A Profile of the Blue Crab and Its Fishery in South Carolina

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I. Introduction

The blue crab (Callinectes sapidus Rathbun) supports an important fishery in South Carolina. Reported commercial landings in 1986 were 5,758,619 pounds (whole weight), with an exvessel value of $1,764,911. Blue crab landings have averaged about 30% of the state's total annual commercial harvest (by weight) of seafood since 1980. These landings support an economically important processing sector, since local processors purchase about 70% of the landings for distribution to various markets throughout the United States. Other activities which contribute to the overall socio-economic value of the state's blue crab resource include recreational crabbing and the production of soft shell crabs.

Reported commercial landings of hard blue crab in South Carolina have fluctuated widely during the past 35 years. In the last ten years, these landings (Fig. 1) have declined substantially and recent annual production has been well below the long-term average. Decreased landings have been noted in Georgia as well, where a downward trend has been evident since 1978. Although commercial landings are generally regarded as indicative of blue crab abundance, they are also influenced by short-term characteristics of the fishery, market conditions, and statistical reporting methods.

Abundance is determined by several factors, including environmental and habitat alterations, disease, and possibly fishing effort and methods. Atypical drought conditions in recent years have resulted in below-average rainfall and river discharge rates. Although documented pollution problems have not increased substantially in recent years, coastal development has expanded greatly. Disease-related problems, such as "gray crab" disease, exist but remain localized. Participation in the local fishery appears to have declined (Fig 2), but it is not known whether this reflects catches, economic conditions, or a combination of stock-independent factors. Although an estuarine-dependent species like the blue crab is adapted to survive wide fluctuations in physical, chemical, biological and man-related variables, it is not known what limits or factor combinations severely impact the populations.

The possible continuation of the declining trend in commercial landings intensifies the need for effective management. Such management would be greatly facilitated by the ability to accurately predict and evaluate fluctuations in blue crab stocks. It is the purpose of this report to summarize available information on the biology of the blue crab and the characteristics of its fisheries in South Carolina, to indicate the limitations of this information, and to recommend measures to expand our information base.

II. Description of the South Carolina Resource

A. General Distribution

The blue crab is the most valuable species of its genus that occurs along the Atlantic coast. Others include C. bocourti, C. danae, C. exasperatus, C. larvatus, C. ornatus, and C. similis, but the latter two are the only others that are abundant in South Carolina waters (Williams 1984).

The blue crab occurs from Maine to Florida and throughout the Gulf of Mexico. Occasional records extend the range to Nova Scotia, but most reports north of Cape Cod are associated with warm periods (Williams 1984, Scattergood 1960). Although C. sapidus, C. similis, and C. ornatus are tolerant of a broad salinity range, the blue crab appears to be the most tolerant of extremes. It occurs on a variety of bottoms in freshwater, estuaries, and coastal ocean (Franks et al. 1972). Occurrence of C. ornatus and C. similis in South Carolina has largely been noted in high salinities (Lunz 1951).

B. Biological Characteristics

1. Spawning and Reproductive Biology

The life history of the blue crab involves a complex cycle of planktonic, nektonic and benthic stages which occur throughout the estuarine-nearshore marine environments. Migratory patterns appear similar in the Middle Atlantic and southeastern United States. Mating occurs in low or moderate salinity following terminal molt of the female. Females mate once while their exoskeleton is soft (Van Engel 1958; Williams 1984). Seminal products are stored in paired receptacles and may fertilize eggs two or more times during a one to two year period (Pyle and Cronin 1950; Van Engel 1958; Williams 1984). The ovary increases in size until it becomes mature and orange, about two months after copulation (Hard 1942). Females which are recruited to the October - November pot fishery undergo terminal molt in August and September, then migrate to higher salinity waters during the winter. These females become the early "sponge" crabs in April and May (Eldridge and Waltz 1977). Movement to deeper water apparently occurs as temperatures decrease in winter.

Those crabs which mated in fall spawn the following spring and are nearshore inhabitants. Ovigerous females occur from March through September, but are most consistent from April through August, with an apparent peak during April through early June. The rarity of ovigerous females in late August and September may be due to mortality of older

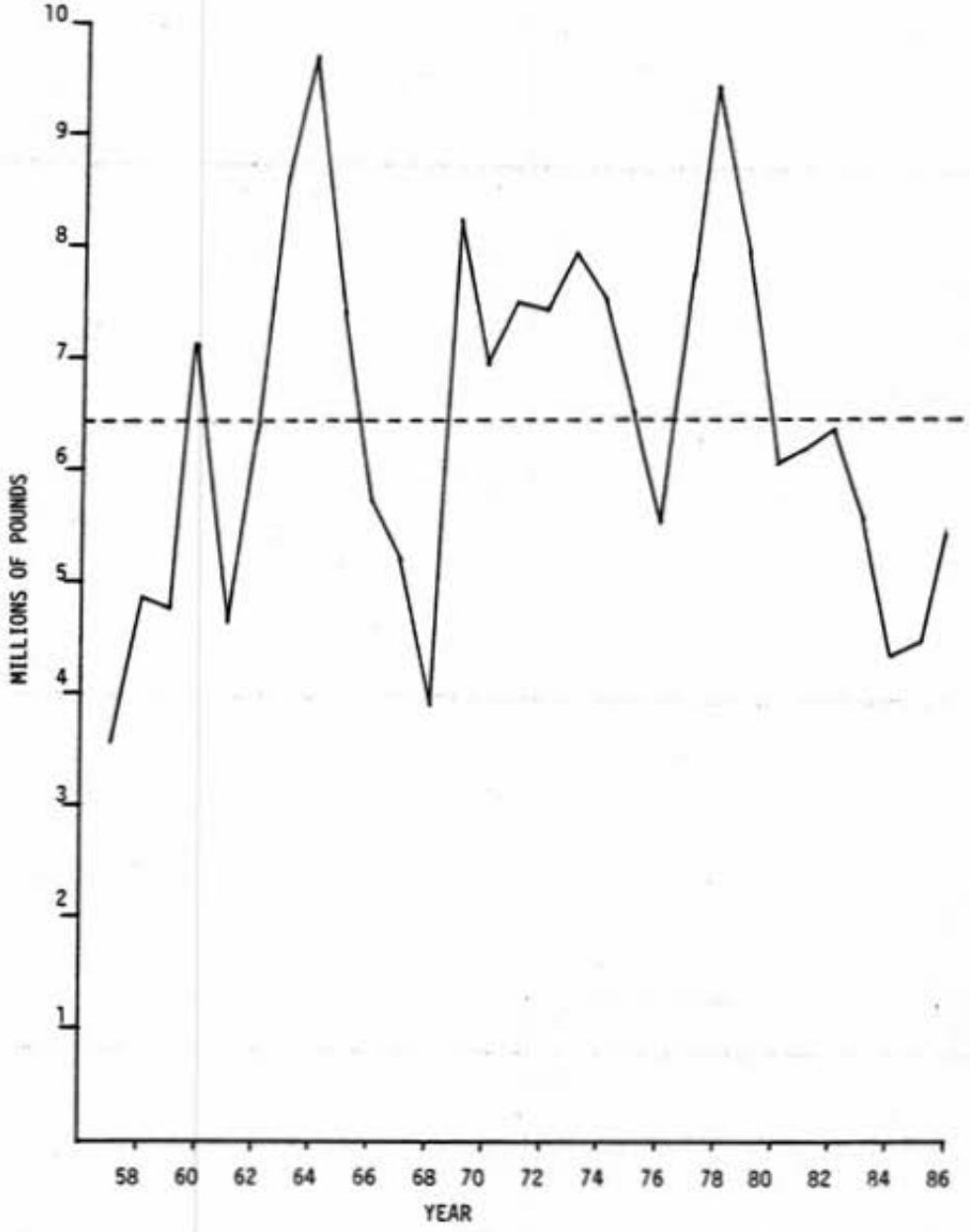

Fig. 1. Commercial landings of blue crab in South Carolina. The dotted line denotes the 30-year average.

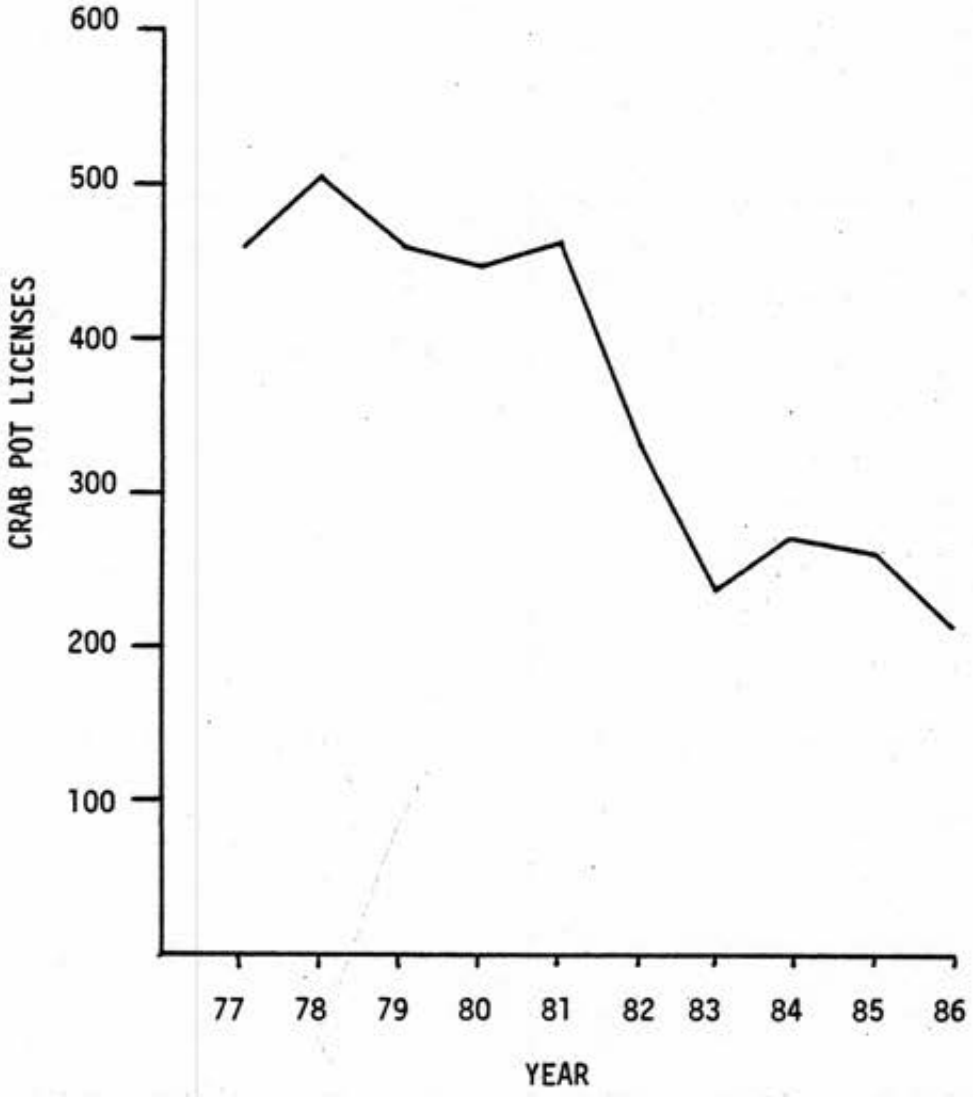

Fig. 2. Number of crab pot licenses issued in South Carolina, by fiscal year (e.g. 1977 is FY 1977-1978). The 1986 figure includes licenses issued to March 15, 1987.

females (Eldridge and Waltz 1977). Spent females may re-enter the estuary and develop a second egg mass which hatches in summer. The second peak of ovigerous females may be amplified by individuals that mated in spring and migrated to the lower estuary during summer (Rees 1963). A third spawning peak has not been reported for South Carolina.

