infrequently in South Carolina when small whites enter fishing areas in large numbers. Management actions differ in these situations depending on a variety of factors. The results of a North Carolina study (Waters, et al., 1979) state that the potential for increasing income in the fishery through reduced discards exists only at very high discard rates due primarily to high mortality in succeeding months and the low probability of catching those pink shrimp that are saved from discard. It also states the problem is not severe enough to warrent adoption of a management policy to protect juvenile pinks during normal seasons.

Another form of competition involving possible waste is that between seiners and cast netters who harvest and retain or discard pre-commercial size shrimp which could possibly be a more valuable future catch. Operators of large trawlers maintain that netters in nursery areas destroy potentially valuable shrimp to little or no benefit, and they often suggest that the minimum recreational gear mesh size be made equal to that imposed on commercial trawlers. In South Carolina, where the minimum mesh size (bar) allowed in nursery areas is 1.3 cm (1/2 in), McKenzie and Whitaker (1981) determined that any increase in mesh size probably would eliminate capture of creek shrimp except just before they move into deeper water during later stages of development. Such action would reduce substantially the recreational shrimp catch.

Some general statements can be made concerning the desires of various user groups on the subject of competition. Recreational and bait shrimpers want to utilize moderate size mesh in a wide geographic area for as long a season as possible. Operators of small and medium size trawlers want inshore trawling areas opened as early and as long as is reasonable. Some want restrictions put on activity in the nursery areas, and some want limits put on the maximum size of trawlers and nets allowed in-shore. Operators of large trawlers, in many cases, want in-shore areas kept permanently closed, broad restrictions on nursery area activity, and long off-shore seasons. Many trawler operators want out-of-state entry limited but want no limitations which would prevent them from obtaining larger or additional boats, or their sons from entering the fishery.

8.2.6.2 With Other Fishermen

Competition to a lesser degree than mentioned above and conflicts to a greater degree exist between shrimpers and other fishermen. Shrimpers compete with other fishermen simply by removing such incidental catches as blue crabs and juveniles of commercially and recreationally important finfish, often to the benefit of no one. Conflict for gear space may exist in areas where moving and stationary gear are utilized, a good example being shrimp trawlers and stationary crab traps. It has become of major importance in North Carolina where the number of traps has increased from about 56,000 in 1977 to an estimated 120, 000 to 130,000 in 1981 (D. Spitsbergen, N.C. Dept. Nat. Res. and Comm.Devl., Div.

Marine Fisheries, Morehead City, NC; pers. comm.). The excess effort is probably not harmful to the crab resource since it is basically a single-year crop. But the number of traps has made a considerable amount of legal trawling area untrawlable because of props and trawls snagging them. Currently the North Carolina Division of Marine Fisheries designates trap areas and the season as being between May 1 - November 1, but those actions are becoming insufficient.

8.2.6.3 Related to Conservation and the Environment

Land modifications such as dredging, draining, filling, and impounding of wetlands and timbering, mining, and development of highlands adjacent to wetlands are major sources of detrimental effects on shrimp survival, and therefore conflict with shrimpers' success. Such modifications are widespread in the South Atlantic states, and major steps have been made in alleviating the conflicts related directly to wetlands (Section 6.4). But protection of upland areas which affect adjacent wetlands is not so secure. An example is the critical increased runoff of freshwater in North Carolina coastal areas resulting from agriculture, silviculture, peat mining, land development, and channelization activities. Those activities have reduced storage capacity and retention time for freshwater. The resulting large slugs of runoff have reduced salinity levels in shrimp nursery areas primarily in the tributaries of Pamlico Sound. The effects of hyposalinity have been documented by the North Carolina Division of Marine Fisheries. Shrimp abundance in the nursery areas and subsequent commercial harvest is directly related to salinity regimes in the nursery area (D. Spitsbergen, N.C. Dept. Nat. Res. and Comm. Devl., Div. of Marine Fisheries, Morehead City, NC; pers. comm.).

Other existing and potential sources of conflict which could impact shrimp or shrimping include artificial reef and trolling alleys, and offshore oil rigs, pipelines, ports and spills.

One major and well known conflict which shrimpers have faced in recent seasons is the protection of marine turtles. Commercial shrimping activities have been highly implicated as a cause of mortality of several marine turtle species (Hillestad et al., 1978; Ulrich, 1978). Ulrich in Sandifer et al. (1980) summarized the available data concerning occurrence, habits and incidental capture of marine turtles in the Sea Island Coastal Region of South Carolina and Georgia. A summary of that treatment follows with emphasis on the effects of shrimping activity on marine turtles.

The Atlantic leatherback (Dermochelys coriacea), Kemp's ridley (Lepidochelys kempi), and Atlantic hawksbill (Eretmochelys imbricata imbricata) ~~turtles~~ are considered transient species in the Sea Island Coastal Region (hereafter termed Region) which stretches from Pawleys Island, Georgetown County, South Carolina to Cumberland Island, Camden County, Georgia. They and the Florida population of the Atlantic green sea turtle (Chelonia mydas) another transient species in South Carolina and Georgia waters, are listed as endangered under the 1973 U.S. Endangered Species Act. The Atlantic loggerhead turtle (Caretta caretta caretta) is considered threatened (U.S. Dept. of Interior, Fish and Wildlife Service, 1979) and is the only seasonally resident marine turtle species in the Region. Marine turtles are associated with coastal waters at times of mating and nesting, hatching, and feeding during warm months. Considerable data concerning nesting are available, but a paucity of data concerning other aspects exist. Most occurrence records in the Region are the result of incidental capture by fishery vessels or strandings of carcasses on beaches (Hillestad et al., 1978; Ulrich, 1978).

The Atlantic loggerhead turtle is the only marine turtle nesting on South Carolina and Georgia beaches and it utilizes most barrier islands to some degree, many extensively. The barrier island beaches of South Carolina and Georgia provide some of the most important loggerhead nesting sites in the United States. Female loggerhead turtles may nest as many as five times during a nesting season (Davis and Whiting, 1977) which is from mid-May through mid-August with peak activity in late June and early July. In South Carolina the most significant nesting area is in the Cape Romain National Wildlife Refuge, especially Cape Island. In Georgia, Little Cumberland, Cumberland, and Jekyll Islands provide that State's most important loggerhead nesting beaches. The probability of individual females returning to the same nesting beaches appears high (Bell and Richardson, 1978; Richardson et al. 1978). Major problems include the depredation of nests by humans, raccoons, and ghost crabs; human development of nesting beaches; erosion; overexploitation; and incidental catch. Despite these difficulties loggerhead populations appear to be in somewhat better shape than those of other marine turtles in the Region.

There is evidence that some turtles overwinter in offshore waters of the Region. Loggerheads have been found in a "dormant" state partially buried in mud in Florida's Canaveral ship channel during winter (L. Ogren, 1977, NMFS Panama City, Fla.; pers. comm.). It is possible that such wintering behavior may occur also in suitable areas of Georgia and South Carolina; however, no evidence was found during recent NMFS surveys.

After entering the sea, hatchling marine turtles are preyed upon by sea birds and predatory fishes. Accounts of young turtles being devoured include a loggerhead taken from the stomach of a black sea bass captured in 26 meters off-shore of Charleston (Charleston Museum files); two loggerhead hatchlings taken from a deep water shark (Brongersma, 1972); one Atlantic green and eight Atlantic loggerhead turtles from the stomach of a dolphin east of St. Lucie Inlet, Florida (Whitham, 1974).

Man's greatest impact on marine turtles in the sub-tidal marine system is the incidental capture and associated mortality caused by commercial fishing. Bullis and Drummond (1978) noted that research vessels captured incidentally six Atlantic loggerheads and one Atlantic hawksbill in the offshore area south of Cape Hatteras, North Carolina to Brunswick, Georgia from 1950 to 1976.

In South Carolina inshore waters Atlantic loggerheads are taken incidentally by shrimp trawlers from mid-May (normal opening of shrimp season) until at least the end of October (Ulrich, 1978). Hillestad et al. (1978) reported incidental captures from June through early October in Georgia. Sitings and catches of other species are much less common in the Region. Juvenile Atlantic green turtles have been taken by shrimp trawlers and have been seen stranded in South Carolina (G. Ulrich, 1978, S.C. Marine Res. Div., Charleston, SC; pers. comm.). Not over three such specimens have been reported in any one season. Hillestad et al. (1978) has reported similarly small figures in Georgia. Recent catches by shrimp trawlers are documented for Kemp's ridley (Hillestad et al., 1978) and Atlantic leatherback (Ulrich, 1978 and Hillestad et al., 1978) turtles in the Sea Island Region.

Incidental capture of Atlantic loggerhead turtles by shrimpers is often thought to pose the most serious threat to breeding females. Yet, the majority (88 percent) of the incidentally captured turtles in Georgia were juveniles (Hillestad et al., 1978).

Similarly, Ulrich (1978) reported that adult females made up only 18 percent and 10 percent of turtles observed during sampling onboard shrimp vessels in 1976 and 1977, respectively, in South Carolina. Thus, available data indicate that contact by shrimpers with the adult segment of the Atlantic loggerhead turtle populations is quite small. Likewise, hatchling turtles also appear to be excluded from the incidental catch (Hillestad et al., 1978). A gill net fishery for Atlantic sturgeon in the Winyah Bay area of South Carolina also results in a relatively small number of turtles drownings related to incidental capture (Ulrich, 1978). Nevertheless, the impact of incidental catch mortality on the continued survival of marine turtles in the Southeastern United States is not currently known because of our lack of information on turtle population sizes, natural survival rates, and annual recruitment.

Research on techniques to reduce the incidental capture and mortality of marine turtles in shrimp trawls has been conducted by the National Marine Fisheries Service, Southeast Fisheries Center. The research has resulted in the development of the turtle excluder device (TED). The TED was tested aboard commercial trawlers on shrimp grounds on the South Atlantic and reduced turtle captures 89 percent while maintaining shrimp catches equal to those of standard shrimp trawls. The TED also has the potential capability to significantly reduce by-catch associated with shrimp trawling other than turtles. It consists of a 4 x 3 x 3 ft frame of galvanized pipe with bars slanting at approximately 45 degrees spaced 3 to 6 inches apart and a 3 ft square door in the bottom or top. The TED is placed inside the trawl at the intersection of the trawl body and the bag. A turtle or other large object entering the bag strikes the slanted bars and is forced toward the trap door. The door opens when preset tension is exceeded, the turtle is ejected, and the door closes (NMFS, 1981). A recent variety of the TED has a top opening door which is held closed by gravity instead of by elastic cords which are used to hold closed the bottom opening variety.

During 1980 washups of sea turtles carcasses were recorded along the coasts of the four South Atlantic states by the Southeast Sea Turtle Stranding and Salvage Network. Table 8-21 shows the number recorded during each month in each state during 1980 with other available data. The number of recorded 1980 strandings is high when compared to that of other seasons. 1980 was the first year of operation of the full Network which was initiated by the Southeast Region Sea Turtle Recovery Team and managed by NMFS. This is a cooperative effort involving federal, state, and private entities (S. Hopkins, S.C. Wildl. Marine Res. Dept., Chas., SC; pers. comm.). The increased attention directed to turtle strandings probably has been the most important factor increasing the total number of strandings recorded, but considerable increases were noted in 1980 on beaches which had been surveyed during earlier years (J. Richardson, Ga. Dept. Nat. Res., and S. Hopkins, S.C. Wildl. Marine Res., Chas.,SC; pers. comm.).

Increased mortalities may be results of larger populations of sea turtles entering trawling areas due to success in stock protection efforts such as hatchery and headstart programs, and conservation measures protecting nesting females and hatchlings.

The results of a meeting of conservationists, shrimp industry representatives and state and NMFS officials in Charleston, South Carolina on September 18, 1980 to examine ways to reduce sea turtle mortality from commercial shrimping activities were as follows:

(1) Shrimp industry representatives were to ask shrimp fishermen to voluntarily reduce trawl time to 90 minutes at all times in critical areas of high

Table 8-21. Available data concerning the numbers of recorded sea turtle carcass strandings in the South Atlantic states during each month 1979, 1980, and 1981. (Sources: North Carolina - Frank Schwartz, Univ. of N.C. at Chapel Hill; South Carolina - Sally Hopkins, S. C. Wildlife and Marine Resources Dept.; Georgia, Jim Richardson, Ga. Institute of Ecology. Florida - Ross Witham, Fla. Dept. of Nat. Resources).

	North Carolina			South Carolina		Georgia			Florida (E.Coast)	
	1979	1980	1981	1980	1981	1979	1980	1981	1980	1981
January	ND	2	1	0	0	0	0	0	4	12
February	ND	2	2	0	0	0	0	0	3	22
March	ND	1	3	0	0	0	0	0	17	21
April	ND	2	39	25	30	21	4	2	13	15
May	ND	14	13	33	12	150	102	5	23	17
June	10	15	27	88	16	68	152	7	85	28
July	4	40	18	282	152	54	324	112	63	15
August	17	30	11	99	68	34	101	40	21	
September	10	8	16	41	33	84	86		23	
October	0	3		17		23	17		9	
November	0	39		0		13	4		14	
December	0	2		0		2	0		29	
Totals	41	158	(130)	585	(311)	449	790	(116)	304	(130)

ND - No data
Totals in parentheses are partial year totals.

sea turtle abundance or mortality. Those critical areas were identified as Georgia, South Carolina, North Carolina, and the upper Atlantic coast of Florida.

(2) NMFS was to promulgate emergency regulations under the Endangered Species Act to provide for an additional method of sea turtle resuscitation on board trawlers and for relocation of turtles to non-shrimping areas (NMFS memorandum, C. Oravetz, September 24, 1980).

The effectiveness of actions taken by shrimp fishermen to reduce the incidental capture and mortality of turtles has not been documented. Sea Turtle Emergency Regulations modifying resuscitation procedures for threatened sea turtles were issued effective October 1, 1980 for 240 days (NMFS memorandum, C. Oravetz, October 6, 1980) and were reissued permanently on September 2, 1981 (U.S. Dept. of Commerce, NMFS, 1981). Their effectiveness has not been documented, either. Reduction in trawl time had earlier been demonstrated to reduce turtle mortality significantly. Trawl time of 60 minutes showed a 2 percent turtle mortality. Trawling for 90 minutes showed a mortality rate of 6 percent while trawling for 270 minutes resulted in mortalities of 26 percent (NMFS memorandum, C. Oravetz, September 24, 1980).

Data needs associated with the incidental catch and mortality of sea turtles include:

(1) Identification and quantification of causes of mortality other than incidental catch by shrimp trawlers. Occasionally sea turtles are caught in other fisheries including those for menhaden, shad, and sturgeon. Parasitism and high water temperatures have been suggested as natural causes.

(2) Expansion of carcass stranding survey efforts. All coastal areas have not been surveyed in the past; therefore, available data are underestimates of total strandings. Additionally, there is evidence that a significant portion of turtle carcasses do not reach beaches. (S. Hopkins, S.C. Wildl. Marine Res. Dept., Charleston, SC; pers. comm.).

(3) Quantitative measurement of the effect of mortalities on turtle stocks. It is widely assumed that considerable negative effects result on turtle stocks by such mortalities, but data concerning the proportions of juvenile and adult mortalities are incomplete. If a biologically acceptable level of mortality exists, it is not known.

(4) Nesting and feeding habits, and qualitative habitat descriptions. Data concerning nesting frequency, age at first nesting, nesting success and other aspects of nesting are geographically spotty. The reasons why selected beaches are utilized heavily by nesting and feeding turtles are not well known. The extent to which turtles are attracted to trawler discards is unknown. Description and identification of critical onshore and nearshore habitat are needed.

(5) Impacts on shrimping industry. Efforts to protect turtles including use of excluder devices, restrictions on shrimping times, areas, and tow duration, and resuscitation efforts will exact some costs on shrimpers. The extent of those costs and their effects on an economically burdened industry is not known.

(6) Information exchange. An understanding of the importance of sea turtles as components of complex coastal marine ecosystems is not held by most fishermen. Education toward such an end would facilitate the recovery of sea turtle stocks. Also, researchers and managers could gain insight from shrimpers concerning turtle habits, gear modifications, and other aspects of turtle/shrimper interactions.

8.2.7 <u>Assessment and Specifications of Domestic Annual Harvesting Capacity (DAHC)</u>

The average landings of shrimp in the South Atlantic states have not increased over several decades, even though the number and efficiency of harvesting units has increased significantly. For that reason the capacity of the domestic fleet to harvest shrimp is believed to be considerably greater than the maximum available resource in any year.

8.2.8 Assessment and Specifications of the Extent to Which U.S. Fishermen will Harvest Optimum Yield

Historically United States fishermen have been the sole producers of the shrimp harvest in the South Atlantic states. Assuming optimum yield to be equal to the average yield of the past 2.5 decades (25 million lb), or equal to the average of only recent high yield seasons (26.9 million lb), or equal to a considerably higher level, the South Atlantic fleet is capable of sustained harvest of optimum yield.

8.2.9 Assessment and Specification of Domestic Annual Processing Capacity

Based on data presented in Section 9.4., the capacity of domestic shrimp processors far exceeds the availability of domestic shrimp.

8.2.10 Historical and Projected Transfers from U.S. Harvesters to Foreign Vessels

There is no evidence of historical or projected transfers of shrimp or shrimp products from U.S. harvesters to foreign vessels.

8.3 Foreign Fishing Activity

Exploitation of the shrimp resource of the southeastern Atlantic coast by fishermen or vessels of other nations is non-existent.

8.4 Interactions between Foreign and Domestic Participants

As there are no foreign participants in the shrimp fishery of the southeastern Atlantic coast, there are no interactions between foreign and domestic participants. Neither are there interactions between domestic shrimp fishermen and foreign fishermen of other fisheries.

9.0 DESCRIPTION OF THE ECONOMIC CHARACTERISTICS OF THE FISHERY

Since 1976, there has been a steady increase in the number and size of trawlers in the South Atlantic shrimp fishery (Tables 8-12 to 8-16). This growth in fleet size is indicative of private capital which has been invested in the shrimp fishery. Unfortunately, during 1980 and 1981 the fishery has been under a serious cost-price squeeze. This condition has resulted from a number of interacting factors such as: (1) shrimp landings cannot be increased significantly to improve individual vessel revenue and fleet efficiency; (2) there has been a dramatic increase in operating expenses such as fuel, ice, maintenance, etc.; (3) downturns in the economy have resulted in faltering consumer demand; (4) supply competition from the Gulf of Mexico and foreign imports have had negative effects on South Atlantic ex-vessel prices. The net effect has been the inability of individual vessels to generate enough revenue to satisfy fixed costs and, in some cases, operating expenses. All of the above factors are symptomatic of the severe economic crisis of the South Atlantic fishery.

9.1 Domestic Ex-Vessel and Wholesale Market Trends

9.1.1 Ex-Vessel Market

9.1.1.1 Demand Characteristics of Ex-Vessel Prices

Shrimp consumption in the U.S. has increased steadily during the period 1960-1977 (Table 9-1). The estimated aggregate consumption in 1977 was 482 million lb, an increase of 92 percent from 1960. Per capita consumption has followed the same trend as aggregate consumption during the last two decades. Per capita consumption of shrimp in the U.S. has increased 5.1 percent annually, on the average, from 1960 through 1977. However, consumption of shrimp has declined since 1977.

Doll (1972) estimated ex-vessel price and income elasticities of demand using annual data from 1950 to 1968. The ex-vessel price elasticity of demand

Table 9.1 Supply and utilization of all shrimp (heads-off weight) in the U.S., annually 1960-1980, with emphasis on imports. (Source: Shellfish Market Review, September, 1981. Last three columns calcualted.)

	Supply				Utilization				Relation of Imports To		
Year	Beginning Stocks	U.S. Landings	Imports[1]	Total	Ending Stocks	Exports	Apparent Total	Consumption Per Capita	U.S. Landings	Apparent Consumption	Gulf of Mexico Landings
	million pounds							pounds	Percent		
1960	46.0	148.5	119.1	313.6	51.0	11.5	251.2	1.396	80	47	97
1961	51.0	103.9	134.6	289.6	26.2	15.5	247.7	1.354	130	54	169
1962	26.2	119.2	152.5	297.9	37.9	10.6	249.4	1.342	128	61	171
1963	37.9	150.7	167.3	355.9	55.8	21.8	278.4	1.477	111	60	130
1964	55.8	133.1	169.5	358.4	45.5	24.1	288.8	1.511	127	58	150
1965	45.5	152.3	179.0	376.8	38.2	25.3	313.4	1.619	118	57	147
1966	38.2	148.3	194.9	381.4	42.5	26.3	312.5	1.598	132	62	173
1967	42.5	190.0	202.1	434.6	57.6	36.1	340.9	1.726	106	59	143
1968	57.6	184.1	210.1	451.7	55.8	31.7	364.2	1.827	114	57	164
1969	55.8	195.0	220.7	480.9	62.5	51.8	356.6	1.771	112	61	173
1970	62.5	224.3	247.1	534.3	72.2	62.2	399.5	1.960	110	61	169
1971	72.2	238.1	215.1	525.4	69.9	62.7	392.8	1.905	90	54	149
1972	69.9	235.9	254.5	560.2	92.7	57.4	410.1	1.970	107	61	176
1973	92.7	228.6	230.8	552.1	79.0	74.6	398.5	1.899	100	57	200
1974	79.0	225.5	267.5	572.0	76.0	53.1	442.7	2.094	119	60	228
1975	76.2	209.2	231.0	516.3	47.4	52.3	416.6	1.955	111	55	215
1976	47.4	245.6	270.7	563.7	61.0	52.5	450.2	2.097	111	60	205
1977	61.0	288.4	270.4	619.9	80.1	57.9	481.9	2.227	94	56	163
1978	81.1	256.9	239.0	576.0	56.2	66.6	453.2	2.077	94	52	154
1979	56.2	205.6	267.1	528.9	78.3	51.1	399.6	1.816	129	65	208
1980	78.3	207.9	256.0	542.1	62.1	41.1	438.9	1.974	123	58	190

1/ Almost all is fresh and frozen.

was -1.27, indicating that shrimp are price elastic. This implies that increased landings mean a decrease in price but an increase in total revenue to fishermen. The positive income elasticity of demand for shrimp (1.12) indicates that a one percent increase in income nationally, increases the demand for shrimp by 1.12 percent (Doll, 1972). The study also concluded that domestic landings remain as the largest single source of price variation.

Ex-vessel or dockside prices per pound vary in direct proportion to size of the shrimp. Historically price differentials for species have been used in purchasing shrimp (see U.S. Bureau of Commercial Fisheries, 1958), but this practice has apparently become insignificant in recent years. In general, size-oriented price differentials can influence the substitution of certain counts (sizes) for others into different products like processed product vs. fresh-frozen uses. In the Gulf of Mexico fishery, Chui (1980) found demand higher for the larger shrimp sizes with the exception of small shrimp, although the larger the size, the greater the price response to fluctuations in supply. Chui's (1980) study also indicated that demand structure by shrimp size can significantly influence the aggregate ex-vessel value of domestic landings in the Gulf. This study showed that the Gulf total monthly value could be maximized when total monthly regional supplies (12.6 million lb) were allocated to only "large" and "medium" categories. Population dynamics of penaeid stocks would actually preclude such an allocation since it is beyond the feasibility of the resource due to growth and mortality characteristics.

In the 1975-1979 period, South Atlantic landings averaged about 10 percent of total domestic shrimp landings and only 4 percent of total U.S. annual shrimp supplies. Consequently, the average ex-vessel prices received from South Atlantic states generally follow Gulf prices (Carley and Frisbie, 1968). For example, Waters et al. (1980) concluded from their preliminary price analysis of different North Carolina shrimp counts that ". . . North Carolina prices follow those established in the larger Gulf or national market." In the case of North Carolina, there was some evidence for assuming shrimp demand to be perfectly elastic (Waters et al., 1980).

Since South Atlantic shrimp stocks tend to be isolated from critical environmental factors directly influencing Gulf stocks, the assumed high demand elasticity of South Atlantic shrimp prices can apparently amplify profitability or losses for South Atlantic shrimpers compared to their Gulf counterparts. Carley and Frisbie (1968) described this dilemma for Georgia shrimpers:

> "However, an above average catch for Georgia and a poor catch in the Gulf results in an exceptionally good year for Georgia due to the lower total catch and higher prices. The direct opposite of this condition results in a poor year for Georgia."

9.1.1.2 Domestic Ex-vessel Value Trends

The value of the South Atlantic shrimp fishery increased steadily from 1960 through 1980 (Table 9-2). Most of the increase in aggregate ex-vessel value was due to increases in prices. In the 1961-70 period, about 33 percent of the value of all landings in the region were contributed by Georgia, 25 percent from Florida and the remaining 42 percent from the Carolinas. Again in 1971-80, 33 percent of the region's ex-vessel value was derived from Georgia, about 29 percent from South Carolina and 38 percent from North Carolina and Florida. In 1979, the South Atlantic shrimp fishery experienced a record setting year for its total ex-vessel value ($67 million).

Since the increases in total ex-vessel value include inflationary price trends, the 1967 Consumer Price Index of 100 is often used to deflate aggregate ex-vessel value and price series (Maiolo et al., 1981). With the CPI deflation of total ex-vessel value (Table 9-3) the aggregate real ex-vessel value of the region's landings has still generally increased compared to 1967. The 1974 recession and related national shrimp market conditions generally contributed to the 1974 decline in ex-vessel prices (Table 9-4) not landings (Table 8-1). In

Table 9-2. Ex-vessel value of penaeid shrimp landings by state (in thousands of dollars).
Sources: 1961 through 1978 - Shrimp Landings, NMFS, NOAA; 1979 - South Atlantic State/Federal Statistics Program and TIMS, NMFS; 1980 - South Atlantic State/Federal Statistics Program.

Year	North Carolina	South Carolina	Georgia	Florida(East Coast)	Total
1961	830	1,301	2,371	2,437	6,939
1962	2,239	2,613	3,880	2,543	11,275
1963	1,065	643	1,802	1,736	5,246
1964	1,503	861	2,298	1,971	6,633
1965	1,719	2,635	3,418	2,388	10,160
1966	2,566	2,181	3,341	2,726	10,814
1967	1,809	1,679	3,022	2,500	9.010
1968	2,357	3,687	4,929	3,024	13,997
1969	4,476	3,429	4,984	3,298	16,187
1970	2,493	2,879	3,371	2,645	11,388
1971	4,766	6,388	6,466	2,996	20,616
1972	3,549	5,547	5,678	3,742	18,516
1973	4,738	8,907	9,343	3,567	26,555
1974	4,606	4,853	5,587	3,120	18,166
1975	5,054	10,803	10,485	3,841	30,183
1976	8,171	11,044	10,879	4,666	34,760
1977	7,239	5,616	6,839	3,701	23,395
1978	3,884	9,579	11,829	5,076	30,368
1979	9,729	19,578	24,775	12,949	67,031
1980	17,184	13,486	17,130	9,385	57,185

Table 9-3. Real (Deflated)[1] aggregate ex-vessel value of Penaeid shrimp landings by State in the South Atlantic States, 1967-80.
(Source: NMFS Fishery Statistics of the United States, shrimp landings, and unpublished data.)

Year	North Carolina	South Carolina	Georgia	Florida (East Coast)	Regional Total
		(Dollars in Thousands)			
1967	1,809	1,679	3,022	2,500	9,010
1968	2,262	3,538	4,730	2,902	13,433
1969	4,077	3,123	4,539	3,004	14,742
1970	2,144	2,476	2,899	2,274	9,792
1971	3,929	5,266	5,331	2,470	16,996
1972	2,832	4,427	4,532	2,986	14,777
1973	3,560	6,692	7,020	2,680	19,951
1974	3,119	3,286	3,783	2,112	12,299
1975	3,135	6,702	6,504	2,383	18,724
1976	4,792	6,477	6,381	2,737	20,387
1977	3,988	3,094	3,768	2,039	12,890
1978	1,988	4,903	6,054	2,598	15,541
1979	4,469	8,993	11,380	5,948	30,791
1980[2]	6,960	5,462	6,938	3,801	23,161

[1] Ex-Vessel value data are deflated by using the Consumer Price Index of 100 for all consumer items at the national level (Maiolo et al., 1981).
[2] Preliminary Data.

contrast, the 1980 total real ex-vessel value was the second highest in the years 1967-80 despite a decrease in the 1980 regional ex-vessel price (Table 9-4). This was attributed to the above average landings in the region (see Table 8-1, pg. 8-3).

9.1.1.3 <u>Current Ex-vessel Price Trends (1980-81)</u>

Compared to previous years, ex-vessel prices advanced substantially in 1978 and 1979 (Table 9-5) and then generally declined in the first half of 1980. This decline was associated with faltering consumer demand in the second half of 1979 and the decline in real disposable income during the 1980 recession. In the fall of 1979, restaurant purveyors were reporting the "slow movement" of shrimp and associated build-up of shrimp inventories (National Restaurant News, 1979).