The estimated number of eggs per spawning ranges from 7×10^5 to 2×10^6 (Churchill 1921; Graham and Beaven 1942; Pyle and Cronin 1950; Van Engel 1958). No data are available which relate fecundity to female weight or number of spawnings (Millikin and Williams 1984). Incubation lasts 12 to 17 days, depending on temperature (Churchill 1921). Hatching occurs near river mouths, inlets and nearshore where salinity is 23 to 33°/oo at temperatures of 19° to 29°C (Sandoz and Rogers 1944).

2. Differential Distribution of Larvae, Juveniles and Adults

Typical development of newly hatched larvae includes seven zoeal stages (Costlow et al. 1959), although a prezoeal stage (Truitt 1942, Davis 1965) and an eighth zoeal stage (Costlow and Bookhout 1959, Costlow 1965) have been described. Laboratory studies indicate duration of zoeal development through the seven stages ranged from 31 to 49 days at 25°C and 26°/oo (Costlow and Bookhout 1959). Optimal laboratory conditions for zoeal development were 30°/oo and 25°C (Costlow and Bookhout 1959; Sulkin and Epifanio 1975; Bookhout et al. 1976), with mortality highest during the first two stages.

Zoeal stages occur in surface oceanic waters of the southeastern U.S. Collections between Cape Hatteras, North Carolina and Jupiter Light, Florida indicated early stage zoeae were located nearshore, while later stages were found 32 to 64 km offshore (Nichols and Keney 1963).

Following the zoeal stage, a megalopal stage occurs which lasts from 6-20 days (Costlow and Bookhout 1959). Megalopae developed optimally in the laboratory at 30°/oo and 25°C with an average duration of 8.4 days (Costlow 1967). Although some debate remains concerning stage at ingress to estuaries, earlier studies concluded that ingress occurred at the juvenile stage (Tagatz 1968; Dudley and Judy 1971, 1973). Recent evidence suggests that invasion is by megalopae (King 1971; Williams 1971; Meredith 1982; McConaugha et al. 1983; Epifanio et al. 1984) and results from studies in the Santee (Olmi. 1986) and Ashley Rivers (D. Mense, 1987; College of Charleston, pers. comm.) suggest that ingress is primarily by megalopae. Sampling in the Santee system revealed that peak concentrations of portunid megalopae (probably C. sapidus) occurred in November (Olmi 1986). Mechanisms of larval transport and dispersal have not been defined in the South Atlantic Bight.

Metamorphosus to the juvenile "first crab" follows the megalopal stage. Juveniles (2.5 mm) grow rapidly and occur in lower salinity, shallow estuarine areas through late winter and summer. Megalopae ingress to shallow marsh habitats of the Charleston Harbor and Ashley River system in October and March, but greatest densities occur in late October (D. Mense, 1987, College of Charleston, pers. comm.).

In South Carolina, sexual maturity occurs about 22 months after hatching (Fischler and Walberg 1962). Females undergo the terminal molt and mate in lower salinity waters during August and September (Eldridge and Waltz 1977). Migration of inseminated females to high salinity spawning grounds then occurs, while the male crabs remain in low salinity waters during warmer months (Dudley and Judy 1971). There is also a peak in mating activity and spawning during April (Bishop 1983).

3. Growth and Morphometry

Growth during molting is affected by temperature, molting frequency, food availability, and life stage (Millikin and Williams 1984). Molt frequency and growth are affected by water temperature. In the laboratory, number of molts per unit of time increased rapidly with increasing temperatures from 13-27°C. The number necessary to attain a certain size also increased with increasing temperature (Leffler 1972). Low temperatures apparently prevent molting or increase the intervals between molts, thereby reducing growth rate. In South Carolina, growth is associated with the warmer seasons and is usually confined to months of March through October, although specific rates are unavailable.

Molt frequency is also size dependent, with the interval between molts increasing as crabs become larger. Sex, maturity, molt sign,

and carapace form affected width-weight relationships of blue crab from the Ashley River (Olmi and Bishop 1983), with males being heavier than similar-sized females. Olmi and Bishop (1983) hypothesized that the lighter weight of adult females compared to immature females was attributable to a pubertal molt transformation to a long-spined form. South Carolina crabs were heavier than those of the same sex and size from Galveston Bay (up to 170 mm), the St. Johns River, Fla.(up to 190 mm), and the Chesapeake Bay (all sizes). Length to width relationships have not been examined for South Carolina crab.

4. Migrations and Local Movements

Movement of larval blue crab has been studied in detail for the Middle Atlantic Bight, but no information is available on transport mechanisms in the South Atlantic Bight. Division personnel believe that estuarine ingress is associated with tidal transport, with the megalopae being in surface waters on flood tides.

Tagging studies in the South Atlantic Bight indicate that blue crab do not migrate appreciably between adjacent estuaries (Fischler and Walburg 1962; Judy and Dudley 1970). Movement within estuaries as it relates to phases of the life cycle was discussed in Section II.B.2. Environmental conditions also influence intraestuarine movement. During winter, blue crab move to deeper, warmer waters and return to the tidal creeks and salt marsh habitat when temperatures increase in spring (Livingston 1976; Subrahmanyam and Coultas 1980).

5. Parasites and Disease

Parasites common to crab populations in South Carolina include the microsporidian protozoan (Ameson), digenetic trematodes, a peritrichous ciliate (Lagenophrys callinectes), the acorn barnacle (Chelonibia patula), a marine leech (Myzobdella lugubris), and parasitic dinoflogellates (Hematodinium). Microsporidian (Ameson) infestations cause heavy mortalities; the weakened crabs usually die when stressed by high water temperatures or poor water quality (Overstreet 1975). Heavily infested individuals have sluggish movements and chalky, opaque tissue due to dissolution of the muscle fibers (Overstreet 1977, 1978).

Metacercariae of the digenetic trematode, Microphaelus basodactylophallus , invade the thoracic muscles, hepatopancreas, and ventral ganglia (Overstreet 1982), which results in weakened muscles in heavily infested individuals. The metacercariae become black when hyperparasitized by spores of a haplosporidian protozoan (Urosporidium crecens), a condition known as "pepper" or "buckshot" (Overstreet 1978). This is not harmful to humans, but poses problems for processors, who must either pick out the cysts or discard the meat (Perry et al. 1984).

The peritrichous ciliate, L. callinectes, has been reported on blue crabs from Maryland to South Carolina (Couch 1967). It adheres to the gill lamellae and can interfere with respiration, which may contribute to mortality in holding or shedding tanks (Couch 1966). This parasite may critically affect survival when dissolved oxygen is low and when the water temperature and density of crabs are high.

The acorn barnacle, C. patula, occurs on the carapace, although Eldridge and Waltz (1977) found that its incidence on blue crab in South Carolina was low. They hypothesized that the seasonal incidence was due to the molting schedule.

The leech, Myzobdella lugubris, occurs on blue crabs from low salinities and uses the carapace as a substrate for its cocoons (Daniels and Sawyer 1975). Crabs from the Ashley River had cocoons on the dorsal and ventral carapaces from March to November (Millikin and Williams 1984).

Diseases that have been reported in blue crab in South Carolina include bacterial infections, fungal infections, and paramoebiasis. Microbial infections include the nonfatal bacteria Vibrio, Pseudomonas, and Beneckea, responsible for shell disease and the pathogenic species of Vibrio. Shell disease is characterized by lesions or softened, darkened areas on the exoskeleton. This contagious condition seldom perforates the cuticle, but can lead to secondary infection of soft tissues by pathogenic bacteria and fungi (Rosen 1967; Cook and Lofton 1973).

Shell disease permits invasion by virulent bacteria, e.g. Vibrio parahaemolyticus. This bacterium, fatal to the crab, can cause intestinal disorders in humans (Overstreet 1978). Vibrio cholerae, which causes cholera in humans, also occurs in blue crab but normal

preparation renders carrier crabs safe for consumption (Moody 1982).

The marine fungus, Lagenidium callinectes, causes mortality of crab eggs and larvae (Sindermann 1977). Incidence of infection may be as high as 95% of ovigerous females (Bland and Amerson 1974).

Blue crab with "gray crab" disease (paramoebiasis) are characterized by lethargy, grayish appendages and ventral body surface, and hemolymph with amoeboid cells (Sprague and Beckett (1966). During advanced stages of the disease, the hepatopancreas, gonad, muscle, gills and blood are heavily infected (Couch and Martin 1982). This disease, which occurs only in salinities >25o/oo (Sawyer et al. 1970), has been a periodic problem in South Carolina. Major outbreaks occurred during the mid-1960's and there was a significant incidence in 1984 in Georgia and the southern part of South Carolina.

6. Natural Mortality

Survival is affected by disease, hydrographic conditions, pollutants, food availability, and predation. Very little documented evidence of specific impacts is available.

Mass mortalities of blue crab occurred throughout the southeastern United States during 1966- 1967 with "gray-crab" disease (Paramoeba pernicosa) the suspected cause, although pesticides may also have been implicated (Mahood et al. 1970, Sprague and Beckett 1966).

Millikin and Williams (1984) noted that lack of food would primarily affect the larval stages. The larger juveniles and adult blue crab will eat practically any organic material, so food availability is unlikely a problem for these stages.

Published studies from other coastal states have shown that blue crab populations decline in association with drought conditions and increase after the droughts have passed. Juvenile and mature males prefer areas of intermediate or low salinity and, during years of low rainfall and river discharge, these areas are reduced in extent. Georgia personnel have recently linked a trend in annual catch per landing there to river discharge rates during the juvenile stage. Reductions in adult crab populations are most probably due to reduced rainfall during critical periods of juvenile development. Molting crabs absorb more water and increase to a larger size in lower salinities. Survival may be enhanced in low salinity waters due to the scarcity of predators, e.g. drums, rays, sharks, etc., most of which prefer higher salinities.