The 1979 ending inventory, 78.3 million lb, was about 22 percent higher than the 1975-79 period average (Table 9-1). Due to relatively low supplies (i.e. imports and landings) and efforts to reduce inventory carrying costs, U.S. shrimp inventories dropped rapidly in the first half of 1980 (Gulf of Mexico Fishery Management Council, 1981) and consequently ex-vessel prices increased from June through August (Table 9-5). They declined again as fall Gulf landings and imports increased inventories in the second half of 1980. The 1980 ending fresh and frozen inventory, 62 million lb, was 21 percent below the 1979 ending inventory (Table 9-1).

In 1981, ex-vessel price displayed usual seasonal increases then began to decline (Table 9-5) as above average Gulf landings and imports increased U.S. inventories. During the first half of 1981, total South Atlantic and Gulf landings, 56.4 million lb (heads-off) was 43 percent higher than the 1980 first half and nine percent above the 1975-79 average (Vondruska, 1981) and July landings, 25.1 million lb, were up 40 percent compared to 1980. In July and August, ex-vessel prices decreased 29 percent and 32 percent respectively,

Table 9-4. Ex-vessel shrimp prices by state in the South (dollars per pound heads-off). (Source: Derived from annual landings and value of landings.)

Year	North Carolina	South Carolina	Georgia	Florida(East Coast)	Regional Total
1961	.46	.56	.59	.68	.59
1962	.62	.64	.72	.77	.69
1963	.51	.47	.52	.60	.53
1964	.56	.52	.61	.70	.61
1965	.51	.61	.62	.70	.61
1966	.72	.82	.81	.87	.80
1967	.60	.65	.71	.80	.69
1968	.82	.91	.89	.99	.90
1969	.91	.91	.91	1.01	.68
1970	.79	.91	.87	.91	.87
1971	1.00	.93	1.13	1.43	1.05
1972	1.01	1.07	1.22	1.37	1.15
1973	1.46	1.68	1.75	2.01	1.70
1974	.88	1.02	1.20	1.41	1.08
1975	1.56	1.90	2.02	2.32	1.91
1976	1.97	1.99	2.18	2.62	2.11
1977	2.08	2.25	2.33	2.67	2.27
1978	2.11	3.03	3.36	3.16	3.03
1979	3.16	4.10	4.22	4.28	4.00
1980	2.82	3.43	3.75	3.53	3.18

Table 9-5. Shrimp ex-vessel prices for selected count size, monthly, 1975-1981. (Source: (1) Weighted average, all species, South Atlantic and Gulf price to March 1979, NMFS, Shellfish Market Review, 1978-1980; (2) Weighted average all species, Western Gulf price from April 1979 to present, NMFS, Shellfish Market Review, September, 1981.)

Month	Count Size	1975	1976	1977	1978	1979	1980	1981
	21-25							
January		1.59	3.21	3.73	2.84	4.36	4.85	4.18
February		1.82	3.24	3.83	2.77	4.59	4.62	4.59
March		2.07	3.46	3.96	2.87	4.78	4.47	4.85
April		2.32	3.59	3.67	3.05	5.06	4.09	4.98
May		2.65	4.06	3.64	3.16	5.23	4.04	5.06
June		2.55	4.03	3.70	3.28	5.65	4.29	4.99
July		2.56	3.42	3.59	3.32	5.32	4.35	4.46
August		2.67	3.01	2.93	3.62	5.32	4.39	3.32
September		2.85	3.30	2.61	3.95	5.17	4.08	
October		2.90	3.15	2.75	3.78	5.03	3.67	
November		2.96	3.53	2.82	4.03	4.79	3.54	
December		3.04	3.65	2.66	4.02	4.80	3.79	
Average		2.51	3.47	3.32	3.62	5.01	4.18	
	31-40							
January		1.26	2.57	2.81	2.08	3.66	3.99	3.31
February		1.46	2.84	2.88	2.07	3.91	3.81	3.53
March		1.63	2.82	3.04	2.19	4.11	3.69	3.63
April		1.84	2.98	2.69	2.31	4.33	3.51	3.62
May		2.08	3.17	2.56	2.36	4.70	3.44	3.47
June		1.95	2.74	2.25	2.42	4.76	3.53	3.07
July		1.95	2.26	2.09	2.48	4.26	3.53	2.50
August		2.08	2.17	2.16	2.72	3.90	3.50	2.39
September		2.23	2.37	2.10	2.98	3.88	3.16	
October		2.30	2.31	2.05	2.96	4.12	3.03	
November		2.39	2.58	2.08	3.22	4.00	2.90	
December		2.48	2.66	2.01	3.21	3.97	3.08	
Average		2.03	2.62	2.39	2.73	4.13	3.43	
	51-67							
January		0.84	1.43	1.53	1.25	2.31	2.54	2.31
February		.98	1.55	1.60	1.30	2.62	2.28	2.63
March		1.13	1.60	1.75	1.42	2.80	2.53	2.51
April		1.28	1.75	1.48	1.62	2.93	2.39	2.93
May		1.37	1.79	1.35	1.46	3.06	2.30	2.77
June		1.23	1.33	1.19	1.37	2.83	2.23	2.31
July		1.26	1.42	1.30	1.57	2.44	2.31	2.09
August		1.35	1.55	1.34	1.69	2.49	2.50	1.97
September		1.36	1.56	1.27	1.84	2.69	2.41	
October		1.34	1.35	1.25	1.73	2.75	2.32	
November		1.40	1.45	1.22	1.88	2.67	2.22	
December		1.41	1.45	1.20	1.93	2.61	2.19	
Average		1.25	1.52	1.37	1.59	2.68	2.35	

for 31-40 counts compared to the same months in 1980. These low prices were generally attributed to above average summer landings in the Gulf and uncertainty regarding consumer demand. This market instability was apparently increased by high inventory carrying costs due to current interest rates (Vondruska, 1981). As previously discussed (Section 9.1.1.1) the combination of relatively low prices partially induced by high Gulf landings and the apparent below average landings in the Carolinas and Georgia in the 1981 shrimp season will decrease the aggregate ex-vessel value of the 1981 South Atlantic harvest. The 1981 season may be another example where the environmental isolation of Carolina and Georgia shrimp stocks from the Gulf of Mexico has amplified the losses of the South Atlantic fishermen.

9.1.2 Domestic Wholesale Market

9.1.2.1 Wholesale Value of Shrimp Products

The wholesale value of processed shrimp products from South Atlantic plants was 62.4 million in 1979. Raw breaded shrimp generated the most gross sales, 42 percent, for South Atlantic processors (Figure 9-1). Cooked breaded shrimp represented 30 percent of the total and peeled and deveined shrimp 15 percent (Figure 9-1).

Although the nominal aggregate wholesale value of shrimp produced by South Atlantic plants has increased since 1971, the real wholesale value during the 1970's has not increased (J. R. Duggan, shrimp processor; pers. comm.). Consequently, an increase in the total nominal wholesale value of processed shrimp products since 1971 is not indicative of expanded market shares or rising profits for these plants.

9.1.2.2 Imported Products

The volume of imported shrimp increased from 119.1 million lb in 1960 to 256.0 million lb in 1980 (Table 9-1) with record imports of 270.4 million lb in 1977. During the last two decades, imports have generally increased with the 1970-79 annual average imports, 248.9 million lb, exceeding the pre-

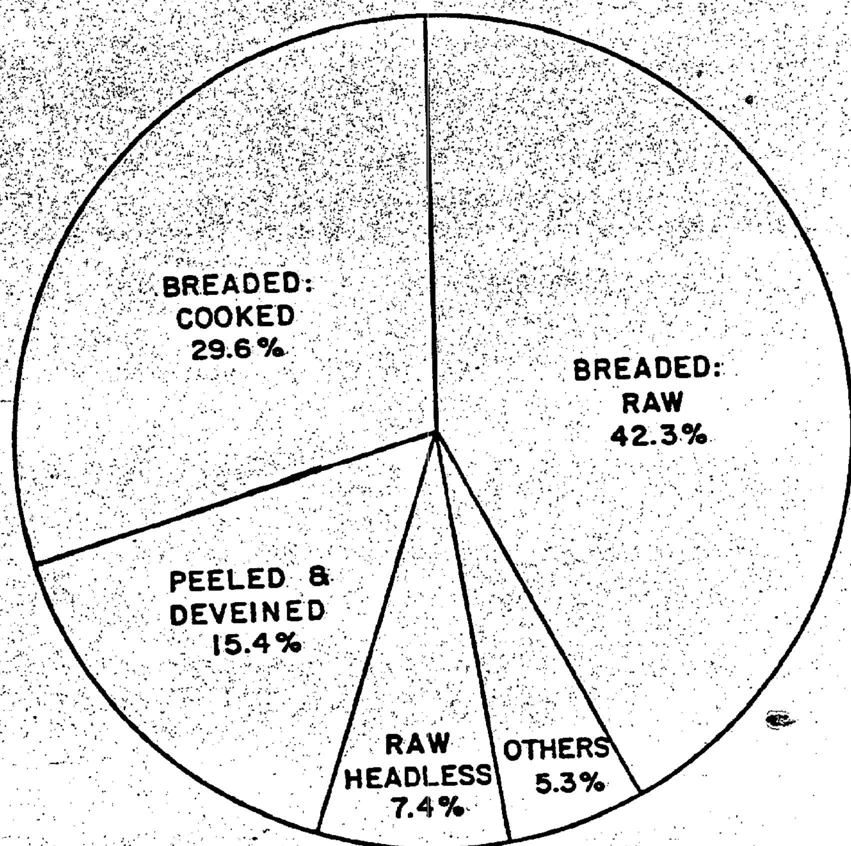


Figure 9-1. Shrimp products of the South Atlantic States, 1979. (Source: National Marine Fisheries Service, Processed Fishery Products, Annual Summary, 1979. Washington, D.C.: Dept. of Commerce.)

Note: Some of the products have been processed from raw products imported from other states or from foreign countries.

vious decade (174.8 million lb) by 42 percent. In the last 20 years, (1960-1980) domestic shrimp landings have only exceeded imports during five years and shrimp imports averaged about 58 percent of the U.S. annual apparent consumption (Table 9-1).

The major type of imported shrimp product, raw headless shrimp, constituted 63.3 percent by product weight of all product types in 1980 (Table 9-6). In the same year, the North American Continent continued to absorb more than 50 percent of all shrimp imports (Table 9-7) with about 35 percent of all U.S. imports provided by Mexico (GMFMC, 1981).

Penaeid shrimp raised by Ecuadorian mariculture firms supplied an estimated 10 million lb to U.S. markets in 1980 (Fish Boat, 1981). These mariculture firms apparently have lower total production costs per pound produced compared to conventional shrimp trawling technology (International Proteins Corporations, 1980). Although these penaeid mariculture firms provide only a small percent of the U.S. total shrimp supply, their capability to provide large shrimp (less than 40 count) could have a significant seasonal price effect on these counts in the future.

Due to depressed ex-vessel prices in 1974, the National Shrimp Congress filed a petition with the U.S. International Trade Commission to seek import relief pursuant to Section 201 of the Trade Act of 1974 (USITC, 1976). The final determination of the commission's investigation was that imported shrimp was increasing in such quantities as to be the substantial cause of serious economic injury to the domestic harvesting industry (USITC, 1976). Adjustment assistance for the shrimp harvesters was recommended.

The economic impact of shrimp imports and the related issue of government intervention to control imports has been reviewed by others (Miller and Marasco, 1976; GMFMC, 1981). In summary, imports have a detectable negative impact upon domestic ex-vessel price. For example, Miller (1975) concluded

Table 9-6. U.S. imports of shrimp, by type of product, 1980. (Source: NMFS, Fisheries of the United States, 1980.)

Type of Product	Quantity Thousand lb	Quantity Thousand $	Percent of Total lb	Percent of Total $
Shell-on (heads-off)	138,750	519,217	63.3%	72.2%
Peeled:				
Canned	4,225	8,063	1.9%	1.1%
Not breaded:				
Raw	66,270	170,459	30.2%	23.7%
Other	9,891	21,129	4.5%	2.9%
Breaded	172	395	.1%	.1%
Total	219,308	719,263	100.0%	100.0%

Table 9-7. U.S. imports of shrimp, by region of origin, 1980. (Source: NMFS, Fisheries of the United States, 1980.)

Region	Quantity Thousand lb	Quantity Thousand $	Percent of Total lb	Percent of Total $
North America	117,135	446,595	53.4%	62.1%
South America	48,074	156,914	21.9%	21.8%
Asia	46,058	89,646	21.0%	12.5%
Europe	4,617	14,717	2.1%	2.0%
Australia and Oceanic	1,530	6,692	0.7%	0.9%
Africa	1,894	4,699	0.9%	0.7%
Total	219,308	719,263	100.0%	100.0%

that ex-vessel prices could be increased by 30 percent if total supplies, which includes imports, were reduced by 18 percent. This would have required a 36 percent import reduction in 1975 assuming no change in the domestic landings.

In contrast, shrimp imports have a positive impact on the processing industry which depends on imports for up to 50 to 70 percent of its raw product needs (Prochaska and Cato, 1981). A reduction of imports would lower U.S. production of processed shrimp products. Significant reductions in shrimp imports would likely cause processing equipment and labor to be idle at times of the year when domestic landings are low. This would increase costs, therefore increasing the total difference or makeup between ex-vessel prices and consumer prices. This increase in the marketing margin would be partly passed on to consumers in the form of higher prices and possibly to fishermen in the form of lower ex-vessel prices (Prochaska and Cato, 1981).

In essence, shrimp imports have a positive effect on supplies and do not produce tremendous pressures on domestic prices. In addition, government interference could decrease the market stabilizing effects of imports; consequently, import restrictions might be counterproductive (GMFMC, 1981). Hutchinson (1978) suggested that adequate information on foreign markets, not import quotas, might reduce the apparent volatility of the U.S. shrimp market.

9.2 Export Market

U.S. exports of shrimp in 1980 consisted of 25.5 million lb of fresh and frozen products valued at $82.9 million and 6.2 million lb of canned products valued at $17.9 million (Table 9-8). About 34 percent of shrimp products exported in 1980 were imported from foreign countries. Data on exports by South Atlantic shrimp processors are not available.

Canada, Japan, and Mexico were the major markets for U.S. domestic fresh and frozen shrimp (Table 9-9). Small amounts of fresh and frozen shrimp were exported to Saudi Arabia, Netherlands, Sweden, etc. Exports of domestic canned

Table 9-8: Exports of domestic and foreign shrimp products, 1980. (Source: NMFS, Fisheries of the United States, 1980.)

ITEM	Quantity: Thousand pounds	Quantity: Thousand dollars	Percent of Total: pounds	Percent of Total: dollars
Fresh and frozen:				
Domestic	15,913	48,928	62.4%	59.0%
Foreign	9,566	33,997	37.4%	41.0%
TOTAL	25,479	82,925	100.0%	100.0%
Canned:				
Domestic	5,832	17,207	94.0%	96.2%
Foreign	371	679	6.0%	5.8%
TOTAL	6,203	17,886	100.0%	100.0%
Total:				
Domestic	21,745	66,135	68.6%	65.6%
Foreign	9.937	32,676	31.4%	34.4%
TOTAL	31,682	100,811	100.0%	100.0%

Table 9-9. Exports of domestic fresh and frozen shrimp, by country of destination, 1980. (Source: NMFS, Fisheries of the United States, 1980.)

Country	Quantity		Percent of Total	
	Thousand lb	Thousand $	lb	$
Canada	8,016	23,403	50.4%	47.8%
Japan	2,841	11,670	17.9%	23.9%
Mexico	3,723	10,416	23.4%	21.3%
Saudi Arabia	106	450	.7%	.9%
Netherlands	180	346	1.1%	.7%
New Zealand	62	262	.4%	.5%
Sweden	32	135	.2%	.3%
Hong Kong	62	60	.4%	.1%
Other	891	2,186	5.5%	4.5%
Total	15,913	48,928	100.0%	100.0%

shrimp were 5.8 million lb in 1980 (Table 9-8 and 9-10). Exports to Canada accounted for 73.4 percent of the total.

9.3 Domestic Harvesting Sector

9.3.1 Organization and Economic Characteristics

The most recent (1976) and comprehensive survey of the South Atlantic shrimp trawler fleet was performed by Liao (1979). The study examined 301 commercial trawlers that exceeded 20 ft in length. These trawlers were classified into four mobility classes based on the number of states within which they fished for shrimp (Table 9-11). A total of 78 percent were categorized as mobility class I trawlers; the majority of trawlers in the region fished only in their home state. North Carolina and Florida (east coast) had the highest percent of mobility class I trawlers (Table 9-11). In general, results indicated that most trawlers that fished in other states did so during peak shrimping season in the out-of-state fishery. Based upon the characteristics of the trawlers (Table 9-12), a number of factors appeared to be closely associated with mobility of trawlers. The more mobile trawlers (1) were larger, (2) had captains with no outside fishery employment; and (3) had greater productivity per day in out-of-state shrimping.

The profitability of trawler operation is measured by the net returns (income) received from its operation after all costs of production have been deducted from gross returns. The average gross returns of three types of trawlers varied considerably. Mobility classes III trawlers had the highest annual gross returns ($122,000) of three mobility classes (Table 9-13).

Production costs are broken down into two categories, variable and fixed. Variable costs comprise all costs items that vary with fishing effort. Fixed cost (depreciation, insurance, etc.) represent those costs that are incurred regardless of whether the vessel is operated.

Table 9-10. Exports of domestic canned shrimp, by country of destination, 1980. (Source: NMFS, Fisheries of the United States, 1980).

Country	Quanity		Percent of Total	
	Thousand pounds	Thousand dollars	pounds	dollars
Canada	4,282	12,771	73.4%	74.2%
United Kingdom	394	1,078	6.8%	6.3%
Switzerland	288	942	4.9%	5.5%
Thailand	196	396	3.4%	2.3%
New Zealand	105	358	1.8%	2.1%
Sweden	117	328	2.0%	1.9%
Japan	51	116	.9%	.7%
Federal Republic of Germany	19	37	.3%	.2%
Other	380	1,181	6.5%	6.8%
TOTAL	5,832	17,207	100.0%	100.0%

Table 9-11. Number of shrimp trawlers in the four mobility classes in 1976. (Source: Liao, 1979).

State or Region	Mobility Class	Estimated Number of Shrimp Trawlers	Percent Of Total Trawlers
South Carolina	I	264	69
	II	103	27
	III	11	3
	IV	5	1
		383	100
North Carolina	I	938	87
	II	130	12
	III	6	1
	IV	0	0
		1,074	100
Georgia	I	176	53
	II	106	33
	III	28	8
	IV	20	6
		330	100
Florida	I	144	80
	II	27	15
	III	1	1
	IV	8	4
		180	100
All South Atlantic States	I	1,522	78
	II	366	19
	III	46	2
	IV	33	1
		1,967	100

Table 9-12. Average characteristics of trawlers by mobility classes, 1976. (Source: Liao, 1979).

Characteristics	Mobility Class			
	I N=176	II N=91	III N=29	IV N=5
Age (years)	14	11	13	7
Length (feet)	40	57	65	65
Beam (feet)	13	17	19	19
Engine Horsepower	180	237	279	261
Gross Tonage	20	44	59	62
Net Size (feet)	46	59	66	69
Maket Value of the trawler ($)	23,157	60,700	72,190	80,000
Equity of the trawler ($)	16,429	43,610	44,813	31,000
Percent of Trawlers with the following equipment:				
Radar	18	62	59	60
Loran	17	48	55	100
Recorder	56	80	79	100
VHF	45	85	86	100
C.B.	90	97	100	100

Table 9-13: Average annual costs and returns among three mobility classes of trawlers in the South Atlantic states, 1976. (Source: Liao, 1979)

Item	Mobility Class 3/		
	I N=158 1/	II N=69	III N=23
Gross returns:			
Shrimp fishery	$26,512	$65,760	$117,498
Other fisheries	840	821	4,502
TOTAL	27,352	66,581	122,000
Variable costs:			
Vessel repair and maintenance	2,378	4,405	8,443
Gear repair and maintenance	1,234	2,250	4,243
Ice	649	1,898	2,398
Fuel	3,205	6,709	10,908
Heading and packing	1,264	4,090	4,940
Crew shares	9,968	26,144	44,190
Captain shares	6,938	12,707	17,369
Other variable costs	1,198	3,169	4,216
TOTAL Variable costs	26,835	61,373	96,707
Fixed costs:			
Depreciation	1,138	2,522	6,357
License fee	55	231	295
Interest	382	1,044	1,718
Insurance	433	1,314	2,781
Other fixed costs	156	375	413
Total fixed costs	2,164	5,486	11,564
TOTAL Costs (Variable and Fixed costs)	$28,999	$66,859	$108,271
Net Returns (Gross returns- Total costs) 2/	-1,647	- 278	13,729
Income above variable costs (Gross return - variable costs)	517	5,208	25,293

1/ N=Number of vessels

2/ Return to owner's labor, management, and investment

3/ Mobility Class I Trawler - Those who fished only one state
Average length of vessel = 12 m (40 ft)

Mobility Class II Trawler - Those who fished in two states
Average length of vessel =17 m (57 ft)

Mobility Class III Trawler - Those who fished in three states
Average length of vessel = 20 m (65 ft)

Variable costs represent the largest proportion of total costs for all three groups of vessels (Table 9-13). The mobility class III vessel's variable costs ($96,707) were about 4 times higher than that of mobility class I trawlers. Variable costs tended to increase as the size of vessel increased. Annual fixed costs for the average mobility class III trawler were about $11,564, compared to $2,164 for the mobility class I trawler. Obviously, fixed cost items were much higher for mobility II and III trawlers due to higher capital investments associated with these larger vessels.

A wide dispersion in profitability was observed for the South Atlantic shrimp fleet. Net returns for the average mobility class III trawler were $13,729 which was the highest with respect to all mobility classes (Table 9-13). However, not all trawlers in the mobility class III experienced positive net returns; 48 percent of the trawlers in this group had losses. The average mobility class I and II trawlers had total costs greater than gross returns (Table 9-13). Of the 158 mobility class I trawlers, 108 trawlers (68 percent) sustained losses in commercial fishing. Among the mobility class II trawlers, 62 percent had unprofitable operations and only 39 percent could show a profit.

Productivity analysis of trawlers indicated that the more mobile, larger trawlers had a higher catch per day, received higher average prices, and yielded higher gross returns per year than less mobile, smaller trawlers. The number of shrimping days was the most important variable in determining annual shrimp production for trawlers in the region.

9.3.2 Income Trends in the Fleet

9.3.2.1 Historical Gross Income Trends

The number of vessels in the South Atlantic states has increased from 1,090 in 1960 to 1,212 in 1978 (Table 9-14). In addition, there were 814 small boats shrimping in 1960 and by 1975 the number has increased to about 1,259 with a decline in 1978. The average gross tons per vessel has also increased by about

Table 9-14. Number of vessels and boats, gross tonnage per vessel, landings of shrimp, landings per craft and landings per gross ton, South Atlantic states, 1960-1975. (Source: 1960-75 data Fishery Statistics of the U. S., Various annual issues of Statistical Digest series; 1978 data, Richard L. Schween, Resource Statistic Division, NMFS, pers. comm., Oct., 1981).

Item	1960	1965	1970	1975	1978[1]
No. of Vessels	1,090	958	949	1,200	1,212
No. of Boats	814	691	727	1,259	1,013
Total Crafts	1,904	1,649	1,676	2,459	2,225
Gross Tons Per Vessel	27.6	28.5	37.9	43.1	46.0
Total Landings (1,000 lb.)[2]	18,581	16,689	13,080	15,767	10,126
Landings Per Craft (lb)	9,759	10,121	7,804	6,412	4,551
Landings Per Gross ton (lb)	617	612	364	305	182
Real Ex-vessel Dollars per Gross Ton[3]	N/A	N/A	272	362	279

1/ Preliminary Data

2/ Landings reported in heads-off units.

3/ Data calculated by dividing deflated, aggregate ex-vessel dollars (Table 9-3) by aggregate gross tonnage (See Table 8-12) for a given year.

67 percent from 27.6 in 1969 to 46.0 in 1978. However, additional crafts and substantial increases in gross tons per vessel have not resulted in increases in total catch. Landings per year per craft have declined by about 31 percent and landings per gross ton have declined by 61 percent from 1960 to 1978. This indicates that the total of available shrimp has been divided among an increasing number and size of crafts.

In contrast to the apparent decline in average catches in the 1970's, real ex-vessel dollars per gross ton have not declined (Table 9-14). The increase in ex-vessel shrimp prices has evidently offset the decline in catches; consequently, this index (real ex-vessel dollars per gross ton) of gross income per vessel does not display an obvious decline in recent years. Net income trends will be discussed in Section 9.3.2.2.

9.3.2.2 Net Income Trends

Jones et al. (1979) reported average annual costs and returns for South Carolina shrimp trawlers from 1971 thru 1975. There has been no similar temporal surveys published for any of the South Atlantic States since the 1975 season. A crude estimate of average net income for trawlers during the 1976 to 1980 South Carolina shrimp season was prepared in May, 1980 for the South Atlantic Fishery Management Council (Rhodes, 1980). Both studies indicated that the average South Carolina shrimp vessel over 17 m (55 ft) during the 1971-80 season has probably experienced negative net revenues in five of the last ten years. Since South Carolina and Georgia have similar fleet characteristics and associated vessel mobility classes (Liao, 1979), the South Carolina experience may also be applicable to Georgia.

In contrast, the North Carolina and Florida (east coast) resident fleets differ in average gross tonnage (Rhodes, 1980) and shrimp species catch composition compared to South Carolina. Consequently, the analysis of cost trends in South Carolina may not be applicable to North Carolina and Florida.

In addition, annual trends and impacts of income derived from other fisheries by South Atlantic shrimp trawlers are unknown. Liao (1979) has shown that revenues generated from other fisheries by vessels in Mobility Class III (average LOA of 19 m, 65 ft) constituted about four percent of total gross revenues in 1976.

Assuming that the 1971 to 1975 South Carolina time series is generally applicable to the South Atlantic fleet, an indexing of costs and revenues for this period has been prepared (Table 9-15). Fuel cost trends compared to the CPI constitutes the most obvious variable cost increase for the 1971-75 period. Liao's (1979) budgets indicated that the 1976 fuel costs constituted approximately 11 percent of total operating costs for Mobility class II vessels. Rhodes (1980) estimated fuel costs to be about 18 percent of annual operating costs for 17 m (55 ft LOA) vessels. Brown and Lugo (1981) concluded that Southeastern shrimp trawlers had the highest fossil fuel energy input to fish protein energy output of any U.S. commercial fishery. Much of this is due to the distance from fishing grounds, time spent searching for shrimp and bycatches which result in fewer shrimp caught per tow.

Although the rate of increase for fuel prices decreased in 1980 (Table 9-16), fuel costs are still expected to constitute over 15 percent of operating costs. In addition, a simple linear projection of the latest U.S. Department of Energy (August, 1981) wholesale heating oil prices indicates that fuel prices will continue to increase during 1982 (Table 9-16).

Also, there are indirect effects resulting from increased petroleum costs. Such items as nets, plastic buckets, and other gear which are made from petroleum distillates, have increased tremendously. The preparation and distribution of ice, which is relatively energy intensive, has also constituted a significant increase in operating costs. In 1972, a 300 lb block of ice cost South Carolina vessels about \$2.50; by 1980 the vessel price had increased 240 percent

Table 9-15. Cost and revenue index for South Carolina shrimp trawlers as calculated from Jones et al. (1979). (1971=100)

	1971	1972	1973	1974	1975
Variable Costs					
Not Proportional to catch:					
Fuel and Oil	100	124	146	200	235
Other	100	92	90	71	72
Proportional to catch	100	124	157	111	163
Fixed Cost	100	106	100	104	114
Total cost	100	108	117	107	124
Total Revenue	100	97	130	87	141
Consumer Price Index 1/	100	109	137	140	152

1/ Consumer Price Index (1967=100) for meat, poultry and fish indexed to 1971 for this table.

Table 9-16. Typical quarterly and shrimp season No. 2 diesel fuel prices paid in South Carolina, 1971 to 1980. (Source: S.C. Marine Resources Center, Charleston, S.C.)

Year	Season[1/] Mean	Standard Deviation
1971	$0.14	0
1972	0.14	0
1973	0.18	.07
1974	0.33	.03
1975	0.35	.03
1976	0.38	.02
1977	0.43	0
1978	0.45	.02
1979	0.76	.57
1980	0.97	N/C
1981 (May-Sept)	1.11	N/C

Quarterly Means

	1978	1979	1980	1981	1982
I	$0.43	$0.51	$0.94	$1.12	$1.16*
II	0.43	0.61	0.96	1.11	1.17*
III	0.44	0.78	0.96	1.16*	1.19*
IV	0.47	0.82	0.99	1.16*	1.22*

1/ Mean price for eight months, May to December.