C. Ecological Relationships

1. Habitat and Substrate

The blue crab inhabits most estuarine areas during its life cycle. Juveniles are more abundant in soft-bottomed, vegetated areas than in adjacent unvegetated areas in Chesapeake Bay (Heck and Orth 1980; Penny 1982; Heck and Thoman 1984). Weinstein (1979) found that shallow salt marshes in North Carolina were important nurseries, while current research in South Carolina (D. Mense, College of Charleston, unpublished data) also indicates that shallow marsh habitat is an important nursery area.

The optimum sediment for small crabs is detritus, mud, or mud-shell bottom (Adkins 1972). Evink (1976) found abundance to be greatest on mud bottom. Larger crabs occur over a variety of bottom types but are generally in deeper portions of the estuaries than are the juveniles.

2. Trophic Relationships

Zoeae were reported by Darnell (1959) and Tagatz (1968) to consume phytoplankton, but Costlow and Bookhout (1959) demonstrated that molting was unsuccessful in first stage zoeae that had been fed unicellular algae. Millikin and Williams (1984) concluded that zooplankton are principal prey for blue crab larvae.

Juvenile and adult crabs feed primarily on molluscs, crustaceans, and fish (Darnell 1958), although the importance of prey items changes with size. Laughlin (1982) found that individuals < 31 mm carapace width fed on bivalves, detritus, ostracods, and plant matter. Crabs in the 31 - 60 mm size range preyed mainly on fishes, gastropods, and xanthid crabs, while larger crabs ate bivalves, fishes, xanthid crabs and other blue crabs. Other studies (Jaworski 1972) found that crustaceans and molluscs were equally important to the mid-size crabs, while the large animals consumed mostly molluscs.

Blue crab larvae are probably preyed upon by coelenterates, larval fish (Van Engel 1958), and adult herrings and menhaden (Millikin and Williams 1984). Important fish

predators of adult crab include Atlantic croaker (Micropogonias undulatas), red drum (Sciaenops ocellata), and American eel (Anguilla rostrata) (Jaworski 1972, Overstreet and Heard 1978 a,b). In the Wando River, oyster toadfish (Opsanus tau), white catfish (Ictalurus catus) and American eels were predators of soft shell blue crab (J. Bishop, SCWMRD, pers. comm.). Predator birds include the clapper rail (Rallus longirostrisus) (Bateman 1965), great blue heron (Ardea herodius) (Day et al. 1973), and diving ducks (Stieglitz 1966).

D. Abundance and Present Condition

1. Factors Affecting Abundance

Fluctuations in the annual population of blue crab are caused by numerous factors, including those described under Natural Mortality (Section II.B.6). Changing environmental conditions are particularly important to the larval and juvenile stages. Recent evidence suggests that inner continental shelf circulation and wind direction are important factors determining ingress of larvae to estuaries in the Middle Atlantic Bight (Boicourt 1982). Movement of megalopae from the offshore larval development areas into the estuaries of the southeastern United States is facilitated by depth regulatory movements of the larvae (Sulkin and Van Heukelem 1982) and circulation/advection patterns (Boicourt 1982).

Once ingress has occurred, hydrographic conditions in the nursery area and habitat availability are major factors affecting abundance. Temperature and salinity are important determinants in Chesapeake Bay (Van Engel 1982) and Gulf coast estuaries (Hoese 1960; More 1969). In South Carolina, data collected by the Crustacean Management Section suggest that declining commercial landings in the southern district are related to reduced river discharge there and recent drought conditions (D. Whitaker, SCWMRD, pers. comm.).

2. Population Structure

Eldridge and Waltz (1977) reported that pot landings in South Carolina averaged 72% male and 24% female crabs, while mature females comprised 84% of the landed catch by shrimp trawlers. The predominance of females in trawl catches results from their congregation in more saline areas, where trawling occurs. Lunz (1951) reported that males were overwhelmingly dominant in experimental trawl catches in South Carolina creeks. Studies elsewhere have indicated that males are most abundant in lower salinity areas, such as the more inland portions of tidal waters, and females are more dominant in higher salinity areas, such as the lower rivers and sounds (Palmer 1974, Tagatz 1968).

Female crabs have long carapace spines (Olmi and Bishop 1983), thus their average carapace width is larger than that of males in both the pot and trawl catches in South Carolina (Eldridge and Waltz 1977). The average weight of the males is greater. Approximately 85% of the immature female crabs taken in commercial pot catches in South Carolina were below the minimum legal size (5 in. or 127 mm) (Eldridge and Waltz 1977). Mean carapace width of males was 135-138 mm, while that of females was 148-154 mm.

3. Effects of Environmental Alterations

Because blue crabs occupy much of an estuary at some part of their life cycle, alteration of the estuarine habitat could cumulatively affect their distribution and abundance. Recent data indicate that larval and early stage crab are abundant in shallow subtidal areas along salinity gradients (D. Mense, 1987, College of Charleston, pers. comm.) and are therefore vulnerable to marsh filling. Another recent study indicated that coastal impoundments retain mature females, thus preventing them from migrating to higher salinity areas to spawn (E. Wenner, unpublished data). It is unlikely that enough crabs are so affected as to have any impact on the spawning population and subsequent recruitment.

III. Description of the South Carolina Fishery

A. Laws, Regulations, and Management Policies

Applicable measures in other blue crab-producing states are summarized in Table 1.

1. Protection of Female Crab

It is unlawful to catch, hold, or possess any female crab bearing visible eggs or a female from which the egg pouch has been removed. This does not apply to "sponge" crabs imported from other states, where the taking and possession of such crabs is lawful. An invoice from a licensed harvester or a certificate from the appropriate agency of the state of origin must accompany legally imported "sponge" crabs.

Table 1. Summary of regulations pertaining to harvest and sale of blue crab in the Gulf of Mexico and Atlantic blue crab producing states. Regulations may have been changed by recent legislative/administrative action in some states.

	Alabama	Florida	Louisiana	Mississippi	Texas
Licenses and Fees:					
Wholesale dealer					
Resident	$50 for packers, canners, processors	$100	$50	} $100	} Truck $125
Nonresident	$100	$150/$500(alien)	$150	}	} Business $250
Retail dealer					
Resident		$10	$5		
Nonresident		$25/$50(alien)	$50		
Commercial Fisherman					
Resident			$25 crab pot		} $10
Nonresident		$25	$500 crab pot		}
Vessel			$1,000 nonresident	$2	$6
Recreational			$2		$5
Minimum Sizes:					
Hard crabs	4" commercial	5"; 10% allowance for undersized	5"	None	5"; 5% allowance for undersized
Soft-shell	None	Special permit	4.5"	None	4.5"; 5% allowance
Peelers	None	Special permit	None	None	4" (except in Galveston County
Bait crabs	None	Special permit	None	None	None
Protection of Females:	None	No sale of sponge crabs	No sale or possession of sponge crabs	No possession of sponge crabs south of Intracoastal Waterway	No taking of sponge crabs from coastal waters
Gear Restrictions:					
Pots	None	Bouys with ID	Buoys, ID in L. Ponchartrain	ID	Buoys with ID Various county restrictions
Trawls	None	None	Illegal; can be bycatch from shrimp trawls	OK if boat has crab license	5" minimum stretch mesh
Limits	None	None	None	None	300 pots per fisherman
Restrictions on Methods:	None	Cannot pull traps at night or without permission from owner	Cannot molest gear or remove crabs from pots Cannot set gear in channels or stream mouths	None	Cannot set pots in net-free zone or within 200 ft of marked channel (Aransas County)
Possession Limits:					
Commercial	None	None	None	None	None
Recreational	None	None	None	None	None

	Maryland	Virginia	North Carolina	Georgia
Licenses and Fees:	Noncomml. resident $10 Noncomml. nonresident $20 Up to 50 pots, scrapes, etc. $50 More than 50 pots $150 Unlimited gear $175	Purchaser business license $25 Vessel or vehicle $15 Pot boat operator $15 Pot boat operator and assistants $25 Dredge, scrape boat $30 Trotlines $15.75 Pounds $3 each Hand scrape $8.25	Vessels under 18'; $1 per ft 18'-38'; $1.50/ft over 38'; $3/ft Nonresident $200 Unprocessed dealer $50 Processor $100	Comml. boat operator Resident $10 Nonresident $100.25 Comml. trawler ≤ 18'; $50 over 18'; $50 plus $3/ft over 18' Other comml. boats ≤ 18'; $5 over 18'; $5 plus $0.50/ft over 18' Soft-shell dealer $10
Minimum Sizes:				
Hard crabs	5"; undersized allowance of 10/bu. or 25/bbl.	5"; 10% undersized allowance Can take mature females of any size	5"; 10% undersized allowance by weight Can take mature females of any size	5"; can take mature females of any size
Soft-shell	3.5"	None	None	3"
Peelers	3"	None	None	3"
Protection of Females:	None	Unlawful to take crabs within a designated area from May 15-September 15 (near mouth of Ches. Bay)	No comml. crabbing during April 1-August 31 in designated areas of Oregon, Hatteras, Ocracoke, Drum, and Barden Inlets	None
Gear Restrictions:				
Pots	Buoys with ID Must be no more than 24" on sides with minimum 1" mesh	Must have ID	None	Buoys and boats must have ID
Trawls, dredges, or scrapes	Dredges and scrapes must conform to structural specifications; no more than 2 per boat	None	Dredges cannot weigh over 100 lbs. Trawls must have 3" minimum mesh (2" for peelers). Peeler trawls must be no more than 25' cork-line length (except in Dare and Currituck Counties)	Trawls must have 4" minimum mesh
Pounds	Must conform to structural specifications	None	None	None
Restrictions on Methods:				
Pots	From May 1-September 30, may not be set within 200 yds of public bathing area. Cannot be set in less than 4' of water at low tide (some area exceptions). Cannot be set within 100 ft of navigation aid or within 100 ft of the channel in St. Catherine Sd. Some closed areas.	Cannot be pulled on Sunday or at night. Cannot be placed in officially marked channels.	Cannot be set in marked channels.	Cannot be set in marked stream channels. Cannot be tampered with.
Trawls, dredges, or scrapes	Cannot be used from October 31-April 14. Hand-drawn scrapes can be used only in Queen Anne's and Kent Counties.	Dredges and scrapes cannot be used from April 1-December 1. Not allowed in any rivers, creeks, or inlets except on ocean side of Accomack and Northampton Counties. Cannot be used on Sunday or at night.	Dredges and scrapes cannot be used from March 2-December 31. Some closed areas. Trawls can't be used on Sunday except in the ocean.	Trawls may be used in sounds during January-March if Commissioner opens season.
Pounds	Can be fished only in designated areas.	Must be removed by December 1. Cannot be placed in marked channels or within 100 yds of another pound.	None	None
Trotlines	Cannot be set within 50 ft of another trotline.			
General		Crabs cannot be taken on Sunday or at night.		Illegal to harvest commercially within 100 ft of a property line or dock.
Possession Limits:				
Commercial	None	Can be set by Commission.	None	None
Recreational	1 bu. per person per day or 2 bu. per boat.	1 bu. per person per day.	None	None

2. Minimum Size

It is unlawful to catch, destroy, hold, or possess any blue crab, or allied species, smaller than 5.0 in. across the shell (carapace) from tip to tip. This does not apply to peeler crabs. It is lawful for licensed processors to import blue crab of less than the minimum size from other states, provided that a permit is obtained by the importer from the Marine Resources Division and an invoice or certificate of origin accompanies each shipment.