* Forecasted price based upon "Case 2" price path of wholesale heating oil No.2 (Short-term Energy Outlook, Aug., 1981, U.S. Dept. of Energy). "This case is reflective of current market conditions with assumed tightening of markets in 1982." Marine fuel prices calculated from the following regression: Marina Prices = .0275 + 1.122 (Wholesale Price), R^2 = .970 (T = 15.782).

to about $6.00 (S.C. Div. of Marine Resources, unpubl. data).

Rising wages also have affected the harvesting sector in the form of increasing vessel maintenance expenses and packing costs. In 1972, South Carolina shrimp packing and heading costs were approximately $0.12 per heads-off lb, and by 1978, packing costs over $0.20 per lb were not uncommon (Rhodes, 1980). In 1980, the average packing cost was $0.27 per lb for South Carolina trawlers (S.C. Div. of Marine Resources, unpubl. data).

A similar indexing of costs for Gulf of Mexico shrimp trawlers from 1971 to 1977 demonstrated that fixed costs (e.g. insurance, interest payments, depreciation) increased 249 percent (1971 = 100 percent) second only to the increase in fuel costs. As discussed in Section 10.3.1 the cost of shrimp vessels has risen substantially during the 1970's, consequently, fixed costs especially for new vessels are assumed to have had a greater share of total annual fishing costs in recent years.

9.3.2.3 Current Indicators of Fleet Economic Performance, 1980-81

As noted by others (e.g. GMFMC, 1981) the U.S. Department of Commerce announcement of a $12.2 million aid program for Southeastern shrimpers exemplified the financial crisis faced by the harvesting sector in 1980. In South Carolina for example, the 1981 season is apparently characterized by below average catches coupled with a decline in deflated revenues per nominal vessel days (Table 9-17).

The financial situation of South Atlantic shrimpers is reflected by the difficulties of vessel owners to make mortgage payments or to generate cash flows for future expenditures (e.g. capital construction fund accounts). In the 1979 period, the 3rd Farm Credit District which includes the Carolinas, Georgia, and Florida classified 19 aquatic loans (mainly trawlers) as "problem" loans (C. Richard Crawford, Federal Land Bank of Columbia, S.C.; pers. comm.). In 1980, 33 loans ($2.8 million) were classified as "problem" loans

Table 9-17. Nominal [1] annual catch (heads-off lb) and dollars per vessel-day for South Carolina, 1974 to 1981. (Source: Fisheries Statistics Section, S.C. Marine Resources Division, unpubl. data).

Year	Reported Aggregate Vessel-Day [2]	Per Vessel-Day [1] Catch lb.	Per Vessel-Day [1] Dollars $	Real Dollars [3] $
1974	11,767	200	208	127
1975	17,814	185	355	199
1976	16,648	183	367	205
1977	6,967	181	405	227
1978	13,653	161	494	238
1979	22,533	166	680	285
1980	20,930	165	494	199
1981 [4]	-	76	230	93 [5]

[1] Catch and dollars per vessel-day has not been standardized for fishing gear, location and other factors.

[2] These aggregate vessel days have not been adjusted for changes in participation of shrimp vessel in the reporting system.

[3] Dollars deflated with the U.S. Department of Labor's Consumer Price Index (1967=100) for meats, poultry and fish.

[4] The 1981 data are from June thru August.

[5] Dollars deflated with the 1980 CPI for meats, poultry and fish.

and the District's PCA's incurred $91,000 in bad debt loss. In Georgia, the Small Business Administration's 1977-78 disaster loan program (See Section 10) has 156 (57 percent) borrowers past due and legal action has been initiated to foreclose on 43 borrowers (S. Shipman, Ga. Dept. of Nat. Res., Coastal Res. Devl., Brunswick, GA; pers. comm.). The NMFS's Financial Service Division has reported that deposits in Capital Construction Fund accounts decreased significantly in the South Atlantic States during the 1980 and the current 1981 seasons.

Besides seeking non-fishing income, commercial shrimpers in the Carolinas and Georgia in recent years have basically pursued a combination of two atypical fishing strategies: (1) migrating to the Gulf of Mexico grounds for several months and/or (2) fishing for non-shrimp species off the Atlantic coast during the summer and fall months (see Section 8.2.4.3).

9.3.3 Capitalization

The following section was adapted from the revised Fishery Management Plan for Shrimp, Gulf of Mexico, 1981:

During periods of economic prosperity when shrimp prices are rapidly rising, profits to the owners of shrimp vessels have exceeded the returns their capital could have earned in other alternatives. In economic terms, "excess profits" have been generated; consequently, both new entrants and existing owners in the fishery have been motivated to make capital investments in the fishery. When prices declined, vessels continued to shrimp in the short run even at a loss as long as current gross revenues equal variable operating (trip) costs. When revenues are less than variable costs, vessels ceased fishing for periods of time. The expected decision of the owner would be to sell the vessel and use the capital elsewhere. However, as is the case with much agricultural equipment, shrimp vessels represent a classic case of <u>asset fixity</u>

(prices rising more rapidly than costs) (Johnson, 1958). No entrepreneur wants to invest capital in equipment (i.e. vessel) that will currently yield a negative return; consequently, the vessel owner(s) finds selling his vessel(s) difficult during "poor" years. Therefore, vessel owners sometime face economic hardships because of investment decisions made during times of rapidly rising prices and relatively good catches.

Based upon the preceding information, especially the fleet's declining capacity utilization in both engineering and economic terms and the apparent volatility of vessel profits, it is suggested that the South Atlantic shrimp fishery may be overcapitalized for an open access fishery. Blomo (1981) has concluded that the Gulf of Mexico shrimp fishery also displays the symptoms of overcapitalization in an open access fishery as induced by "... high product prices."

Then given an open access fishery and asset fixity, overcapitalization from an economic standpoint seems inevitable and may become worse as product prices continue to rapidly rise. In addition, this situation will usually place vessel owners in negative return situations during times of falling demand for shrimp and/or significantly low annual shrimp stocks.

Usually the economic impact of free access focuses on the quantities harvested and the effort and capital expended. Much debate normally occurs when proponents of Maximum Economic Yield[1/] management argue that not only less effort but also lower harvests will be beneficial to fishermen, processors, and society at large. As Gulland (1972) indicates, penaeid shrimp fisheries exhibit flat-topped yield curves. At high levels of effort, the implication is that reduction in fishing effort is likely to result in proportionally a smaller decrease in shrimp landings. Thus, management of fishing effort at some point below MSY must be concerned with the benefits and costs of reducing fishing effort. Consequently, with overfishing and lower sustained yield, previously cited as not being a valid concept in the South Atlantic shrimp fishery, the benefits

1/ Maximum Economic Yield (MEY) is the level of harvest from the common property resource that maximizes the stream of generated net incomes over time.

to society from any benefit-cost measurement must mainly come from reductions in harvest costs. Reducing the total harvest costs would involve reducing the number of firms (fishing effort) in the industry. Unfortunately, Anderson (1977) indicates that regulation of harvesting cost is more complicated in penaeid fisheries because the usual concept of both dynamic or static MEY are not applicable. Regardless, uncontrollable external economic variables such as rapidly rising fuel prices, and the normal consumer demand related price movements make the overcapitalization issue apparent during the less satisfactory economic periods. Given the fisheries economic "environment" and the independence of penaeid stocks from fishing effort (i.e. costs), do the positive net economic benefits gained during times of rapidly increasing prices exceed the apparent negative benefits which become evident during times of low prices and to what degree could limited access mitigate these negative benefits?

9.4 Domestic Processing Sector

In the South Atlantic states, most shrimp processing plants are owned by single facility corporations. They engage in peeling, deveining, cooking, freezing, breading, and preparing specialty products. There were 19 shrimp processing plants in 1980 (Table 9-18). Thirteen were located in Georgia and Florida.

Cato and Prochaska (1981) reported that 51 percent of the shrimp processed in Georgia in 1979 were imported from another country, about 37 percent came from the Gulf of Mexico, and the remaining 12 percent of shrimp came from Georgia sources.

Prochaska and Andrews (1974) found that in 1973, Florida processors imported 40 percent of the shrimp entering their plants. The shrimp processing industry in Florida is expanding in total volume, but the rate of withdrawal

Table 9-18. Shrimp processor: plants and employment, 1976-1980. (Source: Southeast Fisheries Center, National Marine Fisheries Service, unpubl. data, 1981)

State	Processing Plant					Employment Average				
	1976	1977	1978	1979	1980	1976	1977	1978	1979	1980
North Carolina	(D)	(D)	(D)	(D)	5	(D)	(D)	(D)	(D)	15
South Carolina	0	0	0	(D)	(D)	0	0	0	(D)	(D)
Georgia	6	4	4	4	5	1027	1064	1154	885	901
Florida (east coast)	9	10	10	10	8	576	670	550	470	200
TOTAL	18	15	17	17	19	1638	1751	1714	1359	1116

(D) Not shown to avoid disclosure of confidential information of individual firms exceeds the rate of new entrants. A shortage of shrimp supplies appears to put a severe constraint on the entrance of new firms and the expansion of existing ones.

Total employment for the South Atlantic shrimp processing industry is shown in Table 9-18. Because of the small number of shrimp processing plants in South and North Carolina, detail in presentation of their employment is restricted. The reduction in employment was noticeable during the last three years. This reduction probably reflected declining profitability of shrimp processors in the United States.

10.0 DESCRIPTION OF BUSINESSES, MARKETS AND ORGANIZATIONS ASSOCIATED WITH THE FISHERY

There are few data available on business relationships (e.g. bilateral arrangements, bargaining behavior, etc.) within the various fisheries markets. Maiolo et al. (1980) surveyed the marketing of shrimp in North Carolina but very little has been done elsewhere in the region. Therefore, much of this chapter is based on personal observations of the author and other participants in this study.

10.1 Relationships Among Harvesting, Brokering and Processing Sectors

10.1.1 Industry Structure

10.1.1.1 Shrimp Dealers

The first middleman in the marketing of shrimp is generally the dealer. Seafood dealers or shrimp packers are usually merchant wholesalers commonly found in agricultural markets who buy in small quantities from many producers and assemble large quantities for the market (Marcus et al., 1975). Dealers assemble shrimp for the market by removing the heads with hand labor, packing shrimp in 100 lb boxes containing ice and storing them in coolers until shipping. Some shrimp are usually kept for direct retail sales at the dock. These headless, shells-on shrimp are often called "green" shrimp by various wholesalers.

The average number of trawlers selling to South Carolina and Georgia dealers is about 10 (Nix, et al. 1975; McKenzie et al., 1976), although this number might vary according to the catch, dealer restrictions, physical space and other factors (e.g. interpersonal relationships, dealer services, etc.). During peak fishing periods, some dealers may have facilities to serve more than 25 vessels during a 24 hour period. An inventory of seafood dealer facilities in coastal South Carolina in 1975 (McKenzie et al., 1976) probably typifies the majority of shrimp dealer facilities in the South Atlantic States (Table 10-1). In South Carolina, only 45 percent of the dealers had freezers in 1975 with an average size of 381 square feet (McKenzie et al., 1976).

Table 10-1. Facility characteristics of South Carolina seafood dealers in 1975. (Source: McKenzie et al., 1976).

Number of dealers sampled	22
	Mean
Linear Footage of Dock (feet)	387
Number of resident vessels regularly unloading	10
Packing house size (square feet)	2,290
Cooler size (square feet)	362
Number of dealers with freezers	10 (45%)

In comparison to large seafood ports where higly specialized services have developed, South Atlantic states' seafood dealers also are purveyors of ice, fuel, and other supplies. Other services may be provided including informal and formal credit arrangement and locating needed equipment for vessel repairs. The usual informal agreement in this relationship is an understanding that the shrimper's catch will be handled by the dealer providing these other services. From the dealer's standpoint, other motives may include non-price competition to keep the fishermen at his facilities and to reduce lost shrimping time due to repairs (Maiolo et al., 1980).

There were over 360 seafood dealers in the South Atlantic in 1980 (Table 10-2). In North Carolina, Maiolo et al. (1980) classified general characteristics of dealers based on typical gross sales volume. "Larger dealers" with over one million dollars in sales per year purchased shrimp from large vessels (larger than 15 m; 50 ft) which fished in deeper water areas of Pamlico Sound and oceanic waters. "Medium sized dealers", handling about one hundred thousand to one million dollars in annual gross sales, apparently purchased from locally based smaller vessels (15 m; 50 ft and under) which are oriented toward fishing in protected waters (e.g., sounds). "Small dealers" with annual sales less than $50,000 may purchase shrimp "...from small boats, skiffs and wholesale from larger operators." These dealers include truck wholesalers ("peddlers"), who may only derive a portion of their shrimp income from retail sales. Maiolo et al. (1980) characterize the shrimp peddler as a marketer without permanent facilities and selling shrimp as "...part-time activity undertaken to provide an income supplement."

Shrimp dealers handle "green" headless shrimp and most dealers have limited capacity for their perishable product. These "green" shrimp thus constitute a perishable food commodity sold and purchased at other levels in the marketing channel.

Table 10-2. Licensed shrimp dealers or wholesalers for North Carolina, South Carolina, Georgia, and east coast of Florida[1] in 1980 or 1981. (Source: N.C. Division of Marine Fisheries, S.C. Division of Marine Resources and Georgia Coastal Resources Division.)

State	Number of Dealers or Wholesalers[2]
North Carolina	264
South Carolina	49
Georgia	34
Florida, East coast	16
Total	363

[1] Florida wholesaler licenses do not differentiate species to be sold or purchased. (J. Ernest Snell, NMFS, Miami, Fla., pers. comm.). The number of east coast Florida dealers reporting shrimp landings to the NMFS's Resource Statistics Office in Miami, Florida was used, consequently the Florida data are not comparable to the other.

[2] Except for Florida, these data include small volume dealers and minor wholesalers which may have purchased less than 1,000 pounds of shrimp in a given license year.

10.1.1.2 Processors

Shrimp processors are usually corporate business firms which prepare various processed shrimp products like frozen, canned, breaded, and specialty products (dried, sauces, pastes and convenience dishes) or directly wholesale headless shrimp. In the Southeast region, about half of the processors are family owned and six percent are organized as partnerships (GMFMC, 1980).

Due to expansion of existing processing facilities and the shortage of domestic landings, the rate of withdrawl of individual firms exceeds the rate of new entrants (GMFMC, 1980). Florida processors surveyed in 1972 (Alvarez et al., 1976) indicated half of the firms were characterized by one or more types of vertical integration with six of the seven largest processors displaying backward integration (i.e., ownership of control of raw supplies). Although backward integration is apparently characteristic of shrimp processors, purchases from independent shrimp dealers and other wholesalers still constitute the major source of domestic shrimp for South Atlantic processors.

10.1.1.3 Brokers and other Wholesalers

Wholesalers other than dealers serve as middlemen between various buyers and sellers like dealers, processors, restaurant purveyors, etc. They take legal possession of shrimp products and provide transportation, storage and other functions at various levels in the market.

In contrast to the shrimp wholesalers, the broker does not take physical possession or control over the shrimp he sells. The broker acts as an intermediary at various marketing levels with the biggest use of brokers in interstate and international sales, establishment of new business contacts and promotion of new products. In addition, brokers offer an alternative to the small business firm which find it uneconomical to maintain its own selling agent. For example, Alvarez et al. (1976) noted that medium and small-size Florida shrimp processors generally use brokers to market their products.

10.1.2 Domestic Marketing Channels and Pricing

10.1.2.1 Domestic Marketing Channels

In the South Atlantic region, marketing of shrimp from the trawler to the final consumer may involve a variety of channels but is usually limited to shrimpers, wholesalers, processors, carriers and various retailers (e.g. restaurants, seafood stores, etc.). As a food commodity, size has a strong influence on the wholesaling of headless shrimp (tails). In general, ex-vessel and wholesale prices for "green" shrimp are inversely related to the number of tails per pound (count). Shrimp size also influences final consumer preference and associated marketing channels. Shrimp less than about 40 count generally are sold to restaurants and those over 40 count go principally to different processors (e.g. breaders and canners) and fresh seafood retailers.

Besides raw shrimp sizes and associated prices, there are many other factors which influence marketing channels: (1) informal and contractual marketing channel relationships, (2) degree of industry concentration, (3) domestic raw shrimp sources, (4) foreign market production of raw and processed shrimp products, and (5) product form and product differentiation activities (e.g. exclusive recipes). Product differentiation activities are usually associated with firms having larger shares of the market compared to firms without product differentiation activities (Alvarez et al., 1976). Below normal ex-vessel prices in the Carolinas and Georgia can motivate dealers to emphasize low-volume markets which may temporarily offer higher prices than processor dominated channels. For example, in 1974 depressed ex-vessel prices apparently placed Georgia fishermen and dealers in the position of selling their catches ". . . directly to customers and retail outlets" (Georgia Coastal Area Planning et al., 1976). During 1981, South Carolina dealers increased their shipments to New York's Fulton Fish Market due to depressed ex-vessel prices in other channels. The Fulton Fish Market is generally considered a temporary shrimp market because it is extremely volume sensitive and usually pays competitive prices for large shrimp (i.e., less than 40 count) only.

A summary of raw shrimp marketing from the dealer level (Table 10-3) indicates local retail purchases usually constitute a small percent of shrimp sold by dealers. Although a North Carolina survey (Summey, 1977) indicated that shrimp processors directly purchased 24 percent of the dealer's product, the survey probably underestimates the actual percentage purchased by shrimp processors indirectly from other intermediaries (i.e., brokers and wholesalers). The shrimp processors of Georgia and Florida, with their inventory capacity and other economies (e.g., large raw shrimp purchases) serve as "buyers" for the very seasonal raw supplies provided by South Atlantic shrimpers via the seafood dealers and other intermediaries.

The general marketing channels for the South Atlantic (Figure 10-1) are probably similar to that reported for the Gulf with processors as the key channel members. Retail stores constitute 35 percent of Florida processed shrimp products sales and institutional outlets accounted for 62 percent of 1972 (Alvarez et al., 1976). In South Carolina, about 74 percent of the headless shrimp sold in restaurants were purchased from distributors not directly purchasing South Carolina shrimp (Laurent et al., 1975). Summey (1977) reported that 20 percent of the North Carolina shrimp was exported to Georgia, South Carolina, Florida and other Atlantic states for direct retail and restaurant use. Cato and Prochaska (1981) reported Georgia secondary wholesalers ("retail-wholesale dealers") sold only 28 percent of their product to various Georgia buyers and 69 percent was sold to buyers in other Southeastern states. In summary, marketing channels for raw shrimp and processed shrimp products constitute an elaborate matrix of marketing channels weakly influenced by the landing location and historically dependent upon processor purchases.

10.1.2.2 Pricing of Shrimp

Considering the quantities purchased by processors in the South Atlantic States, processor price quotations obviously constitute critical price information

Table 10-3. Buyers of raw shrimp sold or handled by seafood dealers in the South Atlantic.

Buyers	Annual Percent of Shells-On Headless Shrimp Sold			
	North Carolina 1/	South Carolina 2/	Georgia 3/	Florida 4/
Processors	24%	56%	55%	73%
Other Intermediaries 5/	70%	36%	36%	N/A
Local Retail 6/	6%	8%	9%	N/A

1/ Summarized from Summey (1977) for 1974.

2/ Summarized from Rhodes (1974) for 1971

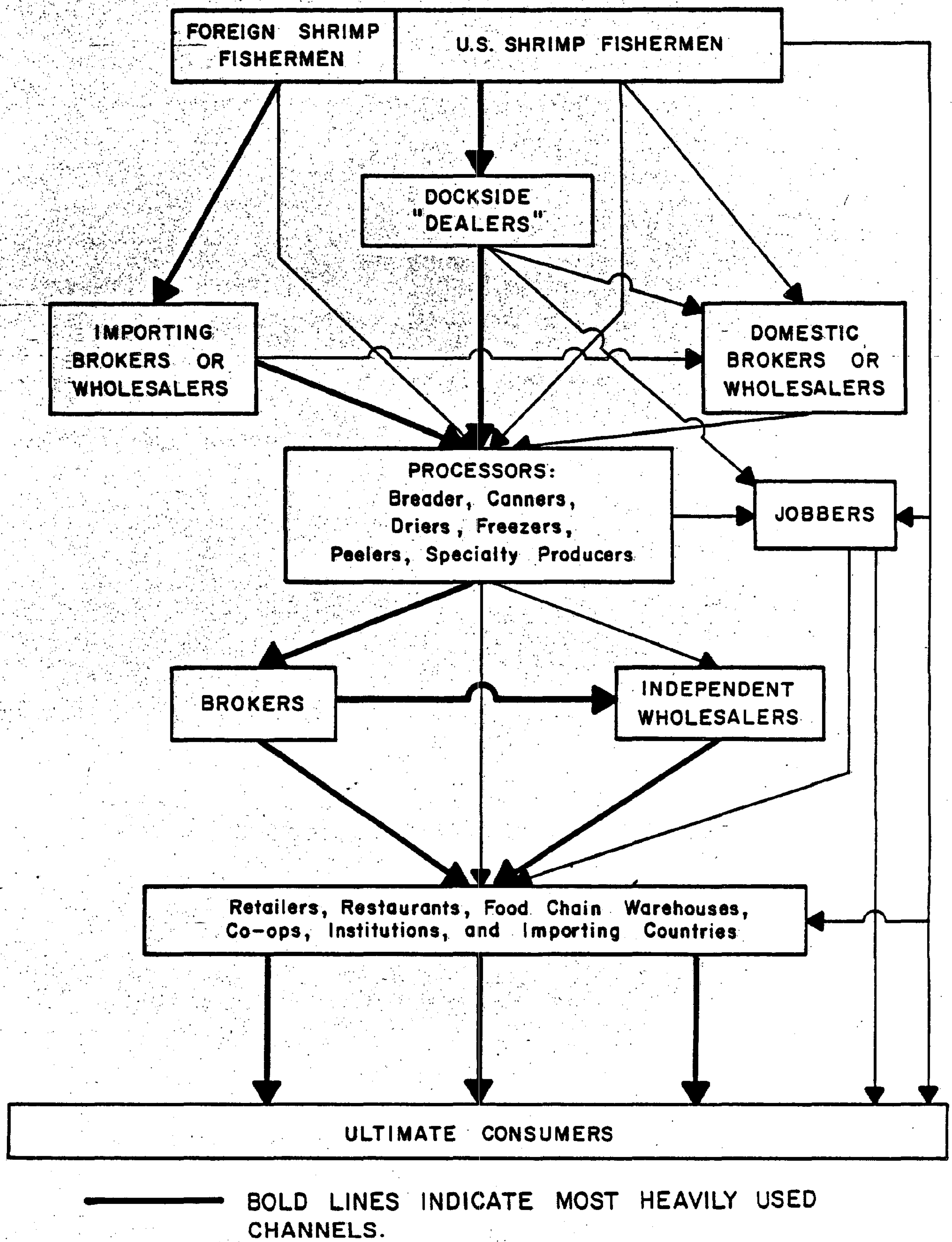
3/ Summarized from Georgia Coastal Area Planning and Development Commission (1976) for 1974.

4/ Summarized from Alvarez et al., (1976) for 1972. Marketing information includes both West and East coast Florida processors purchases and, consequently, may overestimate quantities sold by dealers to processors.

5/ This category includes restaurants, wholesalers and brokers. The brokers and wholesalers may sell a significant portion to the processors.

6/ Quantities sold directly to consumers except for Georgia. Georgia sales include wholesaling to local retailers.

Figure 10-1. Major marketing channels for shrimp production. (Source: GMFMC, 1980).



for at least short-term raw shrimp pricing strategies by various market intermediaries. Due to the competitiveness of existing market channels, wholesalers usually work on narrow margins to cover overhead and profits. During 1981, secondary wholesalers reported losses when purchasing shrimp from dealers. In some situations, "green" shrimp wholesalers will purchase shrimp from dealers at prices which will not yield a net profit to the wholesaler. The wholesaler enters into this breakeven transaction in order to maintain future buying relationships with the dealer.

Although processed shrimp products generally constitute a major market for South Atlantic shrimp catches, margin percents between ex-vessel and wholesale processed shrimp product prices are difficult to compare because: (1) weight losses and gains through processing vary by product line and individual firms, (2) variability among processor prices paid individual dealers due to bilateral agreements, and (3) adjustments in the wholesale processed product price per pound associated with regional consumer demand. Even if annual average ex-vessel prices are used, raw product price equivalents would be over-estimated because smaller than average shrimp are usually purchased by shrimp processors.

Although the National Marine Fisheries Service publishes information on shrimp retail prices, it is only based upon six outlets in Baltimore, Maryland for shells-on raw shrimp. Those green, headless retail sales constitute a small portion of the U.S. shrimp market; consequently, a comparison of these retail prices to ex-vessel and wholesale prices is not indicative of retail margins in major shrimp markets. In addition, retailers sell green shrimp in broad size categories (e.g., "large", "medium" and "small") which make ex-vessel count comparison to retail sizes difficult.

10.2. Fishery Cooperatives or Associations

All fishery cooperatives were authorized under the Federal Fishery Cooperative Marketing Act of 1934. The National Marine Fisheries Service identified three fishery cooperatives for the South Atlantic states in the 1980-81 period

(Wojnowski, 1981) with shrimp as one of their target species. Except for North Carolina, there was one cooperative listed per state; the Florida, Georgia and South Carolina cooperatives had 70, 33 and 10 boats, respectively.

There were several non-profit fishery organizations which are oriented toward various interests in the South Atlantic's shrimp fisheries (Table 10-4) The Gulf and South Atlantic Fishery Development Foundation, as a research and development organization, has been active in funding projects to improve harvesting and marketing of shrimp and developing fishing technology for non-shrimp species for commercial shrimp trawlers. In 1981, the Shrimp Harvesters Coalition of the Gulf and South Atlantic States was formed to influence federal legislation on shrimp imports and federally subsidized loans.

10.3 Service and Supply Industries

10.3.1 Vessel Construction

In 1980, there were 458 fishing vessels built by 42 vessel construction firms in Southeastern United States, 118 vessels (26 percent) were shrimp trawlers delivered to the Carolinas, Georgia, or Florida locations (Table 10-5). Since 1977, 102 trawlers have been delivered to the Carolinas and Georgia shrimpers or about nine percent of shrimp trawlers reported for these states in 1977. Not only have vessel construction firms attempted to meet the demand for new vessels (i.e., hulls) but important hardware including propellers, winches and diesel engines are usually included in the marketing of shrimp vessels.

The cost of new vessels has increased substantially since 1971 (Table 10-6) due to material, labor costs and perhaps optimistic views of future profitability by prospective investors or current industry members (Rhodes, 1980). Unfortunately, new vessel buyers may not realize that their fixed costs can differ significantly from the typical vessel in the fleet. Consequently, the purchase of larger and more expensive vessels can constitute higher fixed costs in the form of loan payments, hull insurance, property taxes, etc., compared to smaller, older vessels which may not have hull insurance or loan payments.

Table 10-4. Regional or State Fishery Associations in the South Atlantic states which include membership from the shrimp industry (R. Rhodes, S.C. Marine Res. Dept.).

Name	Headquarters State
Florida Shrimp Association[1/]	Florida
Georgia Fisherman's Association	Georgia
Gulf and South Atlantic Fishery Development Foundation	Florida
National Shrimp Breaders and Processors Association	Georgia
National Shrimp Congress	Washington, D.C.
North Carolina Fishery Association	North Carolina
Organized Fishermen of Florida	Florida
South Carolina Shrimper's Association	South Carolina
Southeastern Fisheries Association	Florida
Sea Island Fisherman's Association	Georgia

1/ This association is a subsidiary of the Southeastern Fisheries Association.

10-5. New shrimp trawler deliveries or construction for the South Atlantic states from the major vessel construction firms in the Southeast, 1977-80. (Source: Fish Boat Magazine, Various December issues).

	State of Delivery			
Year	North Carolina	South Carolina	Georgia	Florida
1977	3	2	7	89
1978	6	1	22	42
1979	3	6	13	150
1980[1/]	2	17	20	79
Total four year construction	14	26	62	360

1/ In 1980, four trawlers were delivered to the South Atlantic States by vessel construction firms in Virginia and North Carolina. These data are not included in the 1980 data or previous years.

Table 10-6. Cost of new wood U.S. shrimp vessels by various sizes.

Year[1]	Vessel Length, Feet LOA	Cost $	Cost Per Foot $	Percent Increase[3]
1971	53-65 wood & steel	$57,000	$1,000	-
	66-72 wood & steel	76,000	1,000	-
1973	63-69	93,000	1,400	40.0%
1975	68	121,000	1,800	28.6%
1977	68	147,000	2,200	22.2%
	73	164,000	2,200	
1979[2]	73	215,000	2,900	31.8%
1981[2]	73	230,000	3,100	6.9%

[1] 1971 to 1977 data as reported by Warren and Griffin (1978).

[2] Unweighted means for wooden trawlers built by St. Augustine, Florida yards for South Carolina buyers.

[3] Percent increase in cost per foot compared to the previously reported year.

10.3.2 Financial Institutions

The marketing of shrimp, especially by the dealer, depends upon informal agreements between buyer and seller. Short-term and, in some cases, long-term debt financing of commercial shrimpers by dealers is also indicative of informal services provided by dealers. Maiolo et al. (1980) identified three kinds of debt servicing typically provided by South Atlantic dealers for fishermen: (1) simple weekly trade credit for routine operating services and supplies, (2) short-term loans which may or may not be secured and (3) in some cases consigning for various loans. During the last two decades, Maiolo et al. (1980) indicate that the shrimper's historical dependency on dealer financing has decreased with the proliferation of institutional funding sources available from both the public and private sectors.

For the commercial shrimper, funding of a vessel purchase usually constitutes the largest fixed cost. There are currently three general institutional sources of intermediate (i.e., one to 10 years) and long-term debt funding: (1) local Production Credit Associations, (2) commercial banks and (3) finance companies. The Production Credit Associations (PCA) are non-profit financing cooperatives authorized to service the fishing industry following the Farm Credit Act of 1971 (Olson, 1972). They make intermediate and long-term loans (seven years or more to maturity) at interest rates significantly lower than bank commercial loan rates. Commercial banks may provide conventional loans for 65 to 75 percent of a vessel's value. Financing companies like General Electric Credit Corporation have become a new source of intermediate vessel financing. In recent years, commercial banks and financing companies have used "balloon" payment schedules to buffer the initial cost of high interest rates on new vessel operations (Wiese, 1980).

In a 1975 survey of Ships Preferred Mortgage Records, Jones (1977) reported private lenders accounted for 15 percent of all loans for South Carolina shrimp trawlers. Institutional lenders in South Carolina held most mortgages (85 percent) with the local PCA providing 60 percent of the new vessel loans. Jones (1977) concluded that South Carolina private lenders extended short-term credit on a personal basis while the major lending institutions made loans on newer larger vessels (generally greater than 18 m, 60 ft., LOA) as strictly business ventures.

PCA funding of new fishing vessels has grown substantially since 1974 in the South Atlantic States (Table 10-7). Excluding Florida PCA loans which include significant loans for other fisheries, the aggregate number of outstanding PCA aquatic loans in these states has increased from 79 in 1974 to 351 loans in June, 1981, more than four times the 1974 loans. The average new loan value in the Carolinas and Georgia more than tripled between 1976 and 1977 due to local PCA's becoming more knowledgeable and active in making loans to the shrimping industry (Table 10-8).

The National Marine Fisheries Service has administered two programs to subsidize development of the U.S. shrimp fishery: (1) the Fishing Vessel Capital Construction Fund (FVCCF), and (2) the Fishing Vessel Obligation Guarantee (FVOG) program. In 1981, there were 90 South Atlantic (excluding Florida) fishing vessels enrolled in the FVCCF program, a tax deferral agreement with the Internal Revenue Service (Table 10-9). In contrast, only 44 fishing vessels were covered under FVOG program for the Carolinas and Georgia (Table 10-9). The PCA'S of these states had 14 aquatic loans guaranteed with the FVOG program (Table 10-9). The 1981 Maritime Authorization Bill reduced the amount of NMFS obligation authority from $1.2 billion to $850 million (National Fisheries Institute, 1981). At present, the National Marine Fisheries Service has about $350 million worth of fishing vessel loans guaranteed in the U.S.; hence, $500 million remains for new loan guarantees on vessels and shoreside facilities (National Fisheries Institute, 1981).

When the FVOG program was legislatively authorized under the Federal Ship Financing Act of 1972, a conditional fisheries concept was established to restrict the use of the FVOG program for fisheries which the NMFS determines have too many

Table 10-7. Number and total outstanding value of Production Credit Associations; aquatic loans from 1973 to June 1981 in the Carolinas and Georgia. (Source: Federal Intermediate Credit Bank of Columbia, South Carolina).

Year	North Carolina		South Carolina		Georgia		Three State Total	
	Loans	Dollars	Loans	Dollars	Loans	Dollars	Loans	Dollars
1973	12	194	20	563	8	194	40	951
1974	17	301	37	1,082	25	786	79	2,169
1975	27	434	49	1,221	29	936	105	2,591
1976	26	510	58	1,412	30	972	114	2,894
1977	43	1,625	80	2,859	36	2,144	159	6,628
1978	56	3,424	105	4,763	38	2,891	199	11,078
1979	76	7,895	137	7,202	51	4,781	264	19,878
1980	93	10,485	166	11,020	84	10,342	343	31,847
1981	100	10,411	166	11,821	85	10,655	351	32,887

Table 10-8. Annual number, aggregate value and average value of new aquatic loans[1/] by Production Credit Association in the Carolinas and Georgia, 1973-1980. (Source: Federal Intermediate Credit Bank of Columbia, South Carolina).

Year	Number	Aggregate Value[2/] $	Average Loan Value[2/] $
1973[3/]	40	951	24
1974[3/]	39	1,218	31
1975	40	1,229	31
1976	44	1,448	33
1977	51	5,499	108
1978	62	7,331	118
1979	106	13,099	123
1980	105	18,649	178

1/ Aquatic loans may include loans for fisheries other than commercial shrimping.

2/ In thousands

3/ Calculated from accumulative balances.

Table 10-9. Active Fishing Vessel Obligation Guarantee (FVOG) cases and Current Fishing Vessel Capital Construction Fund (FVCCF) accounts for South Atlantic states in July, 1981. (Source: NMFS, Financial Services Division and Federal Intermediate Credit Bank of Columbia, South Carolina).

State	FVOG 1/	PCA 2/	FVCCF 3/
North Carolina	8	(8)	12
South Carolina	12	(2)	15
Georgia	10	(4)	9
Florida (entire State)	70	(12)	6
Total	89	(26)	42

1/ These data are based upon the addresses of the shrimp trawler owners.

2/ PCA vessel loans guaranteed under the FVOG in 1980 may not be shrimp trawlers.

3/ Since the monies in these accounts are often used for current existing qualified payments, the above accounts may not be indicative of fishermen's future plans to purchase another vessel.

vessels (Fed. Reg. 38(204), 1973). Although the conditional fisheries concept is not in the FVCCF program's authorizing legislation, the NMFS has administratively extended the concept to apply to the FVCCF program as well (Fed. Reg. 45 (8): 2636, 1980). If the NMFS determines a fishery is conditional, neither program can be used to fund the construction of a vessel for that fishery unless the newly financed vessel will replace an existing vessel which has been retired from the conditional fishery. At present, the NMFS is considering the elimination of the conditional fishery concept altogether and permitting the NMFS program to finance any vessels which qualify under program standards (U.S. Department of Commerce, 1980). Explicit to this view is the "wise use" clause of the Federal Ship Financing Act of 1972. More recently, this has been superceded by enactment of the Magnuson Fishery Conservation and Management Act of 1976 (P.L. 94-265) and resulting measures to regulate fishing effort (Fed. Reg. 45 (8):2636, 1980).

Blomo (1981) concluded that the Gulf of Mexico fishery could qualify as a conditional fishery but recognized that assigning conditional status would not rectify current problems (i.e., increasing factor costs and depressed shrimp prices). Conditional fishery status could stop the future allocation of public resources to the shrimp fishery but specific impacts on the current fleet would take several years (Blomo, 1981). Based upon other conditional fisheries, Blomo (1981) felt that declaring the Gulf fishery conditional may not have a significant negative impact on the availability of credit from private sources.

As discussed in Section 5.1, the winters of 1976-77 and 1977-78 severely reduced white shrimp stocks and resulted in below normal commercial catches in the South Atlantic states. With assistance from the Small Business Administration (SBA), Georgia and South Carolina commercial shrimpers became eligible for Economic Injury Natural Disaster Loans. The loans were granted at a 3 percent interest rate on the first $25,000 and 6.63 percent rate for loans over $25,000.

During 1977 and 1978, the SBA field offices in Georgia and South Carolina approved $12.5 million of disaster loans (Table 10-10).

10.3.3 Seafood Carriers

Seafood carriers or shippers have been critical factors in growth and development of the U.S. fishing industry (Abrahamson and Hoffman, 1961). In the shrimp fishery, carriers may also serve as wholesalers by actually taking possession of the shrimp and selling it to other wholesalers or processors. Maiolo et al. (1980) reported carriers serving as wholesalers still derive their profits from freighting services and not shrimp sales. In a seafood transportation directory prepared by the South Carolina Wildlife and Marine Department 25 fresh seafood carriers were listed with headquarters in the Carolinas, Georgia and Florida. Points of destination of carriers originating in the South Atlantic States include every state in the continental U.S. and Washington, D.C.

10.4 Labor Organizations

Based upon available information, only one seafood processor in the South Atlantic region has union plant workers; they belong to the National Maritime Union of America.

10.5 Foreign Investment

Based upon available information, there is currently no foreign investment in the South Atlantic shrimp fishery; however, business firms in the industry could be subsidiaries of corporations which include foreign investors.

10.6 Economic Impact Analysis

The shrimp industry utilizes services and goods purchased from other industry as input to produce shrimp products. This in turn, is used in other sectors (e.g., seafood retailers). If an increase in shrimp demand occurs, an increase in shrimp production is triggered. Many times this raw supply may not be derived from domestic stocks, but rather from imports. Regardless, the increased production will increase demand for inputs from other sectors, and the resulting effects

Table 10-10. Number and initial outstanding amount of Economic Injury Natural Disaster Loans approved by the Small Business Administration in 1977 and 1978 for Georgia and South Carolina commercial shrimpers suffering economic losses as a result of winter-induced white shrimp stock damage. (Source: Small Business Administration, Atlanta, Georgia and Columbia, South Carolina).

	Georgia	South Carolina
Number of Loans	359	170
Outstanding Amount 1/	$ 9,355	$ 3,191
Aggregate Mean 1/	26	19

1/ In thousands

will ripple through the economy. Using various input-output analysis methods, the interaction between sectors and associated potential economic impact can be predicted with multipliers.

In the coastal areas of the Gulf States, income, sales and employment multipliers associated with fisheries have been calculated using input-output analysis methods (see Jones et al., 1974; Morris and Prochaska, 1979; Nissan et al., 1978). The Jones et al. (1974) analysis specifically addressed the impact of economic activity generated through harvesting by the domestic shrimp fleet for three coastal regions in Texas and the entire state. Explicitly, assuming their multipliers can be extrapolated to the South Atlantic States, economic impacts can be calculated (Table 10-11). A recent example of the shrimp industry's impact on employment is the vessel building firms in St. Augustine, Florida, which specialize in shrimp trawlers and other fishing vessels. During the first half of 1981, employment at a major trawler building yard dropped to about 150 employees compared to more than 300 employees in 1980.

Table 10-11. Estimated aggregate economic impact of the South Atlantic states' shrimp harvesting sector in 1980 based upon Jones et al. (1974) results for the Texas economy.

	Output(Sales) (Dollar in Thousands)	Income
Multiplier	3.09	2.37
Direct Impact (D)	$ 57,185[1/]	$21,158[2/]
Total Economic Impact (T)	176,702	50,144
Indirect Impact (T-D)	119,517	28,986

1/ The preliminary total ex-vessel value of the 1980 South Atlantic states' shrimp landings was $57,185,000 (Table 9-2).

2/ There is an estimated 37¢ direct payment to workers in the shrimp industry for each dollar of output (see Jones et al., 1974) ($.37 x 57,185 = $21,158).

11.0 SOCIAL AND CULTURAL FRAMEWORK OF DOMESTIC FISHERMEN

11.1 Ethnic Character, Family Structure, and Community Organization

11.1.1 Ethnic Character

Ethnic minorities among trawler captains are relatively small. In South Carolina, for example, blacks represented only about 9 percent of total trawler captains in 1980 (Table 11-1). White captains predominated, particularly for the owner-captains (94 percent). In North Carolina 5.2 percent of full-time captains are black while only 1.3 percent of the part-time captains are black. A total of 3.4 percent of all full and part-time captains are black in North Carolina (Maiolo, 1981). In Georgia, approximately 12 percent of trawler captains in 1980 were black (S. Shipman, Ga. Dept. Nat. Res., Coastal Res. Div., Brunswick, GA; pers. comm.). A study of two counties (McIntosh and Glynn) by Nix and Kim (1981) shows that 24.1 percent of the captains are black and 33.7 percent of the strikers are also black. Approximately 28.9 percent of all captains and strikers are black.

In the South Atlantic shrimp fleet, many black captains living on the outer islands of South Carolina and Georgia still speak Gullah - a patois of Elizabethan English mixed with African words. The Gullah or Negro culture is maintained at least in part by the fact that the black fishermen live in backwoods and rural island areas. White fishermen have more capital invested in boats and equipment. Most of the black fishermen feel their lack of capital equipment is not due to lack of ability or experience, but is due to the fact that they have few ties to capital lending institutions (Acheson, 1975).

11.1.2 Family Structure

Nearly 90 percent of captains in North Carolina are married (Maiolo and Still, 1981). Average family size is 2.5 children per married couple which is higher than the national average fertility rate of 1.8. The captain's occupational life is affected by ties of family and kinship. About two-thirds of captains (65 percent) indicated that the influence of the father was responsible

Table 11-1. Number and race distribution of commercial shrimp fishermen, South Carolina, 1980. (Source: South Carolina trawler license file, 1980-1981, unpublished data.)

Item	Owner-Captain No.	Owner-Captain %	Non-Owner Captain No.	Non-Owner Captain %	Total No.	Total %
White	929	93.7	395	84.6	1324	90.8
Negro	57	5.8	68	14.6	125	8.6
Others	5	.5	4	.8	9	.6
Total	991	100.0	467	100.0	1458	100.0

for their entry into fishing as an occupation. About half (49 percent) of the fulltime captains had fathers whose principal occupation was fishing as compared to only 23 percent of part-time captains. These extensive generational ties are consistent with findings of a study on the role of family and kinship ties among Southport fishermen in North Carolina (Sabella et al., 1979). Approximately 86 percent of Southport fishermen had fathers who also were fishermen. Wives play an important role in the family occupational structure for 48 percent of the captains. Their income contributes more than one-third of the total family income.

About 52 percent of crewmen in North Carolina are married while 38 percent are single and 10 percent are separated. Average household size for married crewmen is 4. About 53 percent of those crewmen grew up in a family where their fathers were engaged in fishing. A majority of crews reported that their fathers influenced them to the occupation. Forty percent of crews' spouses have a regular job outside the home.

Data on family structure of commercial shrimpers in South Carolina, Georgia and Florida are not available.

11.1.3 Community Organization

Studies by Maiolo (1981) and Sabella et al. (1979) do not offer any information about community organizations. However, Nix and Kim (1981) found that social participation and community involvement along the Georgia coast is quite limited among shrimp fishermen. They suggest an apparent "community disinvolvement" which is associated with very few social ties, including social organizations and occupational associations. Political participation among shrimp fishermen in the above survey was also limited. Almost 32 percent of the fishermen in the study did not vote. Many of these same fishermen did not even register to vote (Nix and Kim, 1981). According to White (1977) there is a correlation between distance from shore (in terms of time spent away from home and family) and community disinvolvement. With increasing distance and time spent away from shore, there is a weakening of participation in activities of the land-based community.

In communities where non-maritime work predominates, such community disinvolvement has important social and political overtones. This is especially true where prestige and respect are measured by the degree to which one participates in community affairs and decision-making (Nix and Kim, 1981). The more involved one becomes, the more influence that individual can exert and hence the more prestige and respect. Conversely, shrimp fishermen - because of their lack of involvement - feel a sense of community powerlessness and alienation according to White (1977). Thus, emphasis is placed on increased social relationships within the occupational group itself or what White (1977) refers to as "occupational closure." In consideration of this, Nix and Kim (1981) indicate there should be a strong tendency for fishermen to organize themselves into fishermen cooperatives and occupational associations. However, they discuss mitigating factors (i.e., intensified competition for the resource) which discourage such actions. Also, these authors suggest there is a polarization of sex roles in an essentially closed social interaction system. The wife takes on a dominant role in land-based family activities and the corresponding decrease in husband participation alters family and community behavioral patterns (Nix and Kim, 1981).

11.2 Age, Education, and Experience of Commercial Fishermen

There is some evidence to indicate that the life styles of participants in the South Atlantic shrimp fishery are changing (Fisch and Maiolo, 1981). New entrants into the fishery are more educated and a greater portion of them come from families without the father being a fishermen. Such newcomers are born outside their current community of residence and tend to average slightly more income. These new fishermen are more likely to take advantage of financial assistance programs (i.e. Small Business Administration loans, etc.) to enhance and maintain the fishery (Fisch and Maiolo, 1981).

Captains in North Carolina range in age from 18 to 80. Most are in their forties or younger, with the average age slightly under 47 years (Table 11-2). About 20 percent are 61 years or older. Part-time captains are, on the average, older than their full-time counterparts. The average level of education (10.5 years) corresponds to less than a high school diploma (Table 11-3). However, 21 percent of the captains have more than a high school education. There is no significant difference between full-time and part-time captains in educational level.

The majority of captains in South Carolina are middle-aged; the average age is 39 years (Table 11-4). About 5 percent are 61 years or older. Owner-captains are slightly older than hired captains.

The captains of shrimp vessels in Georgia tend to be middle-aged (Table 11-5). More than one-half of the captains (58 percent) fall into the category of 26 to 45 years of age and about 4 percent are 61 years or older.

The average age of trawler captains in the South Atlantic states is 43 years (Table 11-6). Only slight differences are apparent among the captains of the various types of vessels. The categories of captains are similar in terms of years of formal education. The average experience in commercial fishing is 21 years, of which 10 years are worked as a captain and 11 years served as a crew on the trawler.

A survey of 29 crew members of North Carolina shrimp vessels conducted by Maiolo (1980) indicates that the average age of crews is 27 years and educationally, crew members have an average of 11 years of schooling, somewhat less than a high school education. This reveals that crew members are somewhat younger and slightly better educated than their captains. About 83 percent of crews in the survey identify themselves as full-time fishermen and have been engaged in fishing for 8 years.

11.3 Employment Opportunities and Unemployment Rates

One of the indicators of employment opportunities in a fishing community is the change in population. The decline in population indicates a lack of employ-

Table 11-2. Number and age distribution of commercial fishermen, North Carolina, 1980. (Source: Surveys of Fishermen, Department of Sociology and Anthropology, East Carolina University, Spring, 1980).

	Full-Time Captain		Part-Time Captain		Total	
	No.	%	No.	%	No.	%
≤ 20	2	2.1	0	0.0	2	1.1
21-25	4	4.1	2	2.6	6	3.4
26-30	13	13.4	3	3.8	16	9.1
31-35	10	10.3	5	6.4	15	8.6
36-40	17	17.5	6	7.7	23	13.1
41-45	13	13.4	9	11.5	22	12.6
46-50	14	14.4	8	10.3	22	12.6
51-55	10	10.3	9	11.5	19	10.9
56-60	3	3.1	11	14.1	14	8.0
61-65	6	6.2	10	12.8	16	9.1
66 & over	5	5.2	15	19.3	20	11.5
Total	97	100.0	78	100.0	175	100.0
Average (yrs)	42.6		52.3		46.9	

Table 11-3. Years of education of commercial fishermen, North Carolina, 1980. (Source: Surveys of fishermen, Department of Sociology and Anthropology, East Carolina University, April, 1980).

Education (years)	Full-Time Captain		Part-Time Captain		Total	
	No.	%	No.	%	No.	%
1-5	8	8.2	7	9.1	15	8.6
6-8	25	25.8	13	16.9	38	21.8
9-12	50	51.5	34	44.2	84	48.3
13-16	12	12.4	18	23.4	30	17.2
16-19	2	2.1	5	6.4	7	4.1
Total	97	100.0	77	100.0	174	100.0
Average (yrs)	10.1		11.1		10.5	

Table 11-4. Number and age distribution of commercial shrimp fishermen, South Carolina, 1980. (Source: South Carolina Trawler license file, 1980-1981, unpublished data)

Age	Owner-Captain		Non-Owner Captain		Total	
	No.	%	No.	%	No.	%
< 20	11	1.1	22	4.7	33	2.2
21-25	66	6.6	82	17.4	148	10.0
26-30	134	13.4	84	17.8	218	14.8
31-35	163	16.3	67	14.2	230	15.6
36-40	172	17.2	55	11.7	227	15.4
41-45	143	14.2	52	11.0	195	13.2
46-50	134	13.4	33	7.0	167	11.3
51-55	83	8.3	36	7.6	119	8.1
56-60	49	4.9	23	4.9	72	4.9
61-65	28	2.8	11	2.3	39	2.6
66 and over	18	1.8	6	1.3	24	1.9
Total	1001	100.0	471	100.0	1472	100.0
Average (yrs)	40.2		36.3		39.0	

Table 11-5. Number and age distribution of commercial shrimp fishermen, Georgia, 1980. (Source: Georgia documented trawler license file, 1980-1981, unpublished data).

Age	No.	%
<21	12	2.9
21-25	41	9.9
26-30	51	12.3
31-35	52	12.6
36-40	84	20.3
41-45	54	13.0
46-50	36	8.7
51-55	40	9.7
56-60	26	6.2
61-65	9	2.2
66 and over	9	2.2
Total	414	100.0
Average (yrs)	39.1	

Table 11-6. Characteristics of trawler captain by mobility class in South Atlantic states, 1976. (Source: Liao, 1979)

Characteristics	Mobility Class I n=176	II n=91	III n=29	IV n=5	All Class n=301
Age (yrs.)	43	42	40	33	42
Years of Formal Education	10	11	11	12	10
Years of Commercial Fishing Experience	19	22	19	14	21
Percent of Captains with Non-Fishing Employment	50	13	21	0	35

ment opportunities for its residents. Thus, emigration from the community has occurred. Two coastal counties in North Carolina have had population declines and one county has remained unchanged during 1970 to 1977 (Table 11-7). The population of Charleston and Beaufort counties in South Carolina increased very little compared to Dorchester and Berkeley counties, which showed increases of 62.3 percent and 34.5 percent, respectively, during 1970 to 1978 (Table 11-8). These two counties have emerged as possibly the most influential employment center in the South Carolina coastal region, accounting for the population increases. On the Georgia coast, the major population concentrations occur in Chatham, Glynn and Liberty counties. The population in Liberty, Effingham, and Bryan counties experienced large increases from 1969 to 1978. The county which experienced a population decline over the same period was Glynn County (Table 11-9). The rate of annual population increase for the Florida coastal counties was 3.6 percent as compared to 2.2 percent for South Carolina, 1.6 percent for North Carolina, and 1.0 percent for Georgia (Table 11-10).

Coastal counties in the region have an unemployment rate that is higher than the state's rate except that of Florida's east coast (Table 11-11). In South Carolina, the unemployment rate for the coastal counties as a whole was 6.2 percent and for the state in 1979 was 5.0 percent. In 1974, Georgia's unemployment rate of 5.1 percent was less than that of coastal counties as a whole, 5.9 percent.

Data are not available to indicate the extent of unemployment among commercial fishermen. However, since 1980, commercial fishermen have been facing a critical economic situation caused by rising fuel costs and declining shrimp prices. This tends to increase the unemployment rate for commercial fishermen. The employment opportunities for commercial fishermen in non-fishery sectors depends upon the individual fisherman's skill either from currently held part-time jobs or alternative jobs held in the past, level of education, age, and capacity to learn new skills.

Table 11-7. Population trends in coastal counties of North Carolina. (Source: Calculated from North Carolina State Government Statistical Abstract, Division of State Budget and Management, N.C. State Government, 1979).

Counties	Population (thousands) 1970	1977	Change 1970-1977 Expressed as %
Currituck	7.0	10.0	42.9
Camden	5.5	5.7	3.6
Pasquotank	26.8	28.8	7.5
Perquimans	8.4	8.7	3.6
Chowan	10.8	11.7	8.3
Bertie	20.5	21.3	4.3
Washington	14.0	15.0	7.1
Tyrrell	3.8	3.8	0.0
Dare	7.0	10.3	47.1
Hyde	5.6	5.7	1.8
Beaufort	36.0	39.5	9.7
Pamlico	9.5	9.8	3.2
Craven	62.6	68.7	9.7
Carteret	31.6	37.1	17.4
Onslow	103.1	115.7	12.2
Pender	18.1	21.6	19.4
New Hanover	83.0	97.4	17.3
Brunswick	24.2	33.0	36.4
Gates	8.5	8.3	-2.4
Hertford	24.4	24.2	-0.8
Total Coastal Counties	510.4	576.3	12.9
Annual Population Growth			1.8

Table 11-8. Population trends in coastal counties of South Carolina. (Source: Caluclated from South Carolina Statistical Abstract, 1980, the S.C. Division of Research and Statistical Services, S.C. State Government, 1980).

Counties	Population (Thousands) 1970	1978	Change 1970-1978 Expressed as %
Beaufort	51.1	57.7	12.9
Berkeley	56.2	75.6	34.5
Charleston	247.7	259.9	5.0
Colleton	27.7	29.9	7.9
Dorchester	32.3	52.4	62.3
Georgetown	33.5	39.8	18.8
Horry	70.0	91.6	30.8
Jasper	11.9	14.6	22.7
Total Coastal Counties	530.3	621.5	17.2
Annual Population Growth			2.2

Table 11-9. Population trends in coastal counties of Georgia. (Source: Calculated from 1980 Georgia Statistical Abstract, Akioka, 1980 [illegible]

Counties	Population (Thousands) 1969	1978	Change 1969-1978 Expressed as %
Bryan	6.4	8.4	31.2
Camden	11.3	12.0	6.2
Chatham	186.5	192.2	3.1
Effingham	13.2	17.9	35.6
Glynn	50.2	49.6	-1.2
Liberty	16.8	30.2	79.8
McIntosh	7.3	8.9	21.9
Total Coastal Counties	291.7	319.2	9.4
Annual Population Growth			1.0

Table 11-10. Population trends in coastal counties in Florida. (Source: Calculated from Florida Statistical Abstract, Bureau of Economic & Business Research, University of Florida, 1980).

Counties	Population (Thousands)		Change 1970-1979 Expressed as %
	1970	1979	
Nassau	20.6	31.8	54.4
Duval	528.9	566.4	7.1
St. Johns	31.0	45.7	47.4
Flagler	4.5	9.0	100.0
Volusia	169.5	240.4	41.8
Brevard	230.0	275.8	19.9
Indian River	36.0	56.8	58.3
St. Lucie	50.8	82.4	62.2
Martin	28.0	57.4	107.2
Palm Beach	349.0	564.5	61.7
Broward	620.1	966.1	55.8
Dade	1,267.8	1,519.4	19.8
Total Coastal Counties	3,336.2	4,315.7	32.4
Annual Population Growth			3.6

Table 11-11. Unemployment rates for coastal counties in South Atlantic states. (Source: Calculated from (1) North Carolina Statistical Abstract, Division of State Budget and Management, N.C. State Government, 1979; (2) South Carolina Statistical Abstract, 1980, the S.C. Division of Research and Statistical Services. S.C. State Government, 1980; (3) 1980 Georgia Statistical Abstract College of Business Administration, University of Georgia; and (4) 1980 Florida Statistical Abstract, Bureau of Economic and Business Research, University of Florida, 1980).

Item	North Carolina 1977	South Carolina 1979	Georgia 1974	Florida (East coast) 1979
Coastal Counties	7.6%	6.2%	5.9%	5.8%
State Total	5.9%	5.0%	5.1%	6.0%

11.4 Recreational Fishing

In North Carolina, a typical recreational fisherman is a native North Carolinian (Maiolo and Faison, 1980). His average age is 45 (range 16 to 76). Average years of education is just under 12, indicating that he is slightly better educated (in terms of formal education) than his full and part-time fisherman counterparts. Further, 29 percent of the recreational fishermen have experienced some schooling beyond high school, with 16 percent completing four years or more beyond high school. More than a third, 36 percent are employed in white collar occupations, and 52 percent in blue collar jobs most of which are semi-skilled and skilled work roles. Six percent of them were unemployed and 17 percent retired. Forty-five percent of the respondents' spouses work; half are in professional or semi-professional positions (teachers, saleswomen, etc.). About 90 percent of recreational fishermen are married and have two or three children.

The average private boat fisherman with boats measuring 4.8 m (16 ft) or more in South Carolina has been engaged in offshore sport fishing for thirteen years (Liao and Cupka, 1979). Private boat fishermen tended to have a high family income, with an estimated average family income of $29,500. Slightly less than one-third (29 percent) were classified as professionals. Twenty-three percent were self-employed. About one-fifth (21 percent) were managers or supervisors. Retired people accounted for thirteen percent of offshore private boat fishermen. About 8 percent were blue collar workers, and about six percent "white" collar workers (i.e. salespersons, clerical, and service occupations). The majority of private boat fishermen are weekend or holiday fishermen. About 66.5 percent of total recreational shrimp fishermen were private boat fishermen. The remaining 33.5 percent engaged shrimping operations on shore, pier, dock, or bridge (Table 11-12). The demographic profile of these fishermen and private boat fishermen utilizing boats less than 4.8 m (16 ft) is not available.