3. Restrictions on Fishing Methods

a. Crab Trawling

It is unlawful to have onboard any boat trawling for crab a net having a mesh size of less than 4.0 in. (stretch mesh). Chafing gear of any sort shall be confined to not more than one half of the circumference of the tailbag.

It is lawful to trawl for crabs in legal offshore areas, sounds, and bays during December, January, February, and March. (It is unlawful to trawl for crabs in Beaufort County on December 1). A minimum mesh size of 4.0 in. is required if the shrimp trawling season is closed. The Commission may regulate seasons and areas for crab trawling as considered appropriate. (A joint resolution of the General Assembly closed the sounds and Bull Bay to all trawling during 1986 and 1987.)

Trawling is unlawful within one-quarter mile of Hilton Head Island from May 15 through September 30, although shrimp trawling is lawful within one-quarter mile of Hilton Head after September 15. It is unlawful to trawl for crabs within one-half mile of Horry County. It is unlawful to trawl within one-half mile of any fishing pier extending into the ocean, except for Hilton Head Island.

Shrimp trawlers may retain and market crabs taken incidentally during June 1-November 30.

Boats licensed to trawl for crabs shall display registration numbers on both sides of the vessel.

b. Crab Potting

It is lawful to pot blue crabs year-round. Every crab pot, float, or buoy shall be marked with a number issued by the Division. No pots may be placed within 100 yards of a public boat ramp. No pots may be set so as to be left dry at low water. No glass bottles, jugs, or metal cans may be used as floats. No crab pot shall be abandoned or left unattended for more than five days. (Crab pots in violation of the above regulations shall be confiscated.)

It is unlawful to set crab pots at any time, except for personal use, within Chechessee Creek or within Pawley's Island Creek and Midway Creek on Pawley's Island between May 1 and October 1.

c. Peeler Crab Requirements

A "peeler" crab is identified as a blue crab having a new, soft shell fully developed under the hard shell and having a defined white, pink, or red line or rim on the outer edge of the dactyl of the fifth leg. A "soft-shell" crab is defined as a blue crab that has recently shed its hard shell. A person engaged in shedding or transporting peeler crabs for the purpose of producing soft-shell crabs shall be required to have a valid permit or identification card issued by the Division. The Department shall have authority to inspect the business premises of any person engaged in shedding peeler crabs. On each permit, the Division may specify: 1) the area from which peelers may be caught by gear other than crab pots, 2) the types of gear which may be used, 3) catch reporting requirements, 4) boat identification requirements, and 5) any other requirements it may deem necessary.

d. Crabbing for Personal Use

All potting restrictions given above apply to recreational crabbing, unless otherwise stated. No licenses are required for use of handlines, dip nets, drop nets, or two or less crab pots per person. Crab pot floats must be identified with the fisherman's name.

e. Licenses and Fees

The following is a list of current license fees required by the state of South Carolina:

1) Commercial fisherman (vessel captain)- $5
2) Crab pots- $10
3) Trawl vessel - Resident $75/Nonresident $300 (must be applied for between January 1 and February 1)
4) Crab boat (other than trawl)- 18 ft. and under $20 larger $25
5) Wholesale dealer- $50
6) Fisherman's land and sell- $25
7) Soft shell crab operator- $75

B. Hard Crab Fishery

1. History of Exploitation

Prior to 1950, baited trotlines were the principal gear used to capture blue crab in South Carolina. Until the early 1960's, most of the annual catch was taken by trotline.

Crab pots were first used here by commercial fisherman in 1957 and replaced trotlines as the principal gear after 1959. The number of fishermen using pots increased annually to 231 in 1965. From 1965 through 1968, the number of pot fishermen declined to 124. This decrease was apparently in response to mass crab mortalities caused by disease. Crab pot licenses increased during the 1970's and the vast majority of the commercial catch is now taken in pots.

Trawling for blue crab has remained at relatively low levels since first allowed in the 1950's. Boats that have historically participated in the winter trawl fishery have been relatively large, double-rigged shrimp trawlers. The shrimp season has typically been closed in sounds and bays in early to mid-December. The beaches to 3 miles offshore have been closed around December 31. Following closure, some shrimpers have switched to larger-mesh crab trawls, although there have usually been less than ten boats trawling for crabs at any given time during the winter. Most trawling takes place in the southern district, although some occurs near Charleston.

The sounds (St. Helena, Port Royal, and Calibogue) have been popular crab trawling areas. Crab trawling does not require a special permit (other than a trawl license), so it is difficult to measure trawling effort directed at blue crab. It appears that more boats have engaged in crab trawling in years of economic hardship, such as those following seasons when white shrimp landings were very low. Crab trawling is not very profitable relative to most other trawl fisheries in South Carolina.

2. Gear and Watercraft

a. Trawling

Crab trawlers have the same characteristics as the larger boats used in shrimp trawling (McKenzie 1981). Most vessels are greater than 50 ft and tow nets that usually exceed 50 ft in footrope length. All boats appear to employ the legal minimum 4.0-in. mesh and most fishermen use chafing gear. Tickler chains are commonly used and may be heavier than those used with shrimp trawls. Footropes of crab trawls carry more chain than do those of shrimp nets, although the trawls are fished in the same manner. Crabs are packed in baskets. Most of the fishing is done very close to shore, permitting day trips.

b. Potting

Crab pot boats are typically under 20 ft and most are open boats with side-mounted steering. Engine size varies, but typically is 70-100 hp. Some boats are equipped with hydraulic pot haulers, but most fishermen pull their gear by hand. The crew ranges from one person on the smaller boats to two or three on the few 20 to 30 ft vessels that operate in the state.

Crab pots are generally set in a continuous line parallel to shore. Fishing depth varies from a few to 40-50 ft, depending on location and season, but most pots are set along channel edges in less than 25 ft. Distances between pots vary between 30 and 60 yds, depending on location and operator. Crabbers may fish as many as 200 pots, but 50-100 are more common (Bishop 1983). Pots are baited and checked daily, usually in the morning. Fishing during the early daylight hours is particularly advantageous during the warmer months, when mid-day heat can cause crab mortality. When catches are good, pots may be worked twice daily (Rhodes 1974). Prior to rediversion of the Santee River, crabbers fishing the Cooper

River would pull gear daily, but only during slack water, because the high-velocity tidal current would submerge the floats. The preferred bait is menhaden, although any fish may be used. Experienced fishermen prefer fresh menhaden and will often discard bait after a one-day soak.

Commercial harvesting is primarily confined to creeks, rivers, bays, and sounds and may extend inland greater than 10 miles, depending on the estuarine system. Most fishermen target the more valuable, large males ("jimmies"), which are most abundant in the upper reaches of the estuaries.

Most commercial fishermen use the standard 24 x 24 x 24 in. wire pot, described by Andrews (1947), Cronin (1949), and Van Engel (1962). The pots are constructed of 1.5 in. hexagonal mesh wire. Some crabbers use galvanized wire pots, which have one or two zinc anodes attached in the lower corner(s). The use of vinyl-coated wire has become more popular in recent years and now dominates the fishery. The pots used in South Carolina have two compartments - an upper and lower separated by the "apron", which is a wire partition with two funnels leading upward. Commercial fishermen use pots with either two or four entrance funnels. Some prefer the two-funnel pot (Fig. 3) in warm weather, when crabs are more active, to reduce escapement. The four-funnel models are preferred in colder weather, although each type may be used at any time during the year. South Carolina pots have "irons", reinforcement bar bent into 24 x 24 in. square frames, to prevent them from rolling in currents.

Installation of escape rings can make pots self-culling for sublegal crab (Whitaker 1978, 1980; Eldridge et al. 1979). The optimal size of the escape ring is about 2.5 in. for most areas, with three rings installed in each pot (two in the upper chamber and one in the lower chamber), although two rings are also effective. Such pots were found to release more than 80% of the sublegal crabs, while retaining legal crabs, and there was some indication that legal crab catches could actually be increased. Whitaker (1980) speculated that crab pots may reach saturation, regardless of crab size. A pot that allows small crabs to escape would be slower to reach saturation, but the catch would be composed mostly of legal crabs. This phenomenon has also been noted in North Carolina (M. Bridges, pers. comm.). The 2.5 in. escape rings allow many legal "sooks" to escape and crabbers targeting them should use slightly smaller escape rings.

Escape rings may allow peeler crabs to escape. Any peelers that would be feeding, however, would be white sign peelers, which are considered of poor quality because they require holding for 7-14 days before molting (Christian et al 1987). Pink sign (3-6 days) and red sign (1-3 days) peelers would probably not be lost, because these nonfeeding crabs would only enter a pot by being cradle-carried by a male. The male does not usually release a female peeler when captured in a pot.

Each crab pot is buoyed: braided nylon is easier to hand-pull and works better in mechanical haulers than does polypropylene line. Buoys range from hard plastic floats designed for the purpose to jugs used for milk, bleach, etc. Some crabbers use two floats to a line to facilitate pick-up.

3. Landings

Landings increased steadily from 1957 to a peak in 1964 (see Fig. 1), then declined until 1968. This decline was thought to have been disease-related (See Section II.B.5, Parasites and Disease). Landings rebounded in 1969, then remained relatively stable until 1975. They dropped in 1975-1976, then increased to a modern record in 1979. Since then, annual catches have consistently been below the long-term average. Years of very low production have occurred rather regularly at 6 or 7-year intervals.

South Carolina commercial landings have been below those in both North Carolina and Georgia (Fig. 4). North Carolina annual landings

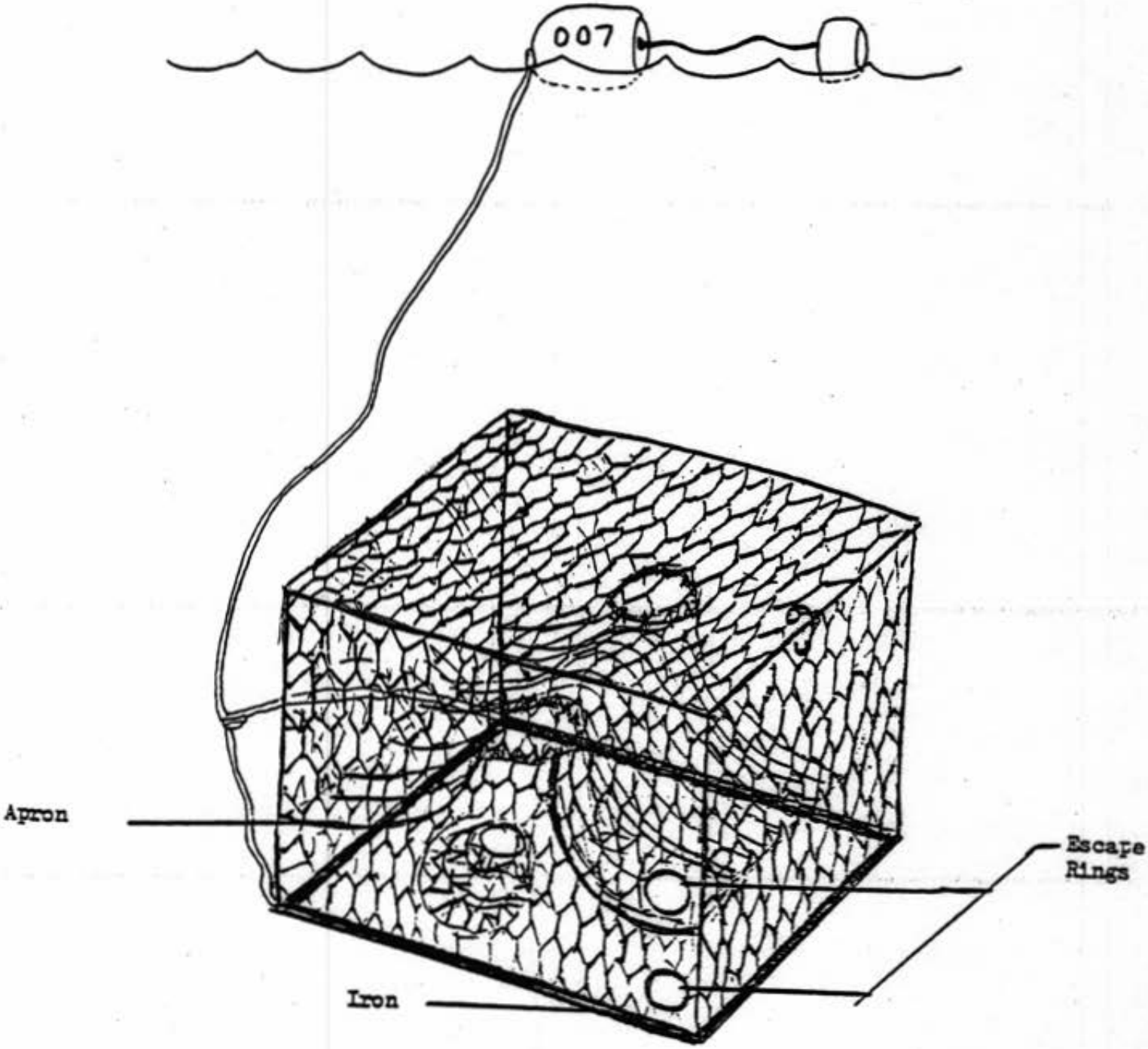

Fig. 3. Two-funnel wire crab pot typically used by South Carolina commercial crabbers, with optional escape rings.

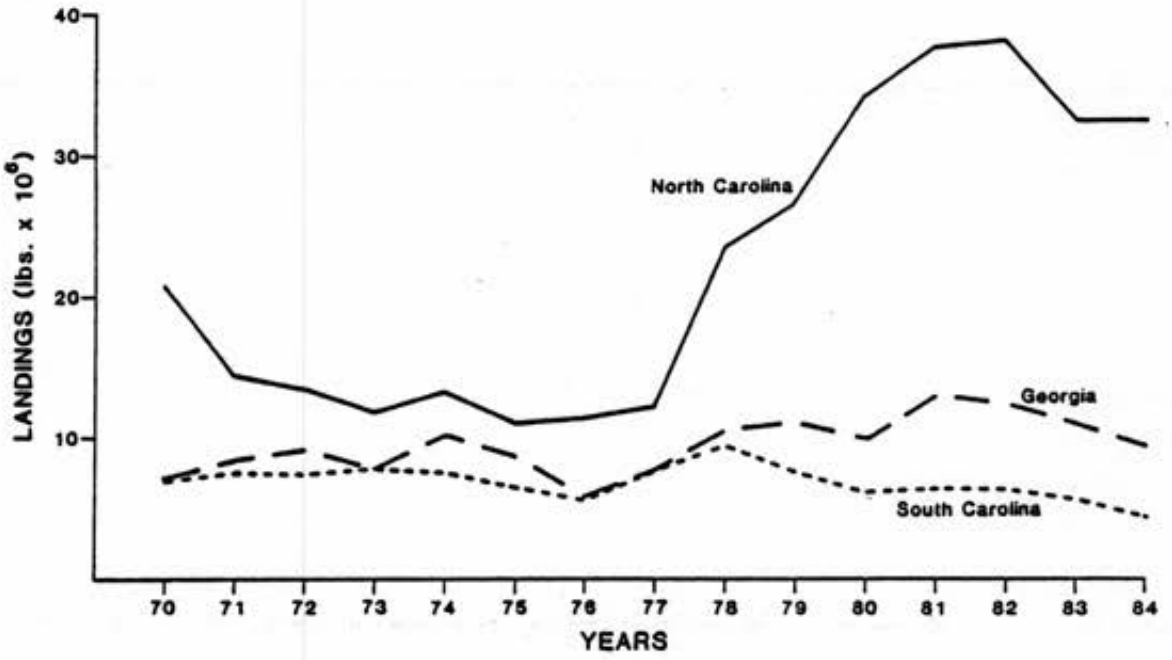

Fig. 4. Reported annual landings of blue crab in North Carolina, South Carolina, and Georgia.

from 1971 to 1977 were below 15 million pounds. After 1977, reported landings rose substantially and have exceeded 30 million pounds since 1980. This increase has been largely attributed to improved landings data from expanded port sampling efforts (S. McKenna, NCDNRCD, pers. comm.), rather than actual growth of the fishery. Georgia landings were comparable to South Carolina's until 1977, but have hovered near 10 million pounds in recent years. Georgia's increased production may be related to substantially increased effort since 1977. The number of pots in Georgia increased from 9,745 in 1976 to 23,970 in 1978. This may have resulted from closure of Georgia sounds to shrimp trawling, which increased the effective crabbing area during the fall.

In South Carolina, monthly landings increase gradually through the year, reaching a peak in October (Fig. 5). A slight decline in April probably reflects the appearance of "sponge" crabs. These must be released and their presence causes some fisherman to stop crabbing until the "run" ends. Landings drop quickly in December as water temperatures decline.

About 70-75% of South Carolina's recorded landings come from Beaufort County and 20-25% from Charleston County (Fig. 6). The relative contribution by county has remained very stable. This suggests that the underlying cause of decreased landings is widespread.

Commercial landings in South Carolina (as well as in other southeastern states) are an underestimate of the actual amount of blue crab marketed. Many, particularly the large males, are transported out-of-state in the "basket trade." This market is most attractive during late fall, winter, and early spring. Low catch rates then in northern states produce a strong demand and high prices for southern crab.

There is no way to readily determine how many crab pots are fished, when they are fished, or where. Numerous factors affect participation and fishing effort. Reduced catch rates probably cause fisherman to exit the fishery, as in 1968. Marketing conditions also impact landings, although the overall effect is difficult to evaluate. Prices during summer are generally low. Increased supplies from the Middle Atlantic area lower the demand for southern crab, which also experiences high shipping mortality in warm weather. Thus, the short-range influence of market factors on the level of participation and effort (and production) can be considerable, but is hard to quantify over the course of one year or several.

The trend in overall production has rather closely followed that in the number of pot licenses issued annually since 1979. Although the number of licenses sold may be a poor proxy for the amount of fishing effort, it does suggest that there is some relationship between annual production, annual participation, and the total amount of effort.

4. Sex and Size Composition

Landings data are not very useful for evaluating sex and size composition. Although some dealers report landings by grade, many report their volume as ungraded crabs, which includes a mix of both sexes and all sizes. When crabs are graded, "number ones" consist of the larger (>5.5 in.) males, "number twos" are smaller males and the larger females, and "number threes" are the smaller females. In 1986, 77.0% of the landings were reported as ungraded, 13.3% as "number ones," 2.6% as "number twos," and 6.7% as "number threes."

5. Bycatch

In a study of abandoned ("ghost") pots, Whitaker and Farmer (1979) recorded 17 incidentally caught species. The most common were stone crabs (Menippe mercenaria), hermit crabs (Pagurus and Clibanarius spp.), spadefish (Chaetodipterus faber), sea catfish (Arius felis), and toadfish (Opsanus tau). The most valuable of these in the commercial pot fishery bycatch is the stone crab, although the quantity of claws landed is small. Other species included: pinfish (Lagodon rhomboides), diamondback terrapin (Malaclemys terrapin), black seabass (Centropristis striata), pigfish (Orthopristis chrysoptera), sheepshead (Archosargus probatacephalus), bluefish (Pomatomas saltatrix), striped burrfish (Chilomycterus schoepfi), hogchoker (Trinectes maculatus), croaker (Micropogonius undulatus), spot (Leiostomus xanthurus) and stingray (Dasyatis) sabina). Bishop (1983) reported that diamondback terrapins were frequently caught and one "ghost" pot was recovered with 28 in it. It has also been reported that Octopus vulgaris is infrequently taken (J. Gault, pers. comm.).