Table 11-12. Summarized data from a 1974 survey of the recreational shrimp fishery in South Carolina (Cupka and McKenzie, 1974).

Major gear types used to shrimp recreationally, and percent usage reported:
cast net (66.7%), seine (16.4%), drop net (15.6%), otter trawl (1.3%).

Average annual catch per respondent:
48.6 lb (22.0 kg) (heads on).

Principal county in which respondent shrimped, by percent:
Charleston (52.6%), Beaufort (25.4%), Georgetown (9.4%), Jasper (7.2%), Horry (3.6%) and Colleton (1.8%).

Area or platform from which shrimping occurred, by percent:
boat (66.5%), shore (20.8%), pier or dock (10.6%), bridge (2.1%).

Principal months during which fishing occurred, by percent:
March (0.1%), April (0.4%), May (2.0%), June (9.8%), July (16.9%), August (23.0%), September (24.8%), October (13.7%), November (7.4%), December (1.9%).

Average number of trips annually per respondent:
9.2.

Average catch per trip:
5.3 lb (2.4 kg) (heads-on).

Projected total number of trips annually:
155,117.

Projected total annual catch:
815,717 lb (370,001 kg) (heads on).

In Georgia, no survey exists concerning socio-economic characteristics of recreational shrimpers.

In Florida, sport fishing for shrimp is primarily a cast netting and seining operation. In the St. John's River area, there is a significant amount of recreational shrimping. There were 127 recreational shrimping license holders in the area during the 1980-81 season (S. Kennedy, FL Dept. of Nat. Res., Marine Res. Lab., St. Petersburg, FL; pers. comm.). However, demographic data of recreational shrimpers in Florida are not available.

Recreational shrimping is a popular activity along the coast of the South Atlantic states. However, no historical data are available on the recreational catch of shrimp for the South Atlantic region. A recent study has provided an estimate of the magnitude of this fishery for South Carolina (Cupka and McKenzie, 1974). Total annual catch was 815,717 lb of shrimp (heads-on) by South Carolina recreational shrimpers during 1973. The average catch per trip was 5.3 lb (Table 11-12).

An obvious need is a more comprehensive catch and effort sampling scheme for South Atlantic states so that recreational impact on the total shrimp fishery can be determined on an annual basis. In order to formulate a meaningful management program, it is also necessary to know the magnitude of the social benefits associated directly with recreational shrimping in the South Atlantic region. Unfortunately, no such data are currently available.

11.5 Economic Dependence on Fishing and Related Activities

In 1974, 48 percent of Florida commercial fishermen surveyed fished full-time; the remainder reported that some of their income was earned from employment outside of fishing. Owners of shrimp fishing firms earned 21 percent of their income from sources outside of fishing. Many fishermen are not fully dependent on fishing for employment and instead rely on fishing income to supplement that from other industries. A recent survey of Florida fishermen (all types of fishing) showed that those with income from non-fishing activities had widely varied employment. Based on those who specifically reported type of employment, eight percent were in residential or commercial construction; seventeen percent were employed in marine related jobs such as tug boat captains, marina operators, and boat builders; ten percent were involved in agriculture; nine percent were employed in security type jobs; seven percent held jobs as mechanics and repairmen; twenty-two percent had other occupations such as teachers, chemists, optometrists, broadcasters and flight instructors. Only 21 percent of the respondents said that their nonfishing employment was seasonal (Prochaska and Cato, 1977).

In 1976, 65 percent of trawler captains in the South Atlantic states were full-time commercial fishermen. Approximately 50 percent of all captains in mobility Class I trawlers in the region had non-fishery employment. Only 13 and 21 percent of captains for mobility classes II and III, respectively, had non-fishery employment. No captain in mobility class IV trawlers worked outside the fishery; thus, every captain in this category was a full-time commercial fisherman. Eighty-eight of 175 captains in mobility class I had spent, on the average, about 8 months in non-fishery jobs (Table 11-13). Thus, these are persons who are in occupations other than fishing, but take time off from regular employment, or use their holidays or spare time after working hours, to shrimp commercially. Shrimping is usually done to supplement income from employment outside the commercial shrimping industry for class I captains. Most of these captains held blue collar jobs. About 12 sample captains in mobility class II had non-fishery jobs in 1976 (Liao, 1979)

In 1980, 81 percent of trawler captains in Georgia were full-timers and the remaining 19 percent had employment outside of shrimping (S. Shipman, GA Dept. of Nat. Res., Coastal Res. Div., Brunswick, GA; pers. comm.). Only 55 percent of captains in North Carolina shrimp fishery were found to be full-time fishermen. About 27 percent of the part-timers were in maritime related jobs, i.e. seafood processing, boat repair, etc. (Table 11-14). The remainder reported that they had widely varied non-maritime employment.

Table 11-13. Occupational distribution and length of captain's Non-fishery employment, 1976. (Source: Liao, 1979)

Item	Mobility Class I	II	III	IV
Number of captains in sample	176	91	29	5
Number of captains with non-fishery employment	88	12	6	0
Professional and technical worker	4	1	0	0
Managers and Administrators	5	0	0	0
Blue collar-craftsmen, skilled workers, etc.	51	4	5	0
Sales and Clerical worker	7	0	0	0
Self-employed	11	4	0	0
Laborers and others	10	3	1	0
Average Length of non-fishery employment for those working outside the fishery (months)	8	6	4	0

Table 11-14. Distribution of primary occupation of commercial fishermen, North Carolina, 1980. (Source: Survey of fishermen, Department of Sociology and Anthropology, East Carolina University, Spring, 1980).

Primary Occupation	Full-Time Captain		Part-Time Captain		Total	
	No.	%	No.	%	No.	%
Fishing	92	94.9	11	14.9	103	59.9
Boat Building & Repair	2	2.1	1	1.3	3	1.7
Marine Transportation			4	5.4	4	2.3
Other Maritime related			4	5.4	4	2.3
Farmers			3	4.1	3	1.7
Teachers, except college and University			3	4.1	3	1.7
Former member of the Armed Forces			3	4.1	3	1.7
Managers and Administrators			2	2.7	2	1.2
Real Estate brokers & agents			2	2.7	2	1.2
Machinists			2	2.7	2	1.2
Sheetmetal workers & tinsmith			2	2.7	2	1.2
Current member of Armed Forces			2	2.7	2	1.2
All Others	3	3.0	36	49.5	39	22.7
Total	97	100.0	75	100.0	172	100.0

11.6 Distribution of Income within Fishing Communities

The distribution of personal income in coastal counties of North Carolina is shown in Table 11-15. The table provides an economic picture within which the relative importance of fishing to the local economy can be viewed. Shrimping is included in agricultural services, forestry, fisheries, and other sectors. In Pamlico County, for example, the fisheries, forestry, and agriculture service sector accounts for about 16.6 percent of the personal income. The private industry sectors that contribute the most to total personal income are manufacturing and services sectors in Pamlico County. In most coastal counties, the income from fisheries, forestry, and agricultural services is not a major contributor to total local economy.

In coastal South Carolina, on a county basis, income generated by fisheries, forestry, and agricultural services is of more relative importance in Georgetown County (Table 11-16). Manufacturing, retail trade, transportation, and public utilities are important private sectors contributing to personal income in Charleston and Beaufort counties.

On a comparative basis, the personal income generated by fishery, forestry, and agricultural services is minor in relation to all industry income data in all coastal counties of Georgia except for McIntosh County (17 percent). However, on a total basis, they are of minor importance (Table 11-17).

In Florida, the fisheries, forestry, and agricultural services sector accounts for only 2.0 percent of the personal income in Monroe County, about 1.4 percent in St. John's county and about 1 percent in Nassau County, and about 0.3 percent in Duval County (Table 11-18). Thus, the seafood industry is not a very important element of the local economy of the counties on Florida's east coast.

Table 11-15. Personal income by major sources for coastal counties in North Carolina, 1979. (Source: Local Area Personal Income, 1974-79. U.S. Department of Commerce, Bureau of Economic Analysis).

(Thousands of dollars)

ITEM	Beaufort	Bertie	Brunswick	Camden	Carteret	Chowan	Craven	Currituck	Dare	Gates	Hertford
By Type:											
Wage and salary disbursements	159,963	50,930	117,894	6,756	107,687	45,281	372,389	13,750	41,146	11,788	82,695
Other labor income	16,918	4,940	13,333	408	9,257	3,675	21,476	972	2,886	786	8,654
Proprietors' Income	25,194	23,207	25,851	934	17,992	7,449	29,895	925	9,589	10,904	16,276
Farm	8,952	16,796	11,691	-943	502	3,225	9,380	-2,448	0	8,863	7,942
Nonfarm	16,242	6,411	14,160	1,877	17,490	4,224	20,515	3,373	9,589	2,041	8,334
By Industry:											
Farm	13,253	20,822	12,695	207	1,264	4,445	12,379	-1,176	0	9,822	9,890
Nonfarm	188,822	58,255	144,383	7,891	133,672	51,960	411,381	16,823	53,621	13,656	97,735
Private	165,193	46,850	124,117	5,291	108,156	42,650	184,774	10,515	40,671	8,751	80,983
Agricultural Services, forestry, fisheries, & other	2,491	944	(D)	(D)	3,829	2,170	(D)	(D)	932	77	309
Mining	(D)	(D)	(L)	0	0	0	(D)	0	0	0	0
Construction	7,056	2,188	(D)	1,083	7,515	2,877	15,038	2,054	6,007	428	5,342
Manufacturing	58,671	28,411	67,458	554	29,273	15,930	57,209	1,553	1,782	1,795	31,327
Nondurable goods	23,414	12,475	(D)	(L)	10,754	7,706	26,385	669	435	(D)	11,688
Durable goods	35,257	15,936	(D)	523	18,519	8,224	30,824	884	1,347	(D)	19,639
Transportation & public utilities	8,290	(D)	18,978	(D)	7,784	1,944	16,709	618	1,625	689	3,663
Wholesale trade	11,658	4,313	2,261	584	8,901	5,283	14,156	915	2,371	586	5,028
Retail trade	20,368	4,906	11,258	1,227	21,742	5,230	34,305	2,442	14,130	1,864	12,351
Finance, insurance, & real estate	4,576	882	4,289	50	5,163	886	9,570	(D)	3,098	1,546	1,918
Services	(D)	4,684	10,703	1,104	23,949	8,330	35,576	2,025	10,726	1,766	21,045
Government & government enterprises	23,629	11,405	20,266	2,600	25,516	9,310	226,607	6,308	12,950	4,905	16,752
Federal, civilian	2,326	1,380	5,921	270	3,781	789	82,819	784	4,167	571	1,485
Federal, military	410	197	1,003	175	1,963	127	110,258	362	2,616	111	246
State & Local	20,893	9,828	13,342	2,155	19,772	8,394	33,530	5,162	6,167	4,223	15,021
TOTAL	202,075	79,077	157,078	8,098	134,936	56,405	423,760	15,647	53,627	23,478	107,625

(D) Not shown to avoid disclosure of confidential information
(L) Less than $50,000.

Table 11-15 (Cont.). Personal income by major sources for coastal counties in North Carolina, 1979. (Source: Local Area Personal Income, 1974-79, U.S. Department of Commerce, Bureau of Economic Analysis).

(Thousands of Dollars)

ITEM	Hyde	New Hanover	Onslow	Pamlico	Pasquotank	Pender	Perquimans	Tyrrell	Washington
By Type:									
Wage and salary disbursements	11,986	485,231	578,861	16,347	105,227	33,460	15,912	5,461	31,466
Other labor income	1,032	46,370	16,361	1,336	8,391	2,508	1,231	376	2,086
Proprietors' Income	259	60,075	32,058	3,684	11,396	13,147	7,432	2,449	11,366
Farm	-1,965	-427	10,769	786	83	6,140	3,808	377	7,233
Nonfarm	2,224	60,502	21,289	2,898	11,313	7,007	3,624	2,072	4,133
By Industry:									
Farm	-605	120	13,703	1,668	1,060	9,104	4,623	983	8,985
Nonfarm	13,882	591,556	613,577	19,699	123,954	40,011	19,952	7,303	35,933
Private	10,583	503,111	149,440	14,063	85,504	28,223	15,835	5,319	26,549
Agricultural Services, forestry, fisheries, & other	831	(D)	(D)	2,907	(D)	336	285	174	3,509
Mining	0	(D)	(D)	0	(D)	(L)	0	0	0
Construction	1,891	(D)	16,874	1,105	5,020	2,461	2,967	324	(D)
Manufacturing	1,114	161,892	29,844	2,929	9,562	7,712	3,952	1,761	6,793
Nondurable goods	1,017	(D)	13,707	2,364	4,839	3,980	2,786	(D)	2,968
Durable goods	97	(D)	16,137	565	4,723	3,732	1,166	(D)	3,825
Transportation & public utilities	129	64,233	14,827	478	9,329	2,677	1,211	244	1,540
Wholesale trade	2,199	36,690	6,081	1,816	6,412	2,788	1,534	414	(D)
Retail trade	1,466	79,572	41,005	1,972	27,847	7,399	2,719	1,787	5,426
Finance, insurance, & real estate	1,365	23,154	11,345	379	7,499	838	828	65	1,224
Services	1,588	99,819	28,120	2,477	18,690	3,998	2,339	550	4,132
Government & government enterprises	3,299	88,445	464,137	5,636	38,450	11,788	4,117	1,984	9,384
Federal, civilian	1,009	14,689	70,498	508	11,202	1,045	397	231	770
Federal, military	141	6,374	358,740	145	2,345	252	110	(L)	207
State & Local	2,149	67,382	34,899	4,983	24,903	10,491	3,610	1,715	8,407
TOTAL	13,277	591,676	627,280	21,367	125,014	491,115	24,575	8,286	44,918

(D) Not shown to avoid disclosure of confidential information
(L) Less than $50,000.

Table 11-16. Personal income by major sources for coastal counties in South Carolina, 1979. (Source: Local Area Personal Income, 1974-79. U.S. Department of Commerce, Bureau of Economic Analysis)

(Thousands of dollars)

ITEM	Beaufort	Berkeley	Charleston	Colleton	Dorchester	Georgetown	Horry	Jasper
By Type:								
Wage and salary disbursements	359,276	224,536	1,638,462	83,845	116,200	158,685	374,772	24,333
Other labor income	13,778	17,840	110,520	7,675	10,630	17,736	30,171	1,921
Proprietors' Income	22,214	15,613	96,469	11,386	17,196	13,163	71,812	7,135
Farm	2,375	2,838	251	1,576	4,259	2,900	24,743	1,790
Nonfarm	19,839	12,775	96,218	9,810	12,937	10,263	47,069	5,345
By Industry:								
Farm	4,551	3,696	2,228	2,784	5,093	3,820	31,504	2,488
Nonfarm	390,717	254,293	1,843,223	100,122	138,933	185,764	445,251	30,901
Private	167,365	190,666	1,050,868	81,982	112,527	164,078	347,147	23,430
Agricultural Services, forestry, fisheries, & other	4,598	(D)	(D)	(D)	3,845	7,260	2,934	(D)
Mining	(L)	(D)	(L)	(D)	(D)	(D)	(L)	(D)
Construction	25,559	(D)	(D)	5,337	13,213	8,754	29,879	4,550
Manufacturing	13,409	82,662	188,471	33,979	46,536	94,277	76,050	2,231
Nondurable goods	8,863	51,544	89,723	23,312	11,582	51,015	21,350	1,178
Durable goods	4,546	31,118	98,748	10,667	34,954	43,262	54,700	1,053
Transportation & public utilities	10,263	(D)	136,382	7,058	(D)	5,209	19,469	4,124
Wholesale trade	5,108	(D)	99,416	(D)	(D)	(D)	17,114	886
Retail trade	33,029	14,067	178,083	10,733	17,713	18,112	80,152	4,821
Finance, insurance, & real estate	23,938	2,171	80,527	4,852	3,943	4,962	23,501	626
Services	51,144	23,734	254,243	11,470	14,917	21,417	98,038	5,390
Government & government enterprises	223,352	63,627	792,355	18,140	26,406	21,686	98,104	7,471
Federal, civilian	26,208	25,909	311,048	1,824	1,957	1,448	14,316	635
Federal, military	171,232	949	271,024	409	662	643	39,658	258
State & Local	-25,912	36,769	210,283	15,907	23,787	19,595	44,130	6,578
TOTAL	395,268	257,989	1,845,451	102,906	144,026	189,584	476,755	33,389

(D) Not shown to avoid disclosure of confidential information
(L) Less than $50,000.

Table 11-17. Personal income by major sources for coastal counties in Georgia, 1979. (Source: Local Area Personal Income, 1974-79. U.S. Department of Commerce, Bureau of Economic Analysis.)

(Thousands of dollars)

ITEM	Bryan	Camden	Chatham	Effingham	Glynn	Liberty	McIntosh
By Type:							
Wage and salary disbursements	12,254	71,216	1,064,257	17,159	267,350	231,670	13,182
Other labor income	982	6,768	105,613	1,266	27,110	5,594	1,131
Proprietors' Income	4,365	3,320	82,490	10,378	21,398	3,652	2,088
Farm	1,891	751	874	7,129	207	177	58
Nonfarm	2,474	2,569	81,616	3,249	21,191	3,475	2,030
By Industry:							
Farm	2,023	868	1,635	7,571	324	267	96
Nonfarm	15,578	80,436	1,250,725	21,232	315,534	240,649	16,305
Private	11,517	60,147	1,036,822	14,415	266,033	36,620	12,268
Agricultural Services, forestry, fisheries, & other	(D)	770	(D)	(D)	2,471	751	2,847
Mining	0	0	(D)	(D)	(L)	0	0
Construction	1,907	4,771	87,015	2,962	20,422	4,090	695
Manufacturing	2,450	42,958	316,446	3,156	107,781	11,088	2,959
Nondurable goods	(L)	40,654	206,224	1,002	73,681	9,838	(D)
Durable goods	2,418	2,304	110,222	2,154	34,100	1,250	(D)
Transportation & public utilities	(D)	2,433	157,724	(D)	18,406	4,752	(D)
Wholesale trade	331	320	71,799	606	11,350	553	(D)
Retail trade	2,933	3,963	134,901	3,192	36,020	8,030	2,242
Finance, insurance, & real estate	583	1,071	57,489	559	15,078	1,845	334
Services	2,655	3,861	204,335	2,710	54,491	5,511	1,356
Government & government enterprises	4,061	20,289	213,903	6,817	49,501	204,029	4,037
Federal, civilian	461	2,105	51,236	556	11,249	44,401	408
Federal, military	242	12,455	29,010	343	948	151,048	120
State & Local	3,358	5,729	133,657	5,918	37,304	8,580	3,509
TOTAL	17,601	81,304	1,252,360	28,803	315,858	240,916	16,401

(D) Not shown to avoid disclosure of confidential information
(L) Less than $50,000.

Table 11-18. Personal income by major sources for coastal counties in Florida, 1979. (Source: Local Area Personal Income, 1974-79. U.S. Department of Commerce, Bureau of Economic Analysis.

(Thousands of dollars)

ITEM	Brevard	Broward	Dade	Duval	Flagler	Indian River
By Type:						
Wage and salary disbursements	1,326,334	3,979,307	9,328,908	3,446,910	29,587	227,410
Other labor income	124,903	372,959	886,000	323,241	2,681	22,930
Proprietors' Income	76,885	422,882	784,171	216,235	5,231	37,243
Farm	15,464	13,409	52,359	1,601	2,307	19,859
Nonfarm	61,421	409,473	731,812	214,634	2,924	17,384
By Industry:						
Farm	20,536	26,830	86,374	8,039	3,855	31,630
Nonfarm	1,507,586	4,748,318	10,912,705	3,978,347	33,644	255,953
Private	1,193,299	4,173,485	9,422,570	3,122,802	28,949	219,038
Agricultural Services, forestry, fisheries, & other	5,492	18,061	(D)	10,431	(D)	14,702
Mining	268	3,792	(D)	2,257	0	135
Construction	108,377	488,573	608,401	235,555	(D)	24,049
Manufacturing	386,942	608,694	1,291,420	489,997	2,346	56,851
Nondurable goods	15,833	135,074	688,363	250,501	88	(D)
Durable goods	371,109	473,620	603,057	239,496	2,258	(D)
Transportation & public utilities	97,718	336,897	1,604,035	457,339	3,089	10,424
Wholesale trade	35,642	306,941	1,044,625	385,675	431	7,143
Retail trade	154,907	785,343	1,316,132	425,860	3,966	38,168
Finance, insurance, & real estate	56,474	431,642	847,725	430,485	(D)	17,915
Services	347,479	1,193,542	2,657,902	685,203	6,337	49,651
Government & government enterprises	314,287	574,833	1,490,135	855,545	4,695	36,915
Federal, civilian	132,848	62,849	294,879	235,242	249	3,742
Federal, military	53,224	10,748	100,596	240,355	272	357
State & Local	128,215	501,236	1,094,660	379,948	4,174	32,816
TOTAL	1,528,122	4,775,148	10,999,079	3,986,386	37,499	287,583

(D) Not shown to avoid disclosure of confidential information
(L) Less than $50,000.

Table 11-18. (Cont.). Personal income by major sources for coastal counties in Florida, 1979. (Source: Local Area Personal Income, 1974-79. U.S. Department of Commerce, Bureau of Economic Analysis.

(Thousands of dollars)

ITEM	Monroe	Martin	Nassau	Palm Beach	St. Johns	St. Lucie	Volusia
By Type:							
Wage and salary disbursements	238,219	218,410	123,544	2,548,856	137,201	277,640	739,685
Other labor income	16,493	22,188	11,765	237,347	13,921	25,846	70,763
Proprietors' Income	21,498	35,335	8,004	270,192	19,703	54,240	105,243
Farm	0	11,855	-391	45,184	3,543	32,451	14,490
Nonfarm	21,498	23,480	8,395	225,008	16,160	21,789	90,753
By Industry:							
Farm	65	29,943	1,719	155,375	8,209	49,679	27,339
Nonfarm	276,145	245,990	141,594	2,901,020	162,616	308,047	888,352
Private	180,555	223,700	101,390	2,558,308	134,214	256,887	755,018
Agricultural Services, forestry, fisheries, & other	6,522	10,349	1,710	38,204	2,490	(D)	6,179
Mining	59	(D)	839	1,703	0	(D)	(L)
Construction	18,247	37,858	(D)	321,750	7,344	30,994	74,364
Manufacturing	9,318	33,659	59,570	549,121	28,589	23,663	120,725
Nondurable goods	6,446	7,019	55,829	113,758	(D)	18,677	28,693
Durable goods	2,832	26,640	3,741	435,363	(D)	4,986	92,032
Transportation & public utilities	16,203	22,248	(D)	165,706	8,723	31,778	61,284
Wholesale trade	7,306	(D)	1,844	127,143	9,489	17,047	33,492
Retail trade	49,801	38,292	12,710	420,754	26,167	49,128	163,683
Finance, insurance, & real estate	15,241	18,563	2,517	249,222	7,658	27,185	60,416
Services	57,858	57,368	13,342	684,705	43,754	56,680	234,867
Government & government enterprises	95,590	22,290	40,204	342,712	28,402	51,160	133,334
Federal, civilian	17,069	2,460	21,237	40,280	4,090	3,808	13,672
Federal, military	38,542	963	421	5,492	476	850	3,039
State & Local	39,979	18,867	18,546	296,940	23,836	46,502	116,623
TOTAL	276,210	275,933	143,313	3,056,395	170,825	357,726	915,691

(D) Not shown to avoid disclosure of confidential information

(L) Less than $50,000.

LITERATURE CITED

Abrahamson, J. D. and C. P. Hoffman
1961 Exempt trucking of fresh and frozen fish and shellfish in interstate commerce. U.S. Fish and Wildl. Serv. Circ. 133, 14 pp.

Acheson, J. M.
1975 Social and cultural aspect of the South Atlantic shrimp industry - a pilot study. Unpubl. rep. Univ. of Maine, Orono, Maine.

Akioka, L. M. (ed.)
1980 1980 Georgia statistical abstract. Div. of Research, College of Bus. Adm., Univ. of Georgia. Athens, Ga.

Aldrich, D. V., C. E. Wood, and K. N. Baxter
1968 An ecological interpretation of low temperature responses in Penaeus aztecus and P. setiferus postlarvae. Bull. Mar. Sci. 18(1):61-71.

Allen, D. M., J. H. Hudson, and T. J. Costello
1980 Postlarval shrimp (Penaeus) in the Florida Keys: species, size, and seasonal abundance. Bull. Mar. Sci. 30(1):21-33.

Alvarez, J., C. O. Andrews, and F. Prochaska
1976 Economic structure of the Florida shrimp processing industry. Univ. of Fla., Rep. No. 9, Sea Grant Program. 46 pp.

Anderson, L. G.
1977 The economics of fisheries management. John Hopkins Univ. Press. Baltimore, Maryland. 214 pp.

Anderson, W. W.
1955 Observations upon the biology, ecology, and life history of the common shrimp, Penaeus setiferus (Linn.) along the South Atlantic and Gulf Coast of the United States. Proc. Indo-Pacific Fish. Council, 1955, 5 pp.

Anderson, W. W.
1956 January to April distribution of the common shrimp on the South Atlantic continental shelf. U.S. Dept. of Interior, Fish and Wildl. Serv., Spec. Sci. Rep., Fish. No. 171. 14 pp.

Anderson, W. W.
1968 Fishes taken during shrimp trawling along the South Atlantic coast of the United States, 1931-35. U.S. Fish Wildl. Serv. Sci. Rep., Fish. No. 570. 60 pp.

Anderson, W. W.
1970 Contributions to the life histories of several penaeid shrimps (Penaeidae) along the South Atlantic coast of the United States. U.S. Fish Wildl. Serv., Spec. Sci. Rep., Fish. No. 605. 24 pp.

Anderson, W. W., J. E. King and M. J. Lindner
1949a Early stages in the life history of the common marine shrimp, Penaeus setiferus (Linnaeus). Biol. Bull. (Woods Hole): 96(2): 168-172.

Anderson, W. W., Lindner, and J. E. King
1949b The shrimp fishery of the southern United States. Com. Fish. Rev. 11(2):1-17.

Anderson, W. W. and M. J. Lindner
1958 Length-weight relations in the common or white shrimp, Penaeus setiferus. U.S. Fish Wildl. Serv., Spec. Sci. Rep., Fish. No. 256, 13 pp.

Anderson, W. W. and G. R. Lunz
1965 Southern shrimp ...a valuable regional resource. Atlantic States Mar. Fish. Comm. Leaf. No. 4. 6 pp.

Baisden, V. W.
1979 Juvenile nursery area study on the Georgia coast. Georgia Dept. Nat. Res., Coast. Fish. Div., Proj. Rep. to NMFS, NOAA. 28 pp.

Bara, M. O., R. W. Tiner and D. C. Newkirk
1977 Guidelines for evaluating proposed wetland alterations in South Carolina. South Carolina Wildl. Mar. Res. Dept. publ. 36 pp.

Barrett, B. B. and Gillespie
1973 Primary factors which influence commercial shrimp production in coastal Louisiana. Louisiana Wildl. Fish. Comm. Tech. Bull. No. 9, 28 pp.

Baughman, J. L.
1950 Utilizing waste fish resulting from the shrimping industry. Fish Meal and Oil Industry 2(12):9-10, 16-17.

Baxter, K. N. and W. C. Renfro
1967 Seasonal occurence and size distribution of postlarval brown and white shrimp near Galveston, Texas, with notes on species identification. Fish. Bull., U.S., 66(1):149-158.

Bearden, C. M.
1961 Notes on postlarvae of commercial shrimp (Penaeus) in South Carolina. Contrib. Bears Bluff Lab., No. 33. 8 pp.

Bearden, C. M. and M. D. McKenzie
1972 Results of a pilot shrimp tagging project using internal anchor tags. Trans. Am. Fish. Soc. 101(2): 358-362.

Beaumariage, D. S.
1968 Manufacture of fish meal from Florida's fishery waste and under-exploited fishes. Fla. State Bd. Cons. Tech. Serv. No. 54. 56 pp.

Bell, R. and J. I. Richardson
1978 An analysis of tag recoveries from loggerhead sea turtles (Caretta caretta) nesting on Little Cumberland Island, Georgia, p. 20-24. In G. E. Henderson, ed. Proceedings of the Florida and inter-regional conference on sea turtles, 24-25 July 1976, Jensen Beach, Florida. Fla. Mar. Res. Publ. 33.

Berry, R. J.
1967 Dynamics of the tortugas (Florida) pink shrimp population. Ph.D. Dissertation. University Microfilms, Ann Arbor, Michigan. 177 pp.

Berry, R. J.
1970 Shrimp mortality rates derived from fishery statistics. Proc. Gulf Caribb. Fish. Inst. 22:66-78.

Bishop, J. M., J. G. Gosselink and J. H. Stone
1980 Oxygen consumption and hemolymph osmality of brown shrimp, Penaeus aztecus. Fish. Bull., U.S., 78(3):741-757.