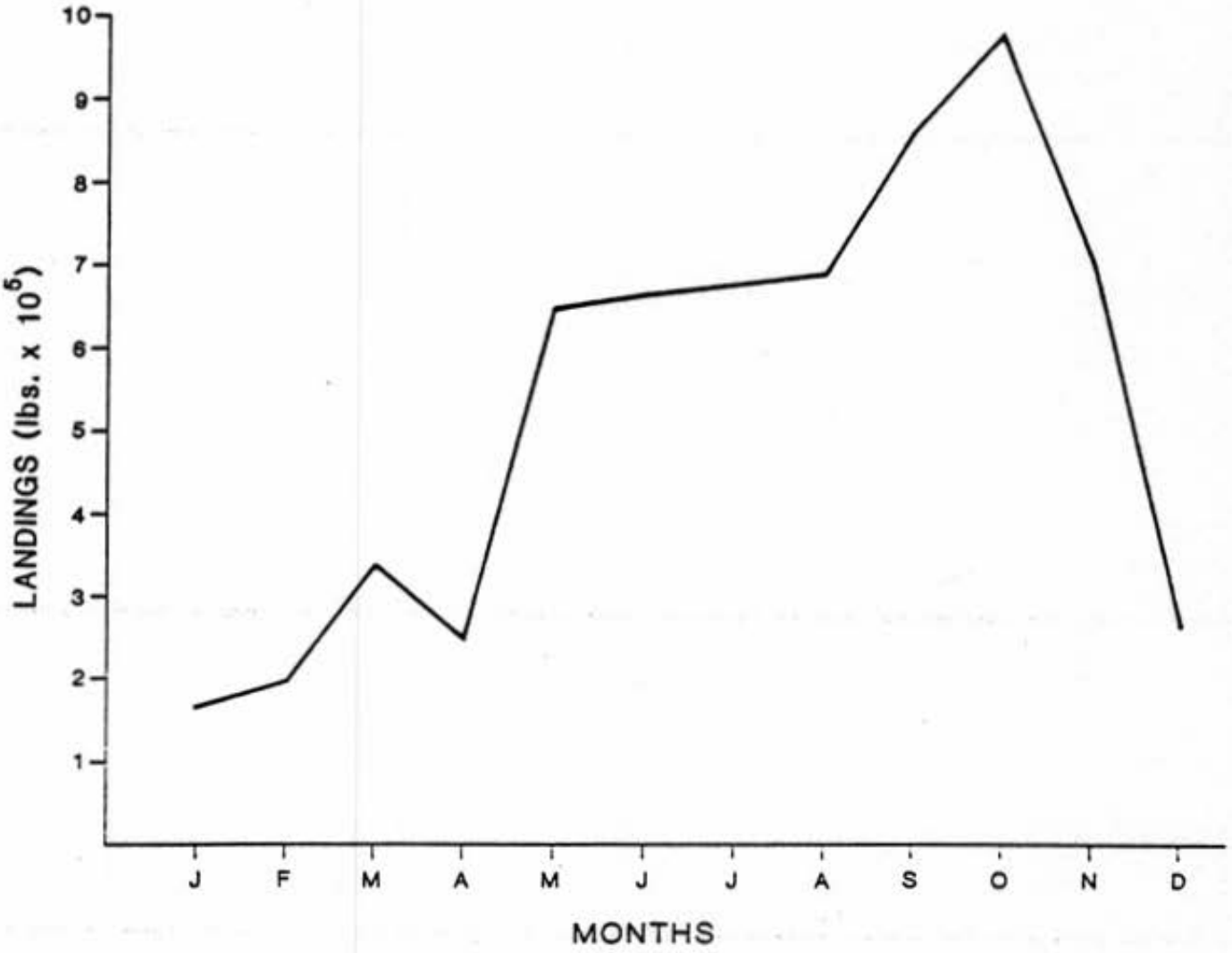

Fig. 5. Average monthly landings of blue crab in South Carolina.

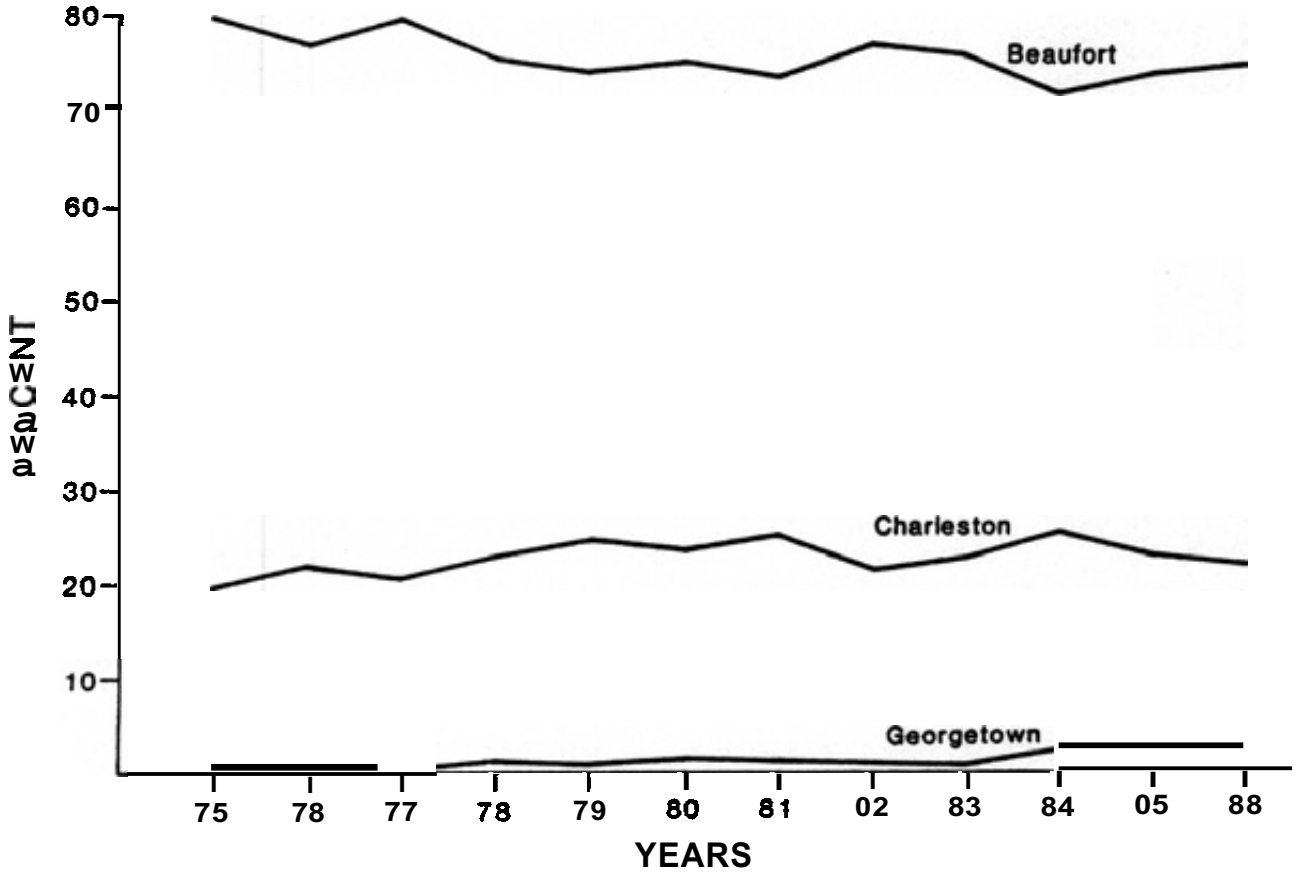

Fig. 6. Reported annual landings of blue crab by county in South Carolina.

C. Soft Crab Fishery

1. History of Development

Little information exists on South Carolina's early soft crab fishery. In 1936, over 9,000 pounds were produced, but production was less than 500 pounds in 1957. Between then and 1978, no soft crabs were produced. The reason for this is not known, but it could reflect the replacement of trotlines with crab pots (Bishop et al. 1979). Trotlines required handling and close inspection of each crab, thus pubertal molt females ("sallies") could be reserved for shedding operations. Potting does not allow easy inspection of individuals and also increases the potential for injury to peeler crabs.

In 1979, at least four pilot operations began and there has been a steady, but relatively small scale, soft shell fishery since then. Most operations have concentrated on the large spring run of "sallies."

2. Harvesting Techniques and Gear

Since 1979, most of the peeler crabs harvested in South Carolina have been "sallies" that were carried into crab pots by feeding males. Recently, a few crabbers have evaluated the usefulness of peeler pots, which are very effective during the spring runs in Chesapeake Bay and North Carolina (Cupka and Van Engel 1979). Peeler pots are unbaited pots made of 1.0-in. mesh vinyl-coated wire. Each has one or more large, "rusty" males confined in small compartments to lure females into the pot. Bishop et al. (1979) found that these pots were very effective here, particularly during spring.

"Habitat" pots also could be useful here (Bishop et al. 1984). These pots have the potential for capturing both male and female peelers, which are seeking shelter during the molt. The most productive areas produced about 1.2 crabs per pot per day. Employment of this gear would require many pots, but would extend the season for peelers through much of the year.

Other gears, such as bush lines and crab pounds described by Perry et al. (1982a) were ineffective here, because of the relatively large tidal range (Bishop et al. 1979). Trawls and crab scrapes have also been tried, but with little success.

3. Shedding Techniques and Facilities

Shedding facilities have been located adjacent to clean, estuarine water and open-flow water systems have been employed. These operations have used shedding tanks similar to those used in Chesapeake Bay (Whitaker et al. 1987). These tanks are about 4 x 8 ft and 9-10 in. deep. Water depth is usually just enough to cover the crabs. Most tanks are elevated, fenced-in to exclude predators, and shaded to prevent overheating. They are usually worked day and night during the primary shedding season.

4. Landings

During 1979-1985, annual soft crab landings remained less than 10,000 pounds. In 1986, nearly 60,000 pounds were produced. It is anticipated that growing interest in soft crab production and experimentation with different gears for harvesting peelers will contribute to a steady rise in landings.

D. Recreational Fishery

1. Gear and Methods

The most basic method requires a length of cord attached to a piece of bait and a dip net. The bait is lowered to the bottom and periodically retrieved slowly. Crabs hang onto the bait and can be dip-netted as they near the surface. This technique is widely employed from banks, docks, bridges, piers, and boats.

Drop nets (ring nets) and collapsible traps are also commonly employed. Bait is placed in the center of the gear and it is lowered to the bottom. The gear is then periodically raised and the crabs removed. This equipment is most often deployed from bridges, docks, and piers.

The other popular gear is the standard commercial crab trap, described in Section III.B.2. Recently, a "sport" trap, which lacks an "apron" and is only about 12 in. high, has been marketed locally. Pots are usually fished from boats or private docks. Boat fisherman will often set out their pots at the beginning of a fishing trip and retrieve them at the end of their trip. Up to two pots may be fished per head of household without a license; additional gear must be licensed like commercial gear, even if used only for personal use. Other restrictions applicable to commercial pots are also in effect for pots used for recreational crabbing.

There is no catch limit for recreationally-caught crabs, but the minimum size limit and prohibition on taking or possession of "sponge" crabs apply.

2. Participation

Most recreational crabbing occurs from May through August, although substantial activity continues into the fall. People may be seen crabbing practically anywhere that provides access to salt water.

Several Division surveys have indirectly evaluated the level of participation in recreational crabbing. One survey interviewed private boat and shore-based fishermen in the Charleston area during June-August, 1979. Only daytime (0800-2000) fishermen were contacted and interviews took place at boat ramps and several popular shore-fishing access points as people were fishing or immediately after they had finished. A crabber was categorized as a person who had been exclusively crabbing (i.e., no other fishing activity). Of 319 shore-based sportsmen interviewed, 23.5% were crabbers, while 2.4% of the 208 boats intercepted contained people who had been exclusively crabbing (Low and Molony 1979).