Bishop, J. M. and M. H. Shealy
1977 Biological observations on commercial Penaeid shrimps caught by bottom trawl in South Carolina estuaries - February 1973 - January 1975. South Carolina Mar. Res. Center, Tech. Rep. No. 25. 97 pp.

Blackmon, J. H.
1974 Observations on the emigration of the brown shrimp, Penaeus aztecus through a tidal pass in the Caminada Bay, Louisiana area. Masters Thesis, Louisiana State Univ., Baton Rouge, Louisiana. 58 pp.

Blomo, V.
1981 Conditional fishery status as a solution to overcapitalization in the Gulf of Mexico shrimp fishery. Mar. Fish. Rev. 43(7):20-24.

Broad, A. C.
1965 Environmental requirements of shrimp. In C. M. Tarzwell (editor), Biological problems in water pollution, pp. 86-91. U.S. Div. Water Supply Pollution Control, 3rd Seminar 1962.

Broekema, M. M.
1941 Seasonal movements and the osmotic behavior of the shrimp Crangon crangon L. Arch. Neerl. Zool. 6:1-100.

Brongersma, L. D.
1972 European Atlantic turtles. Zool. Verh. (Leiden)121:245-247.

Brown, A. and D. Patlan
1974 Color changes in the ovaries of penaeid shrimp as a determinant of their maturity. Mar. Fish. Rev. 36(7)23-26.

Brown, J. and E. McCoy
1969 A review of the North Carolina scrap fishery. North Carolina Department of Conservation and Development, Division of Commercial and Sports Fisheries, Information Ser. No. 1. 12 pp.

Brown, S. and A. Lugo
1981 Management and Status of U.S. Marine Fisheries. Council on Environmental Quality., Washington, D.C. 104 pp.

Bullis, H. R.
1951 Gulf of Mexico shrimp trawl designs. U.S. Fish Wildl. Serv., Fish. Leaf. 394. 16 pp.

Bullis, H. R., Jr. and S. B. Drummond
1978 Sea turtle captures off the southeastern United States by exploratory fishing vessels 1950-1976, pp. 45-50. In: G. E. Henderson, ed. Proceedings of the Florida and interregional conference on sea turtles. Jensen Beach, Fla., July 1976. Fla. Mar. Res. Publ. 33.

Bullis, H. R. and H. Floyd
1973 Double-rig twin shrimp trawling gear used in Gulf of Mexico. Mar. Fish. Rev. 34(11-12):26-31.

Burkenroad, M. D.
1934 The Penaeidae of Louisiana with a discussion of their world relationships. Bull. Am. Mus. Nat. Hist. 68:61-143.

Burkenroad, M. D.
1939 Further observations on Penaeidae of the Northern Gulf of Mexico. Bull. Bingham Oceanogr. Collect., Yale Univ., Vol. 6, Art. 6, 62 pp.

Calder, D. R., P. J. Eldridge, and E. B. Joseph
1974 The shrimp fishery of the southeastern United States: a management planning profile. S.C. Mar. Res. Center Tech. Rep. No. 5. 229 pp.

Captiva, F. J.
1966 Trends in shrimp trawler design and construction over the past five decades. Proc. Gulf Caribb. Fish. Inst. 19:23-30.

Carley, D. H. and C. M. Frisbie
1968 The shrimp fishery of Georgia - an economic evaluation. Ga. Game Fish Comm. Contrib. Ser. No. 13. 14 pp.

Cato, J. C. and F. J. Prochaska
1981 An economic assessment of the production, marketing and expansion potential of the Georgia Seafood Industry. Ga. Dept. of Nat. Res., 229 pp.

Chin, E. and D. M. Allen
1957 Toxicity of an insecticide to two species of shrimp, *Penaeus aztecus* and *Penaeus setiferus*. Texas J. Sci. 9:270-278.

Christmas, J. Y., G. Gunter, and P. Musgrove
1966 Studies of annual abundance of postlarval penaeid shrimp in the estuarine waters of Mississippi, as related to subsequent commercial catches. Gulf Res. Rep. 2(2):177-212.

Chuensri, C. A.
1968 A morphometric and meristic study of postlarval brown shrimp, Penaeus aztecus Ives, pink shrimp, P. duorarum Burkenroad, and white shrimp, P. setiferus (Linnaeus). Masters Thesis, Univ. of Miami, Coral Gables, Florida. 108 pp.

Chui, M. K.
1980 Ex-vessel demand by size for the gulf shrimp. Masters Thesis. Texas A&M Univ., College Sta., Texas. 74 pp.

Clark, S. H. and C. W. Caillouet
1975 Diel fluctuations in catches of juvenile brown and white shrimp in a Texas estuarine canal. Contrib. Mar. Sci. 19:119-124.

Cobb, S. P., C. R. Futch and D. K. Camp
1973 Memoirs of the hourglass cruises: the rock shrimp, Sicyonia brevirostris Stimpson, 1871 (Decapoda, Penaeidae). Fla. Dept. Nat. Res., Mar. Res. Lab., Vol. II, Pt. 1, 38 pp.

Condrey, R. E., J. G. Gosselink and H. J. Bennett
1972 Comparison of the assimilation of different diets by Penaeus setiferus and P. aztecus. Fish. Bull., U.S., 70:1281-1292.

Conte, F. S. and J. C. Parker
1975 Effects of aerially-applied malathion on juvenile brown and white shrimp, Penaeus aztecus and P. setiferus. Trans. Am. Fish. Soc., 104: 793-799.

Cook, H. L.
1966 A generic key to the protozoean, mysis and postlarval stages of the littoral Penaeidae of the Northwestern Gulf of Mexico. Fish. Bull., U.S., 65:437-447.

Cook, H. L. and M. J. Lindner
1970 Synopsis of biological data on the brown shrimp Penaeus aztecus aztecus Ives, 1891. FAO Fish. Rep. 57:1471-1497.

Cook, H. L. and M. A. Murphy
1969 The culture of larval penaeid shrimp. Trans. Am. Fish. Soc. 98: 751-754.

Copeland, B. J.
1965 Fauna of the Aransas Pass Inlet, Texas. I. Emigration as shown by tide trap collections. Publ. Inst. Mar. Sci., Univ. Tex. 10:9-21.

Cornell, J. H.
1948 Potential by-products of the South Carolina fisheries industry. Contrib. Bears Bluff Lab., No. 5.

Costello, T. J. and D. M. Allen
1960 Notes on the migration and growth of pink shrimp (Penaeus duorarum). Proc. Gulf Caribb. Fish. Inst., 12:5-9.

Costello, T. J. and D. M. Allen
1968 Mortality rates in populations of pink shrimp, Penaeus duorarum, on the Sanibel and Tortugas grounds, Florida. Fish. Bull., U.S., 66(3):491-501.

Costello, T. J. and D. M. Allen
1970 Synopsis of biological data on the pink shrimp Penaeus duorarum duorarum Burkenroad, 1939. FAO Fish. Rep. 57:1499-1537.

Courtenay, W. R. and M. H. Roberts
1973 Environmental effects on toxaphene toxicity to selected fishes and crustaceans. EPA Rept. No. EPA-R3-73-035, April 1973. 73 pp.

Cummings, W. C.
1961 Maturation and spawning of the pink shrimp, Penaeus duorarum Burkenroad. Trans. Am. Fish Soc. 90:462-468.

Cummins, R. and J. B. Rivers
1962 New deep water shrimp fishery developed off Florida's east coast. Fish Boat 7(12):19-23; 33-34.

Cupka, D. M. and M. D. McKenzie.
1974 A report on the marine recreational fisheries of South Carolina. S.C. Marine Res. Center., Charleston, S.C. (unpubl.).

Darnell, R. M.
1958 Food habits of fishes and larger invertebrates of Lake Ponchartrain, Louisiana, an estuarine community. Publ. Inst. Mar. Sci. Univ. Tex. 5:353-416.

Davis, B. J.
1981 Contributions to the biology of Sicyonia brevirostris (Decapoda: Penaeidae) off South Carolina. Masters Thesis. College of Charleston, Charleston, S.C. 68 pp.

Davis, G. E. and M. C. Whiting
1977 Loggerhead sea turtle nesting in Everglades National Park, Florida, U.S.A. Herpetologica 33(1):18-28.

Dehnel, P. A.
1960 Effect of temperature and salinity on the oxygen consumption of two intertidal crabs. Biol. Bull. (Woods Hole)118:215-249.

de la Bretonne, L. and J. W. Avault
1971 Movements of brown shrimp, Penaeus aztecus, and white shrimp, Penaeus setiferus, over weirs in marshes of South Louisiana. 25th Annual Conference Southeastern Association of Game and Fish Commissioners, Charleston, S. C. 5 pp.

de Sylva, D. P.
1954 The live bait shrimp fishery of the northeast coast of Florida Florida Bd. Conserv. Tech. Ser. 11. 35 pp.

Dobkin, S.
1961 Early developmental stages of pink shrimp, Penaeus duorarum, from Florida waters. Fish. Bull., U.S. 61(190):321-349.

Doll, J. P.
1972 An econometric analysis of shrimp ex-vessel prices. 1950-68. Amer. J. Agr. Econ. 54:431-440.

Edwards, R. R. C.
1977 Field experiments on growth and mortality of Penaeus vannamei in a Mexican coastal lagoon complex. Estuarine Coastal Mar. Sci. 5: 107-121.

Eldred, B., R. M. Ingle, K. D. Woodburn, R. F. Hutton and H. Jones
1961 Biological observations on the commercial shrimp, Penaeus duorarum Burkenroad, in Florida waters. Florida St. Board Conserv., Prof. Paper Ser. 3:1-139.

Eldred, B., J. Williams, G. T. Martin and E. A. Joyce
1965 Seasonal distribution of Penaeid larvae and postlarvae of the Tampa Bay area, Florida. Florida Bd. Conserv. Tech. Ser. No. 44:1-47.

Ewald, J. J.
1965 The laboratory rearing of pink shrimp Penaeus duorarum Burkenroad. Bull. Mar. Sci. 15(2):436-449.

Fahy, W. E.
1965a Report of trash fish study in North Carolina in 1962. N.C. Dept. of Conservation and Development, Div. of Commercial Fisheries, Raleigh, N.C., March 1965. Sp. Sci. Rep. No. 5.

Fahy, W. E.
1965b Report of trash fish study in North Carolina in 1964. N.C. Dept. of Conservation and Development, Div. of Commercial Fisheries, Raleigh, N.C., Sp. Sci. Rep. No. 7.

Fahy, W. E.
1966 Species composition of the North Carolina industrial fish fishery. Com. Fish. Rev. 28(7):1-8.

Farmer, C. H. and J. D. Whitaker
1978 Results of the overwintering white shrimp study "A report to the Fishermen." South Carolina Wildl. Mar. Res. Dept., Mar. Res. Div. publ. 22 pp.

Farmer, C. H., J. D. Whitaker and Nan L. Chipley
1978 Pilot study to determine the overwintering patterns of white shrimp. Final Report for NMFS Contract 03-6-042-35105. 93 pp.

Farmer, C. H. and J. D. Whitaker
1980 A review of the 1980 spring white shrimp season in South Carolina. South Carolina Wildl. Mar. Res. Dept. Publ. 16 pp.

Fisch, M. and J. Maiolo
1981 Inter and intra generational status transmission among shrimp boat captains: a case study from North Carolina. A paper given at annual meeting of the Mid-South Sociological Association, Shreveport, La., Oct. 1981.

Fish Boat
1981 Ecuador: Bringing them in with no trawler in sight. Fish Boat. Aug. 1981:44-45, 67, 69.

Fontaine, C. T. and R. A. Neal
1971 Length-weight relations for three commercially important penaeid shrimp of the Gulf of Mexico. Trans. Am. Fish. Soc. 100:584-586.

Frisbie, C. M.
1967 Preliminary studies of the seasonal abundance and biological stability of the commercial shrimp of Georgia. Georgia Game and Fish. Comm., Mar. Fish. Div. Contrib. Ser. No. 4. 1-19 pp.

Fuss, C. M., Jr.
1963 Gulf of Mexico shrimp trawls. Parts. 1;2. Fish Gaz. p. 80.

Gaidry, W. J.
1974 Correlations between inshore spring white shrimp population densities and offshore overwintering populations. Louisiana Wildl. Fish. Comm. Tech. Bull. No. 12. 18 pp.

Gaidry, W. J. and C. J. White
1973 Investigations of commercially important penaeid shrimp in Louisiana estuaries. Louisiana Wildl. Fish. Comm. Tech. Bull. No. 8. 154 pp.

Georgia Coastal Area Planning and Development Commission
1976 Feasibility study of a seafood industrial harbor for coastal Georgia. Univ. of Georgia, Athens, Ga. 207 pp.

Georgia Dept. of Natural Resources
1978 Commercial and sport bait shrimp zones, coastal Georgia. Tabloid, 8 pp.

Gulf of Mexico Fishery Management Council
1980 Shrimp fishery of the Gulf of Mexico plan approval and proposed regulations. Fed. Reg. Vol. 45. No. 218:74178-74308 (Nov. 7, 1980).

Gulf of Mexico Fishery Management Council
1981 Draft update of fishery management plan for shrimp, Gulf of Mexico. Gulf of Mexico Fish. Mgt. Council, Tampa, Fla. July, 1981.

Gulland, J. T.
1972 Some introductory guidelines to management of shrimp fisheries. FAO, Rome. J. Cons. Perm. Int. Explor. Mer. 33:471-477.

Gunter, G.
1941 Death of fishes due to cold on the Texas coast, January 1940. Ecology 22:203-208.

Gunter, G.
1945 Studies on marine fishes of Texas. Publ. Inst. Mar. Sci. Univ. Tex. 1:1-190.

Gunter, G.
1950 Seasonal population changes and distributions as related to salinity, of certain invertebrates of the Texas coast, including the commercial shrimp. Publ. Inst. Mar. Sci. Univ. Tex. 1(2):7-51.

Gunter, G.
1961 Habitat of juvenile shrimp (Family Penaeidae). Ecology 42:598-600.

Gunter, G., J. Y. Christmas and R. Killebrew
1964 Some relations of salinity to population distributions of motile estuarine organisms, with special reference to Penaeid shrimp. Ecology 45:181-185.

Gunter, G., and H. H. Hildebrand
1951 Destruction of fishes and other organisms on the south Texas coast by the cold wave of January 28-February 3, 1951. Ecology 32(4):731-736.

Harder, H. W., E. C. Christensen, J. R. Mathews and T. F. Bidleman
1980 Rainfall input of toxaphene to a South Carolina estuary. Estuaries 3(2):142-147.

Harris, C. Duane
1974 Observations on the white shrimp (Penaeus setiferus) in Georgia. Georgia Dept. Nat. Res., Contrib. Ser. No. 27. 54 pp.

Hildebrand, H. H.
1954 A study of the fauna of the brown shrimp (Penaeus aztecus Ives) grounds in the western Gulf of Mexico. Publ. Inst. Mar. Sci. Univ. Tex. 3:231-366.

Hildebrand, H. H.
1955 A study of the fauna of the pink shrimp (Penaeus duorarum Burkenroad) grounds in the Gulf of Campeche. Publ. Inst. Mar. Sci. Univ. Tex. 4:169-232.

Hillestad, H. O., J. I. Richardson, and G. K. Williamson
1978 Incidental capture of sea turtles by shrimp trawlermen in Georgia. Proc. Annu. Conf. Southeast. Assoc. Fish Wildl. Agencies 32:167-178.

Hoese, H. D.
1973 A trawl study of nearshore fishes and invertebrates of the Georgia coast. Contrib. Mar. Sci. 17:63-98.

Hudinaga, M.
1942 Reproduction, development and rearing of Penaeus japonicus Bate. Japanese J. Biol. 10(2):305-393.

Hughes, D. A.
1969 Evidence for the endogenous control of swimming in pink shrimp, Penaeus duorarum. Biol. Bull. (Woods Hole) 136:398-404

Hughes, D. A.
1972 On the endogenous control of tide-associated displacements of pink shrimp, Penaeus duorarum Burkenroad. Biol. Bull. (Woods Hole) 142:271-280.

Hunt, J. H., R. J. Carroll, V. Chinchilli, and D. Frankenberg
1980 Relationship between environmental factors and brown shrimp production in Pamlico Sound, North Carolina. North Carolina Dept. Nat. Res. Comm. Dev., Spec. Sci. Rep. No. 33. 29 pp.

Hutchinson, R. W.
1978 Status and problems of the American shrimp industry. Industry and Consumer Services Div. NMFS, Washington, D. C. Mar. Fish. Rev. 40(9):29-31.

Hysmith, B. T. and R. L. Colura
1976 Effect of salinity on growth and survival of penaeid shrimp in ponds. Proc. World Mariculture Soc., 1976. p. 289-303.

Idyll, C. P., E. S. Iverson, and B. Yokel
1965 Abundance of juvenile pink shrimp on the Everglades National Park nursery grounds. In Biological Laboratory, Galveston, Texas fishery research for the year ending June 30, 1964, U.S. Fish Wildl. Serv., Circ. 230. p. 19-20.

International Proteins Corporation
1980 International Proteins Corporation Annual Report. 1980. Fairfield, N.J. 17 pp.

Jacob, J. W.
1971 Observations on the distribution, growth, survival and biomass of juvenile and subadult Penaeus aztecus in southern Louisiana. Master's Thesis, Louisiana State University, Baton Rouge, Louisiana. 68 pp.

Johnson, D. G.
1958 Supply Function - Some facts and notions. In: Agricultural adjustment problems in a growing economy. Iowa State College Press. Ames, Iowa.

Johnson, F. F. and M. J. Lindner
1934 Shrimp industry of the South Atlantic and Gulf states. U.S. Bur. Fish. Invest. Rep. 21. 83 pp.

Johnson, M. C. and J. R. Fielding
1956 Propagation of the white shrimp, Penaeus setiferus (Linn.), in captivity. Tulane Stud. Zool. 4:175-190.

Jones, A. C., D. E. Dimitriou, J. J. Ewald, and J. H. Tweedy
1970 Distribution of early developmental stages of pink shrimp, Penaeus duorarum, in Florida waters. Bull. Mar. Sci. 20:634-661.

Jones, L. L., J. W. Adams, W. L. Griffin and J. Allen
1974 Impact of commercial shrimp landings on the economy of Texas and coastal regions. Texas A&M Univ. Sea Grant Publ. TAMU.SG-75-204. 18 pp.

Jones, R. R.
1973 Utilization of Louisiana estuarine sediments as a source of nutrition for the brown shrimp Penaeus aztecus. Ph.D. Dissertation. Louisiana State Univ., Baton Rouge, Louisiana. 125 pp.

Jones, T. M.
1977 A productivity and profitability analysis of the South Carolina double-rig shrimp fishery: A case study of a specialized one year class fishery. Ph.D. Dissertation, Clemson Univ., Clemson, S. C. 121 pp.

Jones, T. M., J. W. Hubbard and K. J. Roberts
1979 Productivity and profitability of South Carolina shrimp vessels, 1971-75. Mar. Fish. Rev. 41(4):8-14.

Jones, W. G.
1960 Fish for Petfoods - South Atlantic Coast. In: Fishery resources for animal food. 1969. p. 16-17. U.S. Fish Wildl. Serv. Fish. Leaf. No. 501. 22 pp.

Joyce, E. A.
1965 The commercial shrimps of the northeast coast of Florida. Florida Bd. Conserv. Mar. Lab., Prof. Pap. Ser., No. 6. 224 pp.

Joyce, E. A. and B. Eldred
1966 The Florida shrimping industry. Florida Bd. Conserv., Educ. Ser. No. 15. 47 pp.

Juhl, R.
1961 A study of vessel and gear usage in the shrimp fishery of the southeastern U.S. Com. Fish. Rev. 23(8):1-9.

Juhl, R.
1966 Trends in the Gulf of Mexico shrimp trawling fleet. Com. Fish. Rev. 28(12): 43-46.

Keiser, R. K.
1976 Species composition, magnitude and utilization of the incidental catch of the South Carolina shrimp fishery. S.C. Mar. Res. Center, Tech. Rep. No. 16. 94 pp.

Keiser, R. K.
1977 The incidental catch from commercial shrimp trawlers of the South Atlantic States. S.C. Mar. Res. Center Tech. Rep. No. 26. 38 pp.

Kennedy, F. S. and D. G. Barber
(in press) Spawning and recruitment of pink shrimp Penaeus duorarum, off eastern Florida. Jour. Crust. Biol.

Kennedy, F. S., J. J. Crane, R. A. Schlieder, and D. G. Barber
1977 Studies of the rock shrimp, Sicyonia brevirostris, a new fishery resource on Florida's Atlantic shelf. Florida Dept. Nat. Res., Mar. Res. Lab., Florida Mar. Res. Publ. No. 27. 69 pp.

King, B. D.
1971 Study of migratory patterns of fish and shellfish through a natural pass. Tex. Parks Wildl. Tech. Ser. No. 9. 54 pp.

King, J. E.
1948 Study of the reproductive organs of the common marine shrimp, Penaeus setiferus (Linnaeus). Biol. Bull. (Woods Hole) 94:244-262.

Kinne, O.
1964 The effects of temperature and salinity on marine and brackish water animals. II. Salinity and temperature salinity combinations. Oceanogr. Mar. Biol. Annu. Rev. 2:281-339.

Klima, E. F.
1964 Mark-recapture experiments with brown and white shrimp in the northern Gulf of Mexico. Proc. Gulf Caribb. Fish. Inst. 16:52-64.

Klima, E. F.
1974 A white shrimp mark-recapture study. Trans. Am. Fish. Soc. 103: 107-113.

Klima, E. F. and J. A. Benigo
1965 Mark-recapture experiments. In Biological Laboratory, Galveston, Texas fishery research for the year ending June 30, 1964, U. S. Fish. Wildl. Serv., Circ. 230. 38-40 pp.

Klima, E. F., and R. S. Ford
1970 Gear and techniques employed in the Gulf of Mexico shrimp fishery. Can. Fish. Rep. 17:59-76.

Knapp, F. T.
1949 Menhaden utilization in relation to the conservation of food and game fishes of the Texas Gulf Coast. Trans. Am. Fish. Soc. 79: 137-144.

Knowlton, C. J.
1972 Fishes taken during commercial shrimp fishing in Georgia's close inshore ocean waters. Ga. Game and Fish. Comm., Coastal Fish. Office. Contrib. Ser. No. 21, 42 pp.

Knudsen, E. E., W. H. Herke, and J. M. Mackler
1977 The growth rate of marked juvenile brown shrimp, Penaeus aztecus, in a semi-impounded Louisiana coastal marsh. Proc. Gulf Caribb. Fish. Inst. 29:144-159.

Kristjonsson, H.
1968 Techniques of finding and catching shrimp in commercial fishing... FAO Fish. Rep. 57(2):125-192.

Kutkuhn, J. H.
1966 Dynamics of a penaeid shrimp population and management implications. Fish. Bull., U.S., 65(2):313-338.

Latham, F. F.
1951 Evidence of fish loss due to shrimping in Pamlico Sound. Committee Report to Atlantic States Marine Fisheries Commission, November 1, 1951. Appendix B: 4 pp.

Laurent, A., J. Hite, L. Carter and T. Jones
1975 Economic organization of the South Carolina marine fisheries industry. Clemson Univ. and Div. of Mar. Res. at Clemson, Clemson, S. C. 85 pp.

Liao, D. S.
1979 An economic analysis of mobility of shrimp vessels in the South Atlantic states. South Carolina Mar. Res. Center Tech. Rep. No. 27. 35 pp.

Liao, D. S. and D. M. Cupka
1979 Socio-economic profile of South Carolina's offshore sport fishermen. S. C. Mar. Res. Center Tech. Rep. No. 34. 11 pp.

Lindner, M. J., and W. W. Anderson
1956 Growth, migrations, spawning and size distribution of shrimp, Penaeus setiferus. Fish. Bull., U.S., 56(106):555-645.

Lindner, M. J.
1966 What we know about shrimp size and the Tortugas fishery. Proc. Gulf Caribb. Fish. Inst. 18:18-26.

Lindner, M. J. and H. L. Cook
1970 Synopsis of biological data on the white shrimp Penaeus setiferus (Linnaeus) 1767. FAO Fish. Rep. 57:1439-1467.

Lindall, W. N. and C. H. Saloman
1977 Alteration and destruction of estuaries affecting fishery resources of the Gulf of Mexico. Mar. Fish. Rev. 39:1-7.

Loesch, J.
1965 Distribution and growth of penaeid shrimp in Mobile Bay, Alabama. Publ. Inst. Mar. Sci. Univ. Tex. 10:41-58.

Lunz, G. R.
1944 Special study of the marine fishery resources of South Carolina. S. C. State Planning Bd., Bull. No. 14. 66 pp.

Lunz, G. R.
1955 Trawling vs. Sport Fishing. Bears Bluff Lab. Mimeo. 3 pp.

Lunz, G. R.
1959 Annual report, 1957-1958. Bears Bluff Contrib. No. 30. 15 pp.

Lunz, G. R.
1960 Industrial possibilities, South Carolina fishery industry. Mimeo written for State Development Bd., Bears Bluff Lab., Nov. 23, 1960.

Lunz, G. R.
1967 Farming the salt water marshes. Proceedings of the marsh and estuary management symposium, Baton Rouge, Louisiana, 1967. Pages 172-177.

Lunz, G. R., J. L. McHugh, E. W. Roelfs, R. E. Tiller, C. E. Atkinson
1951 The destruction of small fish by the shrimp trawlers in Pamlico Sound, North Carolina. Unpubl. Rep. to the Chesapeake and South Atlantic Sections, Atlantic States Marine Fisheries Com. 13 pp. with 5 appendices.

Maiolo, J.
1980 The sociocultural context and occupation and marketing structures of the North Carolina shrimp fishery. Second Year Report Vol. III. Surveys of Fishermen. Dept. of Sociology and Anthropology Inst. for Coastal and Marine Resour., East Carolina Univ. 41 pp.

Maiolo, J.
1981 Profiles of fishing activities among N.C. shrimp fishermen. Dept. of Sociology and Anthropology, East Carolina Univ. 31 pp.

Maiolo, J., John Bort, Wm. Still, M. Fisch and R. Faisan
1980 The sociocultural contest and occupational and marketing structure of the North Carolina shrimp fishery. East Carolina Univ. Greenville, N.C.

Maiolo, J. and W. Still
1981 Historical development of the shrimp fishery (N.C.). Dept. of Sociology and Anthropology, East Carolina University. 84 pp.

Maiolo, J. and R. Faison
1980 Surveys of fishermen. Volume III, Second year report of the East Carolina Shrimp Research. Dept. of Sociology and Anthropology, East Carolina University, Greenville, N.C.

Marcus, B., D. Aaker, D. Cohen, Wm. Dommermuth, R. Kantle, B. Mallen, K. Monroe, L. Schiffman, T. Spratlen, D. Twedt, K. Uhl and T. Wotruba.
1975 Modern marketing. Random House, Inc., N.Y. 722 pp.

Marinovich, S., and R. T. Whiteleather
1968 Gulf of Mexico shrimp trawls. Current trends in design and prospective developments. p. 176-181 In DeWitt Gilbert, ed. The future of the fishing industry of the United States. Univ. of Washington Pub. Fish., New Ser., No. 4.

McCoy, E. G.
1968 Migration, growth and mortality of North Carolina pink and brown penaeid shrimps. North Carolina Dept. Cons. Dev., Spec. Sci. Rep. No. 15. 26 pp.

McCoy, E. G.
1972 Dynamics of North Carolina commercial shrimp populations. North Carolina Dept. Nat. Econ. Res., Spec. Sci. Rep. No. 21. 53 pp.

McCoy, E. G. and J. T. Brown
1967 Migration and growth of commercial penaeid shrimps in North Carolina. North Carolina Dept. Cons. Dev., Spec. Sci. Rep. No. 11. 29 pp.

McFarland, W. N. and B. D. Lee
1963 Osmotic and ionic concentrations of penaeidean shrimps of the Texas coast. Bull. Mar. Sci. Gulf. Caribb. 13:391-417.

McGee, J. A., S. K. Midgett and R. H. Tillett
1975 Hangs and obstructions to trawl fishing: North Carolina, South Carolina, Georgia. East Carolina University Sea Grant Publication UNC SG-75-17.

McKenzie, M. D., D. S. Liao and E. B. Joseph
1976 Feasibility study of seafood industrial park for S. C. South Carolina Mar. Res. Center Tech. Rep. No. 14. 95 pp.

McKenzie, M. D. and J. D. Whitaker
1981 A comparative study of shrimp seines and selectivity of various mesh sizes. S. C. Mar. Res. Center unpublished report.

McLeese, D. W.
1956 Effects of temperature, salinity and oxygen on the survival of the American lobster. J. Fish. Res. Bd. Canada 13(2): 247-272.