Other surveys conducted in 1985 and 1986 obtained results on the same order of magnitude. In one study, the survey instrument was a card questionnaire circulated in coastal tackle shops, which fishermen were asked to complete and deposit in collection boxes. Of the 751 valid responses received during June-December, about 27% reported some participation in crabbing (with pots). The rate of positive response was 21% in the northern district, 24% in the central area (Charleston County), and 34% in the southern part of the state. Participation appeared to be very similar between boat fishermen and those who did most of their angling from shore. Of those respondents who replied that private boat fishing was their principal marine recreational angling activity, 26% overall indicated that they also did some crabbing (22% in the northern area, 24% in the central district, and 39% in the southern region). About 30% of the shore-based fishermen also participated in crabbing (21% in the northern district, 30% in Charleston County, and 34% in the southern district). These figures can be interpreted as representative of the percentages of coastal residents who are marine recreational fishermen and also do some recreational crabbing (with pots).

The other studies conducted during 1985-1986 addressed private boat fishermen at public launching ramps. One survey employed card questionnaires and collection boxes as the survey mechanism, while the other was based on personal interviews taken by roving creel clerks. Results from these surveys provide some indication of the relative level of crabbing effort, i.e., the percentage of fishing trips in which some recreational crabbing is also done. Depending on the area and season, fishermen in around 5% of the boats intercepted had done some crabbing, within a range of 1-10%. Responses on the card questionnaires suggested a much higher level of effort (about 21% of the trips), although these data are probably less reliable than those obtained in the direct interview survey. In both surveys, most of the crabbing had been done as an ancillary activity during trips primarily devoted to hook-and-line fishing. Nearly all of the crabbers were state residents and over 80% of them lived in coastal counties (Low et al. 1986).

3. Landings

Data on recreational catches are very limited and no reliable estimates of statewide annual landings are available.

During the summer 1979 creel census in the Charleston area, interviewers observed that shore-based recreational crabbers retained crabs of virtually any size and condition. Many were below the minimum legal size and some were "sponge" crabs. The catch rate for shore crabbers was 1.7 crabs (retained) per hour (Low and Molony 1979).

Data from the 1985-1986 creel census came mostly from the northern district and indicated a catch rate for boat crabbers of about 7.6 crabs per boat-hour. Most of the landings were made during the summer (July-September), although fall catches were also appreciable. The estimated statewide catch for boat fishermen using the surveyed (public) ramps during June 1985-June 1986 was about 410,000 crabs (approximately 135,000 pounds live weight), taken during approximately 29,000 trips. These estimates are based on small samples, were calculated using rough conversion factors for catch

equivalents (bushels to number of crab, etc.), and should be considered very approximate.

E. Incidental Catch

No formal studies have been done and very little quantitative information is available concerning the catch of blue crab by gears used in other fisheries.

1. Whelk Trawl Fishery

This fishery accounts for most of the reported incidental catch that is landed commercially. Since 1978, reported annual landings have ranged from 14,690 pounds (1979) to 166,552 pounds (1982) and averaged about 7,000 pounds. Catches have consisted almost entirely of hard crabs, mostly "sooks." Whelk trawlers employ 4.0-in. mesh nets (the same as applies to crab trawls) and avoid soft mud bottom, thus their catch rate of blue crab is relatively low. Onboard observers have seldom seen more than one or two bushels taken and fishermen have said that most crabs are discarded at sea (W. Anderson, SCWMRD, pers. comm.).

Following a peak in 1982-1983, the whelk fishery has declined to a low level of participation and landings, with little prospect of near-term substantial increases in either category. Since incidental blue crab catches have reflected the amount of effort, rather than the abundance of crabs, the crab bycatch can be expected to also remain low.

2. Shrimp Trawl Fishery

This fishery is the only other appreciable source of incidental bycatches that are landed commercially. Reported annual landings have fluctuated widely, peaking in 1983 at about 20,000 pounds, but have averaged less than 5,000 pounds. These landings are also not indicative of crab abundance. They may be somewhat dependent on shrimping economics; if shrimp catches are very small, the crews tend to retain more bycatch in order to augment their income.

Studies (e.g. Keiser 1976) of incidental bycatch of South Carolina shrimpers have concentrated on finfish and no mention is made of blue crab catch rates. Onboard observations, state sampling, and conversation with shrimpers indicate that blue crab catches fluctuate widely with season, locality, tide, and weather. Adkins (1972) reported that blue crab are often taken by (Gulf) shrimpers following fall cold fronts.

Although conservationists, commercial crabbers, and some recreational fishermen have expressed concern over the bycatch of juvenile blue crab by shrimpers, particularly in sounds and bays (Bearden et al. 1985), most of the blue crab caught incidentally by shrimp trawlers are mature females (Eldridge and Waltz 1977). Most of the small crabs are C. similis. Nearly all of the crab bycatch is shoveled overboard. No studies have addressed the survivability of such crabs, but most probably survive, particularly in colder weather.

3. Channel Net Fishery

There usually are no reported commercial landings of blue crab from this gear. Between September and December 1974, Division personnel observed 14 channel net catches in the Beaufort and Georgetown areas. Of 519 (65 pounds) blue crab observed, 48% were immature females, 28% were immature males, 16% were mature females, and 9% were mature males. About 75% were below the minimum legal size and no "sponge" crabs were seen. The study (Farmer and Boardman 1975) concluded: "Large quantities of blue crabs are not normally caught by individual channel net fishermen. These animals are almost always discarded overboard while still alive and in reasonably good condition."

4. Gill Net and Stop Net Fisheries

Stop nets are gill nets that are staked out as so to enclose a section of shoreline when the tide ebbs. The two gears can be considered jointly in terms of blue crab incidental catch.

There is very little commercial gill net activity in South Carolina (Moore 1980) and only a few individuals practice stop netting, at sporadic intervals. There are no reported crab landings for either gear. No scientific studies have been done on the crab bycatch of these gears.

Observations of a few stop net operations suggest that these seldom take enough crab to justify their retention for sale. Most of the catch is probably released alive.

The only substantial commercial gill net fishery is that for shad, one component of which fishes in the ocean during February and early March. At this time, "sooks" are migrating into nearshore areas and some become entangled in shad nets.

The relatively few so caught are apparantly discarded (W. McCord, SCWMRD, pers comm.).

There is an appreciable amount of recreational gill netting in South Carolina, mostly in the fall near the front beaches (Moore 1980). The extent of crab catches is unknown, but presumably most would be females, many would be undersized, and the majority discarded.

5. Hook-and-Line, Drop Net, Seine, and Cast Net Recreational Fishermen

Some blue crab are caught by each fishery. Although some sport fishermen retain legal crab occasionally, most of this incidental (and unwanted) catch is probably discarded.

IV. Socio-Economic Characteristics of the South Carolina Fishery

A. Commercial Harvesting Sector: Hard Crab Pot Fishermen

As indicated in Section III.B, most of the blue crab commercially harvested are captured with crab pots. Consequently, this description focuses on hard crab pot fishermen.

1. Employment

Information concerning employment in the pot fishery is found in commercial fisheries licensing files and seafood dealer interviews held by the Marine Resources Division. Table 2 lists licensing data for 1977-1986. Prior to FY 1982-1983, a maximum of 100 pots was allowed per license. In July, 1982, a legislative oversight changed the law to allow a licensed crabber to fish as many pots as desired on a single license. Assuming that license sales are a rough proxy for annual participation, the average annual total (268) during 1984-1986 was about 16% less than in 1983. Before the license law change, there had been a general decline in license sales since 1978 (Table 2). Contribution factors could have been improved alternative employment opportunities and/or major declines in real income, especially for marginal producers.

Table 3 shows that, during the 1986-1987 license period, 273 individuals held licenses. Of these, four were residents of Georgia and three of North Carolina. Residents of 12 South Carolina counties were licensed, with four coastal counties accounting for about 80% of the total license holders. During the 1983-1984 license period, ten of the 319 license holders were nonresidents. Nineteen South Carolina counties had license holders and the four primary coastal counties accounted for about 75% of the individuals.

2. Income

Between 1980 and 1986, it is projected that a fulltime crabber's nominal income increased 19%. When deflated (i.e., measured in 1980 dollars), average cash income increased only 7% (Table 4). These projections suggest that the income of commercial crabbers has probably not undergone a major decline between 1980 and 1986. For example, fuel (mainly gasoline) had historically constituted one of the major increases in operating costs (Rhodes and Bishop 1979), but retail prices have generally declined since 1980. Based on these projections, an increase in exvessel crab prices may have allowed some crabbers to sustain their real income. In contrast, if the number of crabbers declined during 1980-1986, the combination of increased catches per license holder after 1981 and increased exvessel prices could have resulted in an increase in real income.

B. Domestic Processing and Market Structure

Processed blue crab is a major value-added seafood in South Carolina and comprises the major market outlet for blue crabs sold by commercial fishermen.

1. Processing Technology

The technology of small processors has not changed significantly during the last 40 years. Unrefrigerated live crabs are usually delivered by truck or boat to the processor on the day harvested, loaded into retort baskets, and batch-cooked. Then the crabs are transferred to a cooler prior to picking. Picking is labor-intensive and mechanization is limited. The Harris machine, which separates the meat from the shell by floatation, was developed in the 1960's for Blue Channel Corporation (Lee et al. 1963) and a new machine, which removes meat by high-speed vibrations, was introduced around 1979. Several different machines are presently used, including the Harris system. Despite mechanization, hand-picked, pasteurized meat is considered superior to machine-picked meat.

Historically, crab meat has been sold in three grades: 1) lump backfin, 2) body, and 3) claw.

Table 2. Annual crab trap license sales.

Year	Licenses Sold[a]	(1000 lbs) Annual Landings	(1000 lbs) Landings/License
1977	462	7,765	16.8
1978	507	9,417	18.6
1979	461	7,422	16.1
1980	449	6,162	13.7
1981	463	6,289	13.6
1982	332	6,320	19.0
1983	319	5,573	23.3
1984	271	4,366	16.1
1985	261	4,622	17.7
1986	273[b]	5,520	25.7

[a] SCWMRD license sales by fiscal year (e.g. 1977 is FY 1977-1978)
[b] to July 1, 1987

Table 3. Numbers of licensed blue crab fishermen in South Carolina counties or other states during July 1983 - June 1984 and July 1986 - June 1987.

STATE	COUNTY	LICENSED CRABBERS 1983-84	1986-87
South Carolina	Bamberg	4	2
	Beaufort	93	74
	Berkeley	8	6
	Charleston	114	95
	Colleton	26	15
	Dorchester	3	6
	Florence	1	2
	Georgetown	25	26
	Greenville	1	0
	Hampton	4	4
	Horry	7	22
	Jasper	9	13
	Kershaw	2	0
	Lexington	1	0
	Orangeburg	1	1
	Pickens	2	0
	Richland	1	0
	Williamsburg	1	0
	Undetermined	6	0
South Carolina		309	266
Georgia		7	4
North Carolina		3	3
TOTAL		319	273

Table 4. Projected annual costs and returns for South Carolina blue crab fishermen in 1986 v. 1980. (Source: R. Rhodes, SCWMRD, unpubl.)