Miller, M. M.
1975 The role of shrimp imports in a declining seafoods market - a background paper. Division of Economic and Marketing Research. U.S. Dept. of Commerce, NOAA NMFS mimeo. 50 pp.

Miller, M. and R. Marasco
1976 Statement on applying import controls on shrimp products entering the United States. Unpublished Nat. Mar. Fish. Service Draft Report. Washington, D. C.

Mock, C. R.
1967 Natural and altered estuarine habitats of penaeid shrimp. Proc. Gulf Caribb. Fish. Inst. 19:86-98.

Moriarty, D. J. W.
1976 Quantitative studies on bacteria and algae in the food of the mullet *Mugil cephalus* L. and the prawn *Metapenaeus bennettae* (Racek and Dall). J. Exp. Mar. Biol. Ecol. 22:131-143.

Morris, R. A. and F. Prochaska
1979 Economic impact of the processing and marketing of commercial Florida marine landings. Fla. Sea Grant Rep. No. 26, 56 pp.

Music, J. L.
1979 Assessment of Georgia's shrimp and crab resources. Georgia Dept. Nat. Res., Coastal Res. Div., Contrib. Ser. No. 30. 75 pp.

National Fisheries Institute
1981 Flashes (Newsletter), August 1981.

National Restaurant News
1979 Shrimp, lobster prices falling. National Restaurant News. 13(24): Dec. 17, 1979.

Nicholls, J. P. and W. L. Griffin
1974 Recent trends in catch and fishing effort in the Gulf of Mexico shrimp industry and economic implications. Departmental Information Rept. 74-5. Dept. of Agric., Economics, Texas A&M Univ., College Station, Texas.

Nissan, E., D. C. Williams, Jr., T. Green, W. E. Hardy, and R. G. Nelson
1978 An economic input-output analysis for Mississippi-Alabama Coastal Counties. Mississippi-Alabama Sea Grant Consortium publ. 50 pp.

Nix, H. and M. Kim
1981 Shrimp fishing off the Georgia coast: a sociological analysis. The Institute of Community and Area Development. Univ. of Georgia, Athens, GA (unpubl. ms.)

Nix, H., S. Glenn and J. N. Whitted
1975 Locational inventory of docks and shrimp trawlers on the coast of Georgia. Univ. of Georgia. Tech. Rept. Ser. No. 75-8. 24 pp.

North Carolina Department of Natural Resources and Community Development
1978 North Carolina shrimp prediction for 1978. Unpublished manuscript. Div. Mar. Fish., Morehead City, N. C. 6 pp.

North Carolina Department of Natural Resources and Community Development
1981 North Carolina shrimp prediction for 1981. Unpublished manuscript. Div. Mar. Fish., Morehead City, N. C. 6 pp.

North Carolina State Government
1979 North Carolina statistical abstract. Div. of State Budget and Management. Raleigh, N. C.

Odum, W. E.
1970 Insidious alteration of the estuarine environment. Trans. Am. Fish. Soc. 99:836-847

Odum, W. E., G. M. Woodwell and C. F. Wurster
1969 DDT residue absorbed from organic detritus by fiddler crabs. Science. 164:576-577

Olson, Fred. L.
1972 Farm credit act of 1971: How it affects fishery industry. Marine Fish. Rev. 34(9-10):3-5.

Panikkar, N. K.
1951 Physiological aspects of adaptation to estuarine conditions. Proc. Indo-Pacific Fish. Council. 2(3):168-175.

Parker, J. C.
1970 Distribution of juvenile brown shrimp (Penaeus aztecus Ives) in Galveston Bay, Texas as related to certain hydrographic features and salinity. Contrib. Mar. Sci. 15:1-12.

Parrack, M. L.
1979 Aspects of brown shrimp, Penaeus aztecus, growth in the northern Gulf of Mexico. Fish. Bull., U.S., 76(4):827-836.

Pate, P. P.
1977 Estimation of North Carolina shrimp harvest and gear utilization by recreational and commercial fishermen. Compl. Rept. NMFS project No. 2-275-R, 30 pp.

Pearson, J. C.
1939 The early life histories of some American Penaeidae, chiefly the commercial shrimp, Penaeus setiferus (Linnaeus). U.S. Bur. Fish. Bull. Vol. 49:1-73 pp.

Perez, Farfante, I.
1969 Western Atlantic shrimps of the genus Penaeus. Fish. Bull., U.S., 67:461-591.

Phares, P. L.
1980 Estimates of natural mortality and fishing mortality for white shrimp in the Gulf of Mexico. NOAA Tech. Memo. NMFS-SEFC-58. 22 pp.

Prochaska, F. J. and C. O. Andrews
1974 Shrimp processing in the Southeast: supply problems and structure change. Southern J. Agricultural Econ. July. p. 247-252.

Prochaska, F. J. and J. Cato
1977 An economic profile of Florida commercial fishing firms: fishermen, commercial activities and financial considerations. Rept. No. 19, State University System of Florida. Sea Grant Program.

Prochaska, F. J. and J. C. Cato
1981 Economic conditions in the Gulf of Mexico shrimp industry: 1960-1981. Staff Paper. Food and Resource Economics Dept., Univ. of Florida, Gainesville, Florida. Staff paper 180:19 pp.

Pullen, E. J. and W. L. Trent
1970 White shrimp emigration in relation to size, sex, temperature and salinity. FAO Fish. Rep. 57:1001-1014.

Purvis, E. E. and E. G. McCoy
1972 Overwintering pink shrimp, Penaeus duorarum, in Core and Pamlico sounds, N. C. North Carolina Dept. Nat. Econ. Res., Spec. Sci. Rep. No. 22. 29 pp.

Purvis, C. E. and E. G. McCoy
1974 Population dynamics of brown shrimp in Pamlico Sound. North Carolina Dept. Nat. and Econ. Res. Special Sci. Rep. No. 25. 26 pp.

Reimold, R. J.
1977 Mangals and salt marshes of eastern United States. In Wet Coastal Ecosystems, ed. V. J. Chapman, Elsevier Scientific Publishing Co. Amsterdam. 428 pp.

Renfro, W. C.
1964 Life history stages of Gulf of Mexico brown shrimp. In Biological Laboratory, Galveston, Tex., fishery research for the year ending June 30, 1963. p. 94-98. U.S. Fish. Wildl. Serv. Circ. 183.

Renfro, W. C. and H. R. Brusher
1963 Spawning populations. In Biological Laboratory, Galveston, Tex., fishery research for the year ending June 30, 1962. p. 13-17. U.S. Fish Wildl. Serv., Circ. 161.

Rhodes, R. J.
1974 Development of an expanded commercial fisheries statistics program for South Carolina. Final Completion report on Prof. 2-137-D incorp. with the Natl. Mar. Fish. Serv., 149 pp.

Rhodes, R.
1980 Preliminary economic analysis of the South Atlantic States shrimp fishery: current trends and outlook. Office of Conservation, Mgt. and Marketing. S. C. Wildl. and Mar. Res. Dept., Charleston, S. C. May, 1980. 23 pp. (unpubl.)

Richardson, T. H., J. I. Richardson, C. Ruckdeschel, and M. W. Dix
1978 Remigration patterns of loggerhead seaturtles (*Caretta caretta*) nesting on Little Cumberland and Cumberland islands, Georgia. p. 39-44. In: G. E. Henderson, ed. Proceedings Florida and interregional conference on sea turtles. Jensen Beach, Fla., July 1976. Fla. Mar. Res. Publ. 33.

Ricker, W. E.
1975 Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Canada 191:382 pp.

Ringo, R. D.
1965 Growth In Biological laboratory, Galveston, Texas, fishery research for the year ending June 30, 1964, U.S. Fish Wildl. Serv., Circ. 230, pp. 69-70.

Ringo, R. D. and G. Zamora
1968 A penaeid postlarval character of taxonomic value. Bull. Mar. Sci. 18(2): 472-476.

Rivers, J. B.
1966 Gear and techniques of the sea bass trap fishery in the Carolinas. Comm. Fish. Rev. 28(4):15-20.

Roberts, K. J. and R. J. Rhodes
1976 Gear and economic efficiency results of a Sea Grant twin-trawl demonstration in South Carolina. Proc. Gulf Caribb.Fish. Inst. 28:65-72.

Roelfs, E. W.
1950 Observations on the capture of small fish by the shrimp trawls. Reprinted from the 1950 Annual Report of the Institute of Fisheries Research of the University of North Carolina. In: Committee Report to Atlantic States Marine Fisheries Commission, Nov. 1, 1951. App. A:4 pp.

Rose, C. D., A. H. Harris, B. Wilson
1975 Extensive culture of penaeid shrimp in Louisiana salt-marsh impoundments. Trans. Am. Fish. Soc. 104:296-307.

Sabella, J. C., R. D. Dixon and M. J. Hepburn
1979 Aspects of family and kinship in a North Carolina coastal community. A comparative study. Marit. Pol. Mgmt. 6(2):93-99.

Sandifer, P. A., J. V. Miglarese, D. R. Calder, et al.
1980 Ecological characterization of the Sea Island coastal region of South Carolina and Georgia. Vol. III: Biological features of the characterization area. U.S. Fish and Wildl. Serv. Office of Biological Services, Washington, D.C. FWS/OBS-79/42. 620 pp.

Schelske, C. L. and E. P. Odum
1961 Mechanisms maintaining high productivity in Georgia estuaries. Proc. Gulf Caribb. Fish. Inst. 14:75-80.

Schwartz, F. J.
1977 Evaluations of colored Floy anchor tags on white shrimp, *Peneaus setiferus*, tagged in Cape Fear River, North Carolina 1973-1975. Fla. Scient. 40:22-27.

Shealy, M. H. and J. M. Bishop
1979 Hydrographic and biological studies in relation to Cooper River, South Carolina low-flow conditions prior to river rediversion. In Cooper River controlled low-flow study. South Carolina Water Res. Comm., Rep. No. 131. 352 pp.

Shipman, S.
1980 Penaeid shrimp migration and growth along the Georgia coast. Annual report October 1979-September 1980. Ga. Dept. Nat. Res., Coast, Res. Div. 46 pp.

Sick, L. V.
1970 Larval distribution of commercially important Penaeidae in North Carolina. J. Elisha Mitchell Sci. Soc. 86:118-127.

Siebenaler, J. B.
1952 Studies of "trash" caught by shrimp trawlers in Florida. Proc. Gulf Caribb. Fish. Inst. 4:94-99.

Sokal, R. R. and F. J. Rohlf
1969 Biometry. W. H. Freeman and Co., San Francisco, California. 776 pp.

South Carolina Coastal Council
1981 Rules and regulations for permitting in critical areas of the coastal zone. S. C. Coastal Council Publ. 49 pp.

South Carolina Marine Resources Division
1981 South Carolina trawler license file. S. C. Mar. Res. Center., Charleston, S. C.

South Carolina State Government
1980 South Carolina statistical abstract. The S. C. Division of Research and Statistical Serv. Columbia, S. C.

South Carolina Sea Grant Consortium
1981 Proceedings of the marine natural bait workshop, August 24-25, 1981 at Charleston, S. C. (In preparation).

Spinner, G. P.
1969 A plan for the marine resources of the Atlantic coastal zone. American Geographical Society, Washington, D. C.

St. Amant, L. S., J. G. Broom and T. B. Ford.
1966 Studies of the brown shrimp, Penaeus aztecus, in Barataria Bay, Louisiana. 1962-1965. Proc. Gulf Caribb. Fish. Inst. 18:1-17.

Subrahmanyam, C. B.
1971 The relative abundance and distribution of penaeid shrimp larvae off the Mississippi coast. Gulf Res. Rep. 3:291-345.

Summey, J. H.
1977 Out-of-state marketing channels for North Carolina fresh seafood during 1974. East Carolina Univ. Sea Grant Publ. UNC-SG-76-11, Dec. 1977: 141 pp.

Tabb, D. C. D. L. Dubrow, and A. E. Jones
1962 Studies on the biology of the pink shrimp, Penaeus duorarum Burkenroad, in Everglades National Park, Florida. Fla. St. Bd. Conserv. Tech. Ser. No. 37:1-32.

Temple, R. F. and C. C. Fischer
1967 Seasonal distribution and relative abundance of planktonic-stage shrimp (Penaeus spp.) in the northwestern Gulf of Mexico, 1961. Fish. Bull., U.S., 66:323-334.

Theiling, D. L.
1977 South Carolina's 1976 shrimp trawler season. S. C. Mar. Res. Center Tech. Rept. No. 24. 19 pp.

Theiling, D. L.
1981 Accomplishment of a pilot study relative to implementation of a cooperative State-Federal regional statistical program along the south Atlantic coast of the United States. S. C. Mar. Res. Center Compl. Rept., NMFS contract no. 03-7-042-35144. 22 pp.

Tiller, R. E.
1951 Observations made on composition of shrimp trawl catches, Committee report to Atlantic States Marine Fisheries Commission, November 1, 1951. Appendix C: 2 pp.

Tiner, R. E.
1977 An inventory of South Carolina's coastal marshes. South Carolina Mar. Res. Center Tech. Rept. No. 23. 33 pp.

Trent. L.
1967 Size of brown shrimp and time of emigration from the Galveston Bay system, Texas. Proc. Gulf Caribb. Fish. Inst. 19:7-16.

Truesdale, F. M.
1970 Some ecological aspects of commercially important decapod crustaceans in low salinity marshes. Ph.D. Dissertation. Texas A&M Univ., College Station, Texas. 164 pp.

Turner, R. E.
1977 Intertidal vegetation and commercial yields of penaeid shrimp. Trans. Am. Fish. Soc. 106:411-416.

Ulrich, G. F.
1978 Incidental catch of loggerhead turtles by South Carolina commercial fisheries. S.C. Mar. Res. Center Compl. Rept. NMFS Contract No. 03-7-042-35121. 36 pp.

U.S. Bureau of Commercial Fisheries
1958 Survey of the United States shrimp industry, prepared in Branch of Economic, Bureau of Comm. Fish., Washington, D.C.

U.S. Department of Commerce
1980 NMFS NEWS: Commerce Secretary Klutznick announces $12.2 million in aid to shrimp industry. Press release Oct. 18, 1980.

U.S. Department of Commerce
Fisheries of the United States. Current fishery Statistical. NMFS. Washington, D.C. Various issues.

U.S. Department of Commerce
Fishery Statistics of the United States. NMFS. Washington, D.C. Various issues.

U.S. Department of Commerce
Local area personal income 1974-79. Bureau of Economic Analysis. Washington, D.C. Southeast Region. Vol. 6.

U.S. Department of Commerce
Processed fishery products. Annual Summary. NMFS. Washington, D.C. Various issues.

U.S. Department of Commerce
Shellfish market review and outlook. NMFS. Various issues.

U.S. Department of Commerce
Shrimp landings, NMFS. Washington, D.C. Various issues.

U.S. Department of Commerce
Shrimp Statistics. NMFS. Washington, D.C. Various issues.

U.S. Department of Commerce, National Marine Fisheries Service
1981 Construction, installation, and handling procedures for the NMFS's sea turtle excluder device. NOAA Technical Memorandum NMFS-SEFC-71. 11 pp.

U.S. Department of Commerce. National Marine Fisheries Service
1981 Regulations modifying threatened sea turtle resuscitation procedures. Federal register 46 (170):43976-43977.

U.S. Department of Commerce. National Marine Fisheries Service
Fishery statistics of the U.S. Several years. NOAA-NMFS Statistical Digests.

U.S. Department of Commerce. National Marine Fisheries Service
Fisheries of the United States. Various issues. NOAA-NMFS Current Fishery Statistics Series.

U.S. Department of Commerce. National Marine Fisheries Service
Shrimp Landings. Several years. NOAA-NMFS Statistics Bulletins.

U.S. Department of Commerce, NOAA
1980 Conditional fisheries concept; proposed amendment. Federal Register, Vol. 45, No. 8. 2635-2638.

U.S. Department of Interior, Fish and Wildlife Service
1979 Lists of endangered and threatened wildlife and plants. Federal Register 44(12):3636-3654.

U.S. International Trade Commission Report to the President
1976 Shrimp. U.S.I.T.C. Publication No. 773. Washington, D.C.

University of Florida
1980 1980 Florida statistical abstract. Bureau of Economic and Business Research. Univ. of Florida. Gainesville, Fla.

Vondruska, J.
1981 Drop in shrimp prices and shrimp business survival. Natl. Mar. Fish. Serv. Memo., Fish Develop. Div. August 18, 1981. 11 pp.

Warren, J. P. and W. L. Griffin
1978 Costs and return trends in the 1970's for the Gulf of Mexico shrimp vessels. Texas A&M Ag.Eco.Dept., College Station, Texas. 20 pp.

Waters, J. R., L. E. Danielson and J. E. Easley
1979 An economic analysis of the shrimp discard problem in Pamlico Sound. Economics Research Report No. 40. N.C. State Univ., Raleigh, N.C. 47 pp.

Waters. J. R., J. E. Easley, Jr. and L. E. Danielson
1980 Economic trade-offs and the N.C. shrimp fishery. NMFS, Beaufort, N.C. Amer. J. Agri. Econ. 62(1):124-129.

Weymouth, F. W., M. J. Lindner and W. W. Anderson
1933 Preliminary report on the life history of the common shrimp *Penaeus setiferus* (Linn.). Bull. Bur. Fish. 48(14):1-26.

White, C. J.
1975 Effects of 1973 river flood waters on brown shrimp in Louisiana estuaries. Louisiana Wildl. Fish. Comm., Tech. Bull. No. 16. 24 pp.

White, D. R. M.
1977 Environment, technology and time-use patterns in the Gulf coast shrimp fishery. The American Ethnological Soc. Monograph 62. Those Who Live By The Sea, R. F. Spencer, ed. 195-214.

Whitham, P. R.
1974 Neonate sea turtles from the stomach of a pelagic fish. Copeia 1974(2):548.

Wiese, C. S.
1980 Commercial fishing financing. Univ. of Alaska. Mar. Adv. Bull. No. 11. 26 pp.

Williams, A. B.
1953 Identification of juvenile shrimp (Penaeidae) in North Carolina. J. Elisha Mitchell Sci. Soc. 69(2):156-160.

Williams, A. B.
1955 A contribution to the life histories of commercial shrimps (Penaeidae) in North Carolina. Bull. Mar. Sci. Gulf. Caribb. 5(2):116-147.

Williams, A. B.
1958 Substrates as a factor in shrimp distribution. Limnol. Oceanogr. 3:283-290.

Williams, A. B.
1959 Spotted and brown shrimp postlarvae (*Penaeus*) in North Carolina. Bull. Mar. Sci. Gulf Caribb. 9(3):281-290.

Williams, A. B.
1960 The influence of temperature on osmotic regulation in two species of estuarine shrimps (*Penaeus*). Biol. Bull. (Woods Hole) 119(3): 560-571.

Williams, A. B.
1965 Marine decapod crustaceans of the Carolinas. Fish. Bull., U. S., 65:1-298.

Williams, A. B. and E. E. Deubler
1968 A ten-year study of meroplankton in North Carolina estuaries: assessment of environmental factors and sampling success among bothid flounders and penaeid shrimps. Chesapeake Sci. 9(1):27-41.

Wilson, K. A.
1975 North Carolina wetlands - their distribution and management.

Wojnowski, M.
1981. List of fishery cooperatives in the United States 1980-81. U.S. Dept. of Commerce, NMFS, Washington, D.C. 11 pp.

Wolff, M.
1972 A Study of North Carolina scrap fishery. N.C. Dept. of Nat. and Eco. Resour., Div. of Commercial and Sport Fisheries, Spec. Sci. Rept. No. 20. 29 pp.

Woodburn, K, D., B. Eldred, E. Clark, R. F. Hutton and R. M. Ingle.
1957 The live bait shrimp industry of the west coast of Florida (Cedar Key to Naples) Fla. Bd. of Cons. Tech. Ser. No. 21.

Young, J. H.
1959 Morphology of the white shrimp; Penaeus setiferus (Linnaeus 1758). Fish. Bull., U.S. 59(145):1-168.

Zein-Eldin, Z.P. and D. V. Aldrich
1965 Growth and survival of postlarval Penaeus aztecus under controlled conditions of temperature and salinity. Biol. Bull. (Woods Hole) 129:199-216.

Zein-Eldin, Z.P. and G. W. Griffith
1970 An appraisal of the effects of salinity and temperature on growth and survival of postlarval penaeids. FAO Fish. Rept. 57:1015-1026.

13.0 Appendix

Primary data sources for tables in this section were Shrimp Landings (various years) and Fishery Statistics of the United States (various years). These publications were produced by the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Department of Commerce. Landings for 1979 and 1980 came from a number of sources including state agencies and the National Marine Fisheries Service. These data are preliminary, but are probably close to final totals.

Table 13-1. Summary of shrimp production for the South Atlantic states, 1950-1980. (White, brown, pink shrimp)

Year	Total Landings Heads-Off Pounds	Annual Landings as percent of 1950-1980 Mean	Year's Rank	Percent of Gulf and South Atlantic	Percent of U.S. Total	Gulf and South Atlantic as percent of U.S. Total
1950	22,858,083	145	1	19	19	98
1951	17,400,501	111	8	13	12	99
1952	16,084,774	102	17	11	11	99
1953	20,634,712	131	2	13	14	99
1954	17,948,622	114	6	11	11	99
1955	17,881,579	114	7	12	12	99
1956	15,906,642	101	18	12	11	98
1957	16,951,614	108	10	14	13	96
1958	13,425,672	85	24	11	10	92
1959	15,475,481	98	22	12	11	90
1960	18,580,291	118	5	13	12	94
1961	11,755,043	75	27	13	11	87
1962	16,446,350	105	15	16	14	92
1963	9,815,793	62	31	7	7	95
1964	10,893,237	69	8	9	9	97
1965	16,688,958	106	13	12	11	95
1966	13,488,849	86	23	11	9	88
1967	13,022,587	83	26	8	8	100
1968	15,516,743	99	21	11	9	80
1969	17,367,951	111	9	12	9	75
1970	13,079,498	83	25	8	6	71
1971	19,476,024	124	3	12	8	69
1972	16,093,384	102	16	10	7	68
1973	15,590,959	99	20	12	7	57
1974	16,896,566	108	11	13	7	60
1975	15,767,035	100	19	13	8	59
1976	16,460,457	105	14	11	7	61
1977	10,309,393	66	29	6	4	62
1978	10,126,654	64	30	6	4	63
1979	16,735,610	106	12	-	-	-
1980	18,547,702	118	4	-	-	-
Mean	15,716,992			11.4	9.7	84.2
SD	3,086,092			2.8	3.2	15.5
Range	9,815,793 22,858,083	62-145		6-19	4-19	57-100

Table 13-2. Summary of shrimp production for North Carolina, 1950-1980. (White, brown, pink shrimp)

Year	Total Landings Heads-off Pounds	Annual Landings as % of 1950-80 Mean	State's Rank in South Atlantic	Year's Rank 1950-1980	State's % of South Atlantic	State's % of Gulf and South Atlantic	State's Percent of Total U.S.
1950	5,206,749	130	3	7	22.8	4.4	4.3
1951	5,136,772	128	2	8	29.5	3.7	3.7
1952	5,458,216	136	1	5	33.9	3.9	3.8
1953	9,174,709	229	1	1	44.5	5.7	5.6
1954	5,752,909	143	1	4	32.1	3.5	3.4
1955	6,467,716	161	1	2	36.2	4.3	4.2
1956	3,911,076	97	3	13	24.6	2.9	2.8
1957	4,721,987	118	2	11	27.0	3.8	3.7
1958	1,500,989	37	4	31	11.2	1.2	1.1
1959	3,796,422	95	3	14	24.5	2.9	2.6
1960	3,564,555	89	4	16	19.2	2.5	2.4
1961	1,795,333	45	4	30	15.3	2.0	1.7
1962	3,615,501	90	3	15	22.0	3.4	3.1
1963	2,097,798	52	3	28	21.4	1.5	1.4
1964	2,665,620	66	3	27	24.5	2.1	2.1
1965	3,395,247	85	4	20	20.3	2.4	2.3
1966	3,552,313	89	2	17	26.3	2.8	2.5
1967	3,066,867	76	3	25	23.6	2.0	2.0
1968	2,875,696	72	4	26	18.5	2.0	1.6
1969	4,892,606	122	2	9	28.2	3.4	2.5
1970	3,153,055	79	3	23	24.1	2.0	1.4
1971	4,753,692	119	3	10	24.4	2.9	2.0
1972	3,502,860	87	3	18	21.8	2.2	1.5
1973	3,164,897	79	3	22	20.3	2.4	1.4
1974	5,256,084	131	1	6	31.1	3.9	2.3
1975	3,232,551	81	3	21	20.5	2.6	1.5
1976	4,143,626	103	3	12	25.2	2.8	1.7
1977	3,481,017	87	1	19	33.8	2.0	1.2
1978	1,842,250	46	3	29	18.4	1.1	0.7
1979	3,081,822	77	3	24	18.4	-	-
1980	6,119,886	153	1	3	33.0	-	-
Mean	4,012,284		2.6		25.1	2.8	2.4
SD	1,595,827		1.0		6.9	1.0	1.1
Range	1,500,989-9,174,709	37 - 229	1-4		11.2 - 44.5	1.1 - 5.7	0.7 - 5.6

Table 13-3. *Summary of shrimp production for South Carolina, 1950-1980.* (White, brown, pink shrimp)

Year	Total Landings Heads-off Pounds	Annual Landings as % of 1950-80 Mean	State's Rank in South Atlantic	Year's Rank 1950-1980	State's % of South Atlantic	State's % of Gulf and South Atlantic	State's Percent of Total U.S.
1950	4,852,917	120	4	7	21.2	4.1	4.0
1951	2,337,061	58	4	28	13.4	1.7	1.7
1952	2,551,189	63	4	26	15.9	1.8	1.8
1953	3,186,246	79	4	21	15.4	2.0	2.0
1954	4,162,292	103	3	15	23.2	2.5	2.5
1955	4,333,946	107	3	14	25.2	2.9	2.8
1956	8,921,362	220	1	1	56.1	6.5	6.4
1957	3,981,907	98	3	18	22.8	3.2	3.1
1958	3,461,498	86	2	20	25.8	2.8	2.6
1959	4,472,948	110	2	12	28.9	3.4	3.1
1960	4,780,083	118	2	8	25.7	3.4	3.2
1961	2,325,472	57	3	29	19.8	2.5	2.2
1962	4,101,989	101	2	16	24.9	3.9	3.6
1963	1,374,879	34	4	31	14.0	1.0	0.9
1964	1,655,329	41	4	30	15.2	1.3	1.3
1965	4,341,451	107	2	13	26.0	3.1	3.0
1966	2,670,658	66	4	24	19.8	2.1	1.9
1967	2,588,130	64	4	25	19.9	1.7	1.7
1968	4,068,895	101	2	17	26.2	2.8	2.3
1969	3,742,499	92	3	19	21.5	2.6	1.9
1970	3,162,150	78	2	22	24.2	2.0	1.4
1971	6,904,491	171	1	3	35.5	4.2	2.9
1972	5,186,152	128	1	5	32.2	3.2	2.2
1973	5,312,590	131	2	6	34.1	4.1	2.3
1974	4,765,358	118	2	10	28.2	3.5	2.1
1975	5,689,721	141	1	3	36.1	4.6	2.7
1976	5,540,227	137	1	4	33.7	3.7	2.3
1977	2,501,544	62	3	27	24.3	1.4	0.9
1978	3,160,899	78	2	23	31.5	1.9	1.2
1979	4,794,791	118	2	9	28.7	-	-
1980	4,589,120	113	3	11	24.7	-	-
Mean	4,048,961		2.5		25.6	2.9	2.4
SD	1,557,997		1.1		8.4	1.2	1.1
Range	1,374,879-8,921,362	34-220	1 - 4		13.4 - 56.1	1.0 - 6.5	0.9 - 6.4

Table 13-4. Summary of shrimp production for Georgia, 1950-1980. (White, brown, pink shrimp)

Year	Total Landings Heads-off Pounds	Annual Landings as % of 1950-80 Mean	State's Rank in South Atlantic	Year's Rank 1950-1980	State's % of South Atlantic	State's % of Gulf and South Atlantic	State's Percent of Total U.S.
1950	6,989,381	145	1	1	30.6	5.9	5.8
1951	4,766,213	99	3	17	27.4	3.4	3.4
1952	3,753,245	78	3	28	23.3	2.7	2.6
1953	4,720,480	98	2	18	22.9	2.9	2.9
1954	4,849,534	101	2	16	27.0	2.9	2.9
1955	4,486,179	103	2	22	25.1	3.0	2.9
1956	5,006,153	104	2	14	31.5	3.6	3.6
1957	5,198,264	108	1	10	29.8	4.2	4.1
1958	5,186,994	108	1	12	38.6	4.2	3.9
1959	4,520,838	94	1	21	29.2	3.5	3.1
1960	6,192,210	129	1	2	33.3	4.4	4.1
1961	4,053,615	84	1	25	34.5	4.4	3.8
1962	5,423,989	113	1	8	33.0	5.1	4.7
1963	3,445,552	72	1	30	35.1	2.5	2.4
1964	3,769,857	78	1	27	34.6	3.0	2.9
1965	5,519,101	115	1	6	33.1	4.0	3.8
1966	4,142,396	86	1	24	30.7	3.3	2.9
1967	4,259,364	89	1	23	32.7	2.8	2.8
1968	5,521,889	115	1	5	35.6	3.8	3.1
1969	5,459,733	113	1	7	31.4	3.8	2.8
1970	3,864,744	80	1	26	29.5	2.4	1.7
1971	5,722,274	119	2	4	29.4	3.5	2.4
1972	4,664,809	97	2	18	29.0	2.9	2.0
1973	5,338,510	111	1	9	34.2	4.1	2.3
1974	4,653,108	97	3	20	27.5	3.5	2.1
1975	5,190,512	108	2	11	32.9	4.2	2.5
1976	4,993,351	104	2	15	30.3	3.4	2.0
1977	2,938,085	61	2	31	28.5	1.6	1.0
1978	3,517,777	73	1	29	35.1	2.1	1.3
1979	5,870,315	122	1	3	35.1	–	–
1980	5,179,058	108	2	13	27.9	–	–
Mean	4,812,824		1.5		30.9	3.5	3.0
SD	876,450		0.7		3.7	0.9	1.0
Range	2,938,085 - 6,989,381	61 - 146	1-3		22.9 - 38.6	1.6 - 5.9	1.0 - 5.8

Table 13-5. Summary of shrimp production for the east coast of Florida, 1950-1980. (White, brown, pink shrimp)

Year	Total Landings Heads-off Pounds	Annual Landings as percent of 1950-1980 Mean	State's Rank in South Atlantic	Year's Rank 1950-1980	State's Per-cent of South Atlantic	State's Per-cent of Gulf & S. Atlantic	State's Per cent of Total U.S.
1950	5,805,658	192	2	1	25.4	4.9	4.8
1951	5,157,885	171	1	2	29.6	3.7	3.7
1952	4,319,788	143	2	3	26.9	3.0	3.1
1953	3,550,227	118	3	7	17.2	2.2	2.2
1954	3,181,234	105	4	12	17.7	1.9	1.9
1955	2,591,096	86	4	24	14.5	1.7	1.7
1956	3,567,769	118	4	6	22.4	2.6	2.5
1957	3,049,456	101	4	16	17.5	2.5	2.6
1958	3,276,191	108	3	11	24.4	2.6	2.8
1959	2,685,273	89	4	22	17.4	2.1	1.9
1960	4,043,443	134	3	4	21.8	2.9	2.7
1961	3,580,623	119	2	5	30.5	3.9	3.4
1962	3,304,871	109	4	9	20.1	3.1	2.9
1963	2,897,564	96	2	19	29.5	2.1	2.0
1964	2,802,431	93	2	20	25.7	2.3	2.2
1965	3,433,159	114	3	8	20.6	2.5	2.3
1966	3,123,482	103	3	13	23.2	2.5	2.2
1967	3,108,226	103	2	14	23.9	2.0	2.0
1968	3,050,263	101	3	15	19.7	2.1	1.7
1969	3,273,113	108	4	10	18.8	2.3	1.7
1970	2,899,549	96	4	18	22.2	1.8	1.3
1971	2,095,567	69	4	26	10.8	1.3	0.9
1972	2,739,563	91	4	21	17.0	1.7	1.2
1973	1,774,962	59	4	28	11.4	1.4	0.8
1974	2,222,016	74	4	25	13.2	1.7	1.0
1975	1,654,251	55	4	29	10.5	1.3	0.8
1976	1,783,253	59	4	27	10.8	1.2	0.7
1977	1,388,747	46	4	31	13.5	0.8	0.5
1978	1,605,728	53	4	30	16.0	1.0	0.6
1979	3,021,682	100	4	17	18.1	-	-
1980	2,659,638	88	4	23	14.3	-	-
Mean	3,049,894		3.3		19.5	2.2	2.0
SD	1,011,499		0.9		5.8	0.9	1.0
Range	1,389,747-5,805,658	46- 192	1.4		10.5 - 30.5	0.8 - 4.9	0.6 - 4.8

Table 13-6. Summary of shrimp production for the South Atlantic, 1957-1980. (White shrimp)

Year	Heads-off Pounds	Annual Landings as % of 1957-80 Mean	Year's Rank 1957-80	Percent of Total S. Atlantic Landings (All species)
1957	9,553,546	109	10	56.4
1958	7,203,177	82	18	53.7
1959	8,326,764	95	15	53.8
1960	12,199,920	139	2	65.7
1961	9,112,583	104	13	77.5
1962	7,879,117	90	17	47.9
1963	4,720,082	54	23	48.1
1964	5,272,219	60	22	48.4
1965	10,587,016	121	8	63.4
1966	5,949,097	68	20	44.1
1967	7,079,288	81	19	54.4
1968	11,003,823	125	5	70.9
1969	10,983,602	125	6	63.2
1970	8,111,121	92	16	62.0
1971	12,214,483	139	1	62.7
1972	10,802,312	123	7	67.1
1973	11,845,130	135	3	76.0
1974	8,685,289	99	14	51.4
1975	10,331,812	118	9	65.5
1976	9,331,374	106	11	56.7
1977	3,221,503	37	24	31.2
1978	5,686,067	65	21	56.1
1979	11,485,711	131	4	68.6
1980	9,257,604	105	12	49.9
Mean	8,785,110			58.1
SD	2,512,017			10.7
Range	3,221,503-12,214,483	37-139		31.2-77.5

Table 13-7. Summary of shrimp production for the South Atlantic states, 1957-1980. (Brown shrimp)

Year	Total Landings Heads-Off Pounds	Annual Landings as % of 1957-80 Mean	Year's Rank 1957-1980	Percent of Total South Atlantic Landings (All Species)
1957	6,049,791	116	7	34.6
1958	5,707,828	109	10	42.5
1959	5,860,132	112	9	37.9
1960	5,613,811	107	11	30.2
1961	1,550,071	30	24	13.2
1962	7,163,164	137	3	43.6
1963	4,749,249	91	16	48.4
1964	4,403,488	84	18	40.4
1965	5,047,419	96	13	30.2
1966	7,207,733	138	2	53.4
1967	4,955,800	95	14	38.1
1968	3,676,714	70	22	23.7
1969	5,323,086	102	12	30.6
1970	4,430,512	85	17	33.9
1971	6,064,881	116	6	30.9
1972	4,798,399	92	15	29.8
1973	2,796,832	53	23	17.9
1974	6,887,364	132	4	40.8
1975	4,169,782	80	19	26.4
1976	5,994,678	115	8	36.4
1977	6,587,123	126	5	63.9
1978	4,100,797	78	21	40.9
1979	4,138,249	79	20	24.7
1980	8,306,249	159	1	44.8
Mean	5,232,631			35.7
SD	1,499,996			11.2
Range	1,550,071 - 8,306,249	30 - 159		13.2 - 63.9

Table 13-8. Summary of shrimp production for the South Atlantic states, 1957-1980. (Pink shrimp)

Year	Landings Heads-off Pounds	Annual Landings as % of 1957-1980 Mean	Year's Rank 1957-1980	Percent of Total South Atlantic Landings (All Species)
1957	1,348,277	147	2	8.0
1958	514,667	56	19	3.8
1959	1,288,585	140	4	8.3
1960	766,560	83	17	4.1
1961	1,092,389	119	10	9.3
1962	1,404,069	153	1	8.5
1963	346,462	38	22	3.5
1964	1,217,530	132	6	11.2
1965	1,054,523	115	12	6.3
1966	332,019	36	24	2.5
1967	986,974	107	13	7.6
1968	836,206	91	16	5.4
1969	1,061,263	115	11	6.1
1970	537,865	58	18	4.1
1971	1,196,660	130	7	6.1
1972	492,673	54	21	3.1
1973	948,997	103	15	6.1
1974	1,323,913	144	3	7.8
1975	1,265,441	138	5	8.0
1976	1,134,405	123	8	6.9
1977	500,767	54	20	4.9
1978	339,790	37	23	3.4
1979	1,111,650	121	9	6.6
1980	983,849	107	14	5.3
Mean	920,231			6.1
S.D.	353,343			2.2
Range	332,019-1,404,069	36		2.5 - 11.2

Table 13-9. Summary of shrimp production for North Carolina, 1957-1980. (White shrimp)

Year	Landings Heads-Off Pounds	Annual Landings as % of 1957-1980 Mean	State's Rank in S.Atlantic	Year's Rank 1957-80	Percent of Total State Landings	Percent of S. Atlantic White Shrimp
1957	421,158	160	4	4	8.9	5.8
1958	50,959	19	4	19	3.4	0.7
1959	72,962	28	4	18	1.9	0.9
1960	233,601	89	4	11	6.6	1.9
1961	101,525	39	4	16	5.7	1.1
1962	32,743	12	4	21	0.9	0.4
1963	0	0	-	24	0	0
1964	10,248	4	4	22	0.4	0.2
1965	565,844	216	4	3	16.7	5.3
1966	265,997	101	4	8	7.5	4.5
1967	127,977	49	4	14	4.2	1.8
1968	83,809	32	4	17	2.9	0.8
1969	175,316	67	4	12	3.6	1.6
1970	238,844	91	4	10	7.6	2.9
1971	381,994	146	4	6	8.0	3.1
1972	1,020,220	389	4	2	29.1	9.4
1973	1,166,497	444	4	1	36.9	9.8
1974	126,890	48	4	15	2.4	13.0
1975	407,900	155	4	5	12.6	3.9
1976	249,069	95	4	9	6.0	2.7
1977	5,759	2	4	23	0.2	0.2
1978	37,316	14	4	20	2.0	0.7
1979	153,351	59	4	13	5.0	1.3
1980	368,499	140	4	7	6.0	4.0
Mean	262,437		4.0		7.4	3.2
SD	298,784				8.9	3.4
Range	0 - 1,166,497	0 - 44			0 - 36.9	0 - 13.0

Table 13-10. Summary of shrimp production for South Carolina, 1957-1980. (White shrimp)

Year	Landings Heads-Off Pounds	Annual Landings as % of 1957-80 Mean	State's Rank in South Atlantic	Year's Rank 1957-1980	Percent of Total State Landings	Percent of S. Atlantic White Shrimp
1957	2,533,074	101	2	14	63.6	35.1
1958	1,461,032	58	3	19	42.2	20.3
1959	2,659,317	106	2	13	59.5	31.9
1960	3,349,393	134	3	8	70.1	27.5
1961	1,798,603	72	3	17	77.3	19.7
1962	1,858,097	74	3	16	45.3	23.6
1963	183,675	7	3	24	13.4	3.9
1964	516,011	21	3	22	31.2	9.8
1965	2,787,023	111	3	12	64.2	26.3
1966	519,423	21	3	21	19.4	8.7
1967	1,124,753	45	3	20	43.5	15.9
1968	3,102,002	124	2	9	76.2	28.2
1969	2,977,273	119	2	10	79.6	27.1
1970	2,001,730	80	3	15	63.3	24.7
1971	5,194,397	207	1	1	75.2	42.5
1972	3,790,630	151	1	5	73.1	35.1
1973	4,244,722	169	2	2	79.9	35.8
1974	3,474,689	139	2	7	72.9	40.0
1975	4,203,717	168	2	3	73.9	40.7
1976	3,804,334	152	2	4	68.7	40.8
1977	434,472	17	3	23	17.4	13.5
1978	1,650,258	66	2	18	52.2	29.0
1979	3,622,783	145	2	6	75.6	31.5
1980	2,854,057	114	2	11	62.2	30.8
Mean	2,506,061		2.4		58.3	26.8
SD	1,361,982		0.6		20.7	10.7
Range	183,675 - 5,194,397	7 - 207	1-3		13.4 - 79.9	3.9 - 42.5

Table 13-11. Summary of shrimp production for Georgia, 1957-1980. (White shrimp)

Year	Landings Heads-off Pounds	Annual Landings as % of 1957-80 Mean	State's Rank in S. Atlantic	Year's Rank 1957-80	Percent of Total State Landings	Percent of S. Atlantic White Shrimp
1957	4,270,689	113	1	9	82.2	59.1
1958	3,069,618	81	1	19	59.2	42.6
1959	3,387,159	90	1	17	74.9	40.7
1960	4,917,880	130	1	5	79.4	40.3
1961	3,705,799	98	1	13	91.4	40.7
1962	3,586,488	95	1	14	66.1	45.5
1963	2,269,950	60	1	23	65.9	48.1
1964	2,541,272	67	1	22	67.4	48.2
1965	4,315,722	114	1	8	78.2	40.8
1966	2,763,460	73	1	20	66.7	46.5
1967	3,132,982	83	1	18	73.6	44.3
1968	5,068,825	134	1	2	91.8	46.1
1969	4,900,279	130	1	6	89.8	44.6
1970	3,230,167	86	1	16	83.6	39.8
1971	5,006,227	133	2	3	87.5	41.0
1972	3,606,302	96	2	15	77.3	33.4
1973	4,960,773	131	1	4	92.9	41.9
1974	3,774,285	100	1	12	81.1	43.5
1975	4,380,028	116	1	7	84.4	42.4
1976	3,823,681	101	1	11	76.6	41.0
1977	1,942,718	51	1	24	66.1	60.3
1978	2,730,674	72	1	21	77.6	48.0
1979	5,143,307	136	1	1	67.6	44.8
1980	4,041,371	107	1	10	78.0	43.7
Mean	3,773,736		1.1		78.3	44.5
SD	948,734		0.3		9.5	5.7
Range	1,942,718-5,143,307	51 - 136	1.2		59.2-92.9	33.4-60.3

Table 13-12. Summary of shrimp production for east coast of Florida, 1957-1980. (White shrimp)

Year	Landings Heads-Off Pounds	Annual Landings as % of 1957-80 Mean	State's Rank in S.Atlantic	Year's Rank 1957-80	Percent of Total State Landings	Percent of S. Atlantic White Shrimp
1957	2,328,625	104	3	13	76.4	32.2
1958	2,621,568	117	2	9	80.0	36.4
1959	2,207,326	98	3	15	82.2	26.5
1960	3,699,046	165	2	1	91.5	30.3
1961	3,506,656	156	2	3	97.9	38.5
1962	2,401,789	107	2	11	72.7	30.5
1963	2,266,457	101	2	14	78.2	48.0
1964	2,204,688	98	2	16	78.7	41.8
1965	2,918,427	130	2	5	85.0	27.6
1966	2,400,217	107	2	12	76.8	40.3
1967	2,693,576	120	2	7	86.7	38.0
1968	2,749,187	122	3	6	90.1	25.0
1969	2,930,734	131	3	4	89.5	26.7
1970	2,640,380	118	2	8	91.1	32.6
1971	1,631,865	73	3	18	77.9	13.4
1972	2,385,160	106	3	2	87.1	22.1
1973	1,473,138	66	3	20	83.0	12.4
1974	1,309,425	58	3	22	58.9	15.1
1975	1,340,167	60	3	21	81.0	13.0
1976	1,454,290	65	3	19	81.6	15.6
1977	838,554	37	2	24	60.3	26.0
1978	1,267,819	56	3	23	79.0	22.3
1979	2,599,270	116	3	10	86.5	22.6
1980	1,993,677	89	3	17	74.5	21.5
Mean	2,244,252		2.5		81.1	27.4
SD	718,535		0.5		9.0	9.8
Range	838,554 - 3,699,056	37 - 165	2-3		58.9 - 97.9	13.0 - 48.0

Table 13-13. Summary of shrimp production for North Carolina, 1957-1980. (Brown shrimp)

Year	Total Landings Heads-Off Pounds	Annual Landings as % of 1957-80 Mean	State's Rank in South Atlantic	Year's Rank 1957-1980	Percent of Total State Landings	Percent of South Atlantic Brown Shrimp
1957	2,976,628	129	1	6	63.0	49.2
1958	941,859	41	3	23	62.7	16.5
1959	2,435,350	105	1	10	64.1	41.6
1960	2,564,394	111	1	9	71.9	45.7
1961	601,419	26	1	24	33.5	38.8
1962	2,180,044	94	2	12	60.3	30.4
1963	1,751,336	76	1	18	83.5	36.9
1964	1,444,942	62	1	21	54.2	32.9
1965	1,774,880	77	1	17	52.3	35.2
1966	2,955,446	128	1	7	83.2	41.0
1967	1,951,916	84	1	16	63.6	39.4
1968	1,963,982	85	1	14	68.3	53.4
1969	3,656,663	158	1	3	74.7	68.7
1970	2,379,976	103	1	11	75.5	53.7
1971	3,175,038	137	1	4	66.8	52.4
1972	1,989,967	86	1	13	56.8	41.5
1973	1,053,826	46	2	22	33.3	37.7
1974	3,809,124	165	1	2	72.5	55.3
1975	1,601,266	69	1	19	49.5	38.4
1976	2,788,670	121	1	8	67.3	46.5
1977	3,105,088	134	1	5	89.2	47.1
1978	1,540,574	67	1	20	83.6	37.6
1979	1,952,612	84	1	15	63.4	47.2
1980	4,894,312	212	1	1	80.0	58.9
Mean	2,312,055		1.2		65.6	43.6
SD	991,936		0.5		14.4	10.7
Range	601,419 - 4,894,312	26 - 212	1-3		33.3 - 89.2	16.5 - 68.7

Table 13-14. Summary of shrimp production for South Carolina, 1957-1980. (Brown shrimp)

Year	Total Landings Heads-Off Pounds	Annual Landings as % of 1957-80 Mean	State's Rank in South Atlantic	Year's Rank 1957-1980	Percent of Total State Landings	Percent of South Atlantic Brown Shrimp
1957	1,443,133	99	2	13	36.2	23.9
1958	2,000,466	137	2	4	57.8	35.0
1959	1,813,631	125	2	5	40.5	30.9
1960	1,430,690	98	2	14	29.9	25.5
1961	526,869	36	2	24	22.7	34.0
1962	2,243,892	154	1	1	54.7	31.3
1963	1,191,204	82	2	17	86.6	25.1
1964	1,139,318	78	3	20	68.8	25.9
1965	1,554,428	107	2	9	35.8	30.8
1966	2,151,235	148	2	2	80.6	29.8
1967	1,463,377	101	2	12	56.5	29.5
1968	963,093	66	2	22	23.7	26.2
1969	765,226	53	2	23	20.4	14.4
1970	1,160,420	80	2	19	36.7	26.2
1971	1,710,094	117	2	8	24.8	28.2
1972	1,395,522	96	2	15	26.9	29.1
1973	1,067,868	73	1	21	20.1	38.2
1974	1,290,669	89	2	16	27.1	18.7
1975	1,478,843	102	2	11	26.0	35.5
1976	1,716,151	118	2	7	31.0	28.6
1977	2,037,451	140	2	3	81.4	30.9
1978	1,503,314	103	2	10	47.6	36.7
1979	1,169,234	80	2	18	24.5	28.3
1980	1,728,844	119	2	6	37.7	20.8
Mean	1,456,041		2.0		41.6	28.5
SD	426,900				20.6	5.6
Range	526,869 - 2,243,892	36 - 154	1-3		20.1-86.6	14.4-38.2

Table 13-15. Summary of shrimp production for Georgia, 1957-1980. (Brown shrimp).

Year	Total Landings Heads-Off Pounds	Annual Landings as % of 1957-80 Mean	State's Rank in South Atlantic	Year's Rank 1958-1980	Percent of Total State Landings	Percent of S. Atlantic Brown Shrimp
1957	912,094	91	3	14	17.5	15.1
1958	2,110,880	211	1	1	40.7	37.0
1959	1,133,204	113	3	9	25.1	19.3
1960	1,274,330	128	3	4	20.6	22.7
1961	347,816	35	3	24	8.6	22.4
1962	1,837,501	184	3	2	33.9	25.7
1963	1,175,602	118	3	7	34.1	24.8
1964	1,221,485	122	2	5	32.4	27.7
1965	1,203,379	120	3	6	21.8	23.8
1966	1,377,787	138	3	3	33.3	19.1
1967	1,126,382	113	3	10	26.4	22.7
1968	453,064	45	3	22	8.2	12.3
1969	559,454	56	3	21	10.2	10.5
1970	633,802	63	3	20	16.4	14.3
1971	716,047	72	3	19	12.5	11.8
1972	1,058,507	106	3	12	22.7	22.1
1973	377,737	38	3	23	7.1	13.5
1974	878,823	88	3	15	18.9	12.8
1975	804,964	81	3	16	15.5	19.3
1976	1,169,670	117	3	8	23.4	19.5
1977	991,171	99	3	13	33.7	15.0
1978	771,167	77	3	17	21.9	18.8
1979	718,673	72	3	18	12.2	17.4
1980	1,126,303	113	3	11	21.7	13.6
Mean	999,160		2.9		21.6	19.2
SD	420,616		0.4		9.5	6.2
Range	347,816 - 2,110,880	35 - 211	1 - 3		7.1 - 40.7	10.5 - 37.0

Table 13-16. Summary of shrimp production for east coast of Florida, 1957-1980. (Brown shrimp)

Year	Total Landings Heads-Off Pounds	Annual Landings as % of 1950-80 Mean	State's Rank in South Atlantic	Year's Rank 1957-1980	Percent of Total State Landings	Percent of S.Atlantic Brown Shrimp
1957	717,936	154	4	4	23.5	11.9
1958	654,623	141	4	5	20.0	11.5
1959	477,947	103	4	10	17.8	8.2
1960	344,397	74	4	15	8.5	6.1
1961	73,967	16	4	24	2.1	4.8
1962	901,727	194	4	2	27.3	12.6
1963	631,107	136	4	6	21.8	13.3
1964	597,743	128	4	7	21.3	13.6
1965	514,732	111	4	9	15.0	10.2
1966	723,265	155	4	3	23.2	10.0
1967	414,125	89	4	13	13.3	8.4
1968	296,575	64	4	20	9.7	8.1
1969	341,743	73	4	16	10.4	6.4
1970	256,314	55	4	23	8.8	5.8
1971	463,702	100	4	11	22.1	7.6
1972	354,403	76	4	14	12.9	7.4
1973	297,401	64	4	19	16.8	10.6
1974	908,748	195	4	1	40.9	13.2
1975	284,709	61	4	22	17.2	6.8
1976	320,187	69	4	17	18.0	5.3
1977	453,413	97	4	12	32.6	6.9
1978	285,742	61	4	21	17.8	7.0
1979	297,730	64	4	18	9.9	7.2
1980	556,790	120	4	8	20.9	6.7
Mean	465,376		4.0		18.0	8.7
SD	210,769		0.0		8.4	2.7
Range	73,967 - 908,748	16 - 195			8.5 - 40.9	4.8 - 13.6

Table 13-17. Summary of shrimp production for North Carolina, 1957-1980. (Pink shrimp)

Year	Landings Heads-Off Pounds	Annual Landings as % of 1957-80 Mean	State's Rank in South Atlantic	Year's Rank 1957-80	Percent of Total State Landings	Percent of S. Atlantic Pink Shrimp
1957	1,324,201	148	1	2	28.0	98.2
1958	508,171	57	1	19	33.9	98.7
1959	1,288,110	144	1	4	33.9	99.9+
1960	766,560	86	1	17	21.5	100.0
1961	1,092,389	122	1	9	60.8	100.0
1962	1,402,714	157	1	1	38.8	99.9
1963	346,462	39	1	22	16.5	100.0
1964	1,210,430	135	1	6	45.4	99.4
1965	1,054,523	118	1	11	31.1	100.0
1966	330,870	37	1	23	9.3	99.6
1967	986,974	110	1	12	32.2	100.0
1968	827,905	92	1	16	28.8	99.0
1969	1,060,627	118	1	10	21.7	99.9
1970	534,235	60	1	18	16.9	99.3
1971	1,196,660	134	1	7	25.2	100.0
1972	492,673	55	1	20	14.1	100.0
1973	944,574	106	1	14	29.8	99.5
1974	1,320,070	147	1	3	25.1	99.7
1975	1,223,385	137	1	5	37.8	96.7
1976	1,105,887	124	1	8	26.7	97.5
1977	370,170	41	1	21	10.6	73.9
1978	264,360	30	1	24	14.3	77.8
1979	975,859	109	1	13	31.7	89.0
1980	867,075	96	1	15	14.0	87.1
Mean	895,204				27.0	96.5
SD	360,295				11.9	7.2
Range	264,360- 1,402,714	30-157			9.3 - 60.8	73.9 - 100.0

Table 13-18. Summary of shrimp production for South Carolina, 1957-1980. (Pink shrimp)

Year	Landings Heads-Off Pounds	Annual Landings as % of 1957-80 Mean	State's Rank in South Atlantic	Year's Rank 1957-80	Percent of Total State Landings	Percent of S. Atlantic Pink Shrimp
1957	5,700	166	3	6	0.1	0.4
1958	0	0	-	-	0	0
1959	0	0	-	-	0	0
1960	0	0	-	-	0	0
1961	0	0	-	-	0	0
1962	0	0	-	-	0	0
1963	0	0	-	-	0	0
1964	0	0	-	-	0	0
1965	0	0	-	-	0	0
1966	0	0	-	-	0	0
1967	0	0	-	-	0	0
1968	3,800	111	3	7	0.1	0.5
1969	0	0	-	-	0	0
1970	0	0	-	-	0	0
1971	0	0	-	-	0	0
1972	0	0	-	-	0	0
1973	0	0	-	-	0	0
1974	0	0	-	-	0	0
1975	7,161	209	3	4	0.1	0.6
1976	19,742	575	2	2	0.4	1.7
1977	29,621	863	3	1	1.2	5.9
1978	7,327	214	4	3	0.2	2.2
1979	2,774	81	4	8	0.1	0.3
1980	6,219	181	4	5	0.1	0.6
Mean	3,431					
SD	7,171					
Range	0 - 29,621	0 - 863			0 - 1.2	0 - 5.9

Table 13-19. Summary of shrimp production for Georgia, 1957-1980. (Pink shrimp)

Year	Landings Heads-off Pounds	Annual Landings as % of 1957-1980 Mean	State's Rank in S. Atlantic	Year's Rank 1957-1980	Percent of Total State Landings	Percent of S. Atlantic Pink Shrimp
1957	15,481	483	2	2	0.3	1.1
1958	6,496	203	2	6	0.1	1.3
1959	475	15	2	11	*	*
1960	0	0	-	-	0	0
1961	0	0	-	-	0	0
1962	0	0	-	-	0	0
1963	0	0	-	-	0	0
1974	7,100	222	2	5	0.2	0.6
1965	0	0	-	-	0	0
1966	1,149	36	2	9	*	0.3
1967	0	0	-	-	0	0
1968	0	0	-	-	0	0
1969	0	0	-	-	0	0
1970	775	24	3	10	*	0.1
1971	0	0	-	-	0	0
1972	0	0	-	-	0	0
1973	0	0	-	-	0	0
1974	0	0	-	-	0	0
1975	5,520	172	2	7	0.1	0.4
1976	0	0	-	-	0	0
1977	4,196	131	4	8	0.1	0.8
1978	15,936	498	3	1	0.5	4.7
1979	8,335	260	3	4	0.1	0.8
1980	11,384	356	3	3	0.2	1.2
Mean	3,202					
SD	5,062					
Range	0-15,936	0-498			0-0.5	0-4.7

*Less than 0.1

Table 13-20. Summary of shrimp production for the east coast of Florida, 1957-1980. (Pink shrimp)

Year	Landings Heads-Off Pounds	Annual Landings as % of 1957-1980 Mean	State's Rank in S. Atlantic	Year's Rank in S. Atlantic	Percent of Total State Landings	Percent of S. Atlantic Pink Shrimp
1957	2,895	16	4	10	0.1	0.2
1958	-0-	0	-	-	0	0
1959	-0-	0	-	-	0	0
1960	-0-	0	-	-	0	0
1961	-0-	0	-	-	0	0
1962	1,355	7	2	12	*	0.1
1963	-0-	0	-	-	0	0
1964	-0-	0	-	-	0	0
1965	-0-	0	-	-	0	0
1966	-0-	0	-	-	0	0
1967	525	3	2	14	*	0.1
1968	4,501	24	2	7	0.1	0.5
1969	636	3	2	13	*	0.1
1970	2,855	15	2	11	0.1	0.5
1971	-0-	0	-	-	0	0
1972	-0-	0	-	-	0	0
1973	4,423	24	2	8	0.1	0.5
1974	3,843	21	2	9	0.2	2.9
1975	29,375	159	2	5	1.8	2.3
1976	8,776	48	3	6	0.5	0.8
1977	96,780	527	2	3	7.0	19.5
1978	52,167	283	2	4	3.2	15.4
1979	124,682	675	2	1	4.1	11.4
1980	109,171	591	2	2	4.1	11.1
Mean	18,374					
SD	37,565					
Range	0 - 124,682	0 - 675			0 - 7.0	0 - 19.5

*less than 0.1