	1986	1980
Average Number of Traps	160	160
Average Ex-vessel Price	$0.31	$0.27
Average Days Fished	256	256
Annual Hard Blue Crab Catch [a]	141,000	141,000
Gross Returns	$43,710	$38,070
Variable Costs:		
Fuel 18.6 gallons/day	$4,095	$4,571
Bait	7,000	6,709
Oil	900	865
Maintenance & Repairs	1,250	1,046
Crab Pots	4,800	4,000
Truck Expenses	3,054	2,908
Helper's Share	1,410	1,058
Self-employment tax	2,608	1,116
Total Variable Costs	$25,116	$22,273
Returns Less Variable Costs:	$18,594	$15,797
Fixed Costs:		
Miscellaneous Expenses	$400	$357
Depreciation	3,000	2,676
Total Fixed Costs:	$3,400	$3,033
Total Costs:	$28,516	$25,306
Net Returns (Nominal Dollars):	$15,194	$12,764
Net Returns (1980 Dollars): [b]	$13,623	$12,764
Percent Change (1980 Dollars): [b]	6.7%	NA

[a] The annual catch for 1986 was set at the 1980 level because the "Landings/License" (see Table 1) in 1986 was greater than 1980.

[b] Adjusted with the Producers Price Index (1980/1986).

Unbroken lump backfin commands the highest price, while the darker claw meat is the least expensive grade. A fourth grade (special) consists of a backfin and body meat mixture. These are only general descriptions and the lack of grading has probably hindered marketing development (R. Martin, NFI, pers. comm.).

Processing yields vary with "fullness," size, and picking technique. For example, "fat" crabs, which have not molted recently and are "full" of meat, can yield 14% of their live weight (Dressel et al. 1983). In South Carolina, average hand-picked yields range between 9-12% if taken during July and October, using crabs of both sexes and various sizes. State processors have reported a decline in yields during recent years.

During 1982, approximately 20% of the fresh crab sold in the United States was pasteurized (Dressel et al. 1983). Pasteurization provides a commercial shelf life of 6-12 months (Duersch et al. 1981) and a major advantage is the ability to increase inventories during periods of high landings and low exvessel/wholesale prices. The summer and fall inventory can then be sold at higher wholesale prices during the late fall and winter.

2. Ecomonic Impact: Employment and Income

The four plants which processed blue crab in 1986 are located in Charleston and Beaufort Counties. In the third quarter of 1986, employment statewide was about 871 people (Table 5), with most of the employment in Beaufort County. Processing is seasonal, normally lasting from May through December, although some processing of trawler-caught crab is done in Beaufort County during the winter.

The processing industry provides seasonal employment in rural coastal communities. In addition, some employees are engaged in other seasonal fisheries (e.g. oyster harvesting), which complement the blue crab fishery and provide year-round employment. Employment by the processing sector during the 1982-1986 period declined in the first and second quarters compared to the same quarters in the 1977-1981 interval (Table 5). This decline is apparently linked to the decrease in landings reported in the first quarter of the 1982-1986 period.

The estimated total economic impact of the processing sector compared to that of the harvesting sector is substantial. A recent survey (Rhodes 1987a) of the processing sector indicated that the 1986 economic impact of processing sales was $10.1 million (Table 6), almost four times the economic impact of exvessel sales.

3. Processed Product Trends

In 1986, the value of South Carolina's processed crabmeat was about $4.4 million. The aggregate value of processed crab products has declined in recent years, mainly due to the decrease in the quantity of crabmeat produced (Rhodes 1987a).

It is assumed that the supply of imported crabmeat has partially influenced the demand for processed blue crab meat in the United States. Crabmeat imports have increased: in 1986, an estimated 23 million pounds of fresh, frozen, and canned crabmeat was imported, with a value of $96 million. The average price of frozen and fresh crabmeat imported in 1986 was $4.94 per pound. Although sales of crabmeat analogs (e.g. surimi-based seafoods) have been expanding rapidly in recent years, these products are not considered direct substitutes for blue crab meat (Rhodes 1986). In contrast, imported pasteurized crab products are considered a direct substitute for blue crab meat. The quantity of such products has expanded in recent years (Rhodes 1987b) and reached an estimated 400,000 pounds, imported mainly from Venezuela, in 1986.

The processing sector has been concerned over health recalls of imported crabmeat, especially those involving pasteurized product. From the domestic industry's perspective, these recalls erode consumer confidence, which directly negates industry promotional activities (Dressel et al. 1983). In contrast, some processors are becoming investors and/or general managers in plants abroad. Consequently, it is assumed that the supply of imported pasteurized crabmeat will continue to expand and associated product quality may improve.

4. Processing Costs and Returns

An analysis of blue crab processing costs in South Carolina is in preparation. The most recently published information was provided by Dressel et al. (1983). Based on field interviews, they estimated that the 1981 cost of picking blue crab meat was about $3.37 per pound.

Table 5. Average monthly employment in South Carolina crab processing plants, 1977-86 (Source: U.S. Dept. of Commerce).

YEAR	PLANTS REPORTING	QUARTER[a] I	II	III	IV
1977	3	307	560	909	921
1978	3	280	773	973	861
1979	3	369	724	810	887
1980	3	408	678	861	740
1981	3	352	566	837	945
1982	3	220	708	942	931
1983	3	346	644	949	839
1984	3	168	220	678	674
1985	3	239	440	772	623
1986	4	265	349	871	707
Averages/Quarter					
1977-86:		295	566	860	813
1977-81:		343	660	878	871
1982-86:		248	472	842	755
% Change[b] :		-27.9%	-28.5%	-4.1%	-13.3%

[a] Employment data may include labor for processing products without crabmeat.

[b] Percent change in employment: 1982-86 vs. 1977-81.

Table 6. Preliminary estimate of the economic impact of the crab harvesting and processing sector in South Carolina during 1986 (Source: Rhodes 1987a).

1. CRAB HARVESTING SECTOR ECONOMIC IMPACT:

	DIRECT (In Thousands)	X	MULTIPLIER =	TOTAL ECONOMIC IMPACT (In Thousands)
DOCKSIDE SALES:	$1,709	x	1.5	$2,564
INCOME:	$649	x	2.0	$1,299
EMPLOYMENT:	130	x	1.3	169 person-years

2. CRAB PROCESSING SECTOR ECONOMIC IMPACT:

	DIRECT (In Thousands)	X	MULTIPLIER =	TOTAL ECONOMIC IMPACT (In Thousands)
PRODUCT SALES:*	$4,669	x	2.2	$10,131
VALUE ADDED:	$2,160	x	3.1	$6,698
INCOME:	$1,585	x	3.5	$5,546
EMPLOYMENT:	390	x	2.8	1,092 person-years

3. (1+2): TOTAL ECONOMIC IMPACT OF CRAB HARVESTING AND PROCESSING

		Contribution of Processing
TOTAL SALES:*	$12.7 million	80%
VALUE ADDED:	$6.7 million	100%
INCOME:	$6.8 million	81%
EMPLOYMENT:	1,261 person-years	87%

* Sales includes 6% of seafood items other than crab products.

NOTE: The economic multipliers used in this table were reported in the publication, "Economic Impact of the Commercial Fishing Industry in the Gulf of Mexico and South Atlantic Regions" by Centaur Assoc., Feb., 1984. This table does not include wholesale, mainly in Maryland, or retail sales of live blue crabs.

including overhead, with labor costs constituting about 49% of the total cost. If these cost estimates are applicable to South Carolina processors, then they have been operating with very low profit margins (and perhaps net losses) in some years. For example, if the cost of raw crab meat in 1981 was about $2.12 per pound ($0.255, 12% yield) and the average wholesale price was about $6.00 per pound, then the mark-up cost would have been around 10% ($6.00/$5.47). A mark-up over cost of 15% would be considered a modest profit for seafood processors. Dressel et al. (1983) reported that some plants were selling meat at $6.10 when they had costs of $6.00, a mark-up of less than 2%.

5. Market Channels

The market channels for hard and soft crab are illustrated in Fig. 7. In 1980, it was estimated that about 70% of the United States hard crab landings were processed and the remainder sold as live crabs in baskets for restaurant or home consumption (Dressel et al. 1983). Hard crabs harvested in South Carolina are purchased for immediate processing or shipped directly to the mid-Atlantic states for the "basket" trade. In 1986, South Carolina crab plants purchased an estimated five million pounds of hard crabs from South Carolina fishermen, mainly for processing, and nearly one million pounds from out-of-state sources. In 1985, processors procured almost two million pounds from out-of-state.

Although South Carolina processors purchase about 70% of the reported crab landings in the state, commercial fishermen will often sell "number ones" to "basket" trade buyers, especially during the spring and early summer. Historically, the extent of these sales has been dependent on the price spread between local processors and "basket" trade buyers (Rhodes 1974). From the commercial crabber's standpoint, present marketing structure allows more flexibility (Rhodes and Bishop 1979). Although local processors are not solely dependent on South Carolina crabbers for raw material, the rising prices received for live "number one" and "number two" crabs during the spring have apparently reduced profit margins in recent years. The processors have attempted to compete with the "basket" trade buyers by purchasing all of the fishermen's crabs, including "number ones," at market prices. The processors then ship the "number ones" for the "basket" trade and process the remaining crabs. The success of this approach has been questionable, because "basket" crab buyers have several advantages, including payment with cash instead of checks and much lower overhead.

C. Exvessel and Wholesale Price Trends

1. Exvessel Price Trends

Although nominal exvessel prices have increased during the past 10 years, much of the increase can be attributed to inflation. In the 1977-1986 period, real exvessel crab prices in South Carolina (Fig. 8) have not changed significantly. In contrast, real exvessel prices paid to domestic crabbers in the 1960-1980 period increased at a compound rate of 2.1% per year, or 50% overall (Dressel et al. 1983). It should be noted that, if the catch sold as "basket" crab is being under-reported, then the average nominal exvessel price may have increased more than the reported data indicate.

Several studies have analyzed the effects of various factors on annual exvessel prices. Price regression models by Prochaska et al. (1982) indicated that disposable income is highly significant in price determination and both models explained 96% or more of the total price variation. Perry et al. (1982b) also reported that disposable income is the independent variable most highly significant in explaining Gulf price variations between 1960-1980. Chesapeake regional landings were also significant in explaining Gulf exvessel prices (Perry et al. 1982b).

Capps (1982) reported that seasonal trends in landings and wholesale prices have a significant impact on exvessel prices of hard blue crabs in Chesapeake Bay. Lamberte and Pomeroy (1985), when analyzing monthly exvessel prices in South Carolina, found that South Carolina landings had little significant impact on exvessel prices. It is possible that the monthly wholesale prices in North Carolina and the Chesapeake Bay area influence South Carolina monthly exvessel prices.

2. Wholesale Prices

Nominal wholesale prices for pasteurized crabmeat have increased during the last 10 years. Although wholesale prices may have increased faster than exvessel prices, the average profit margin on wholesale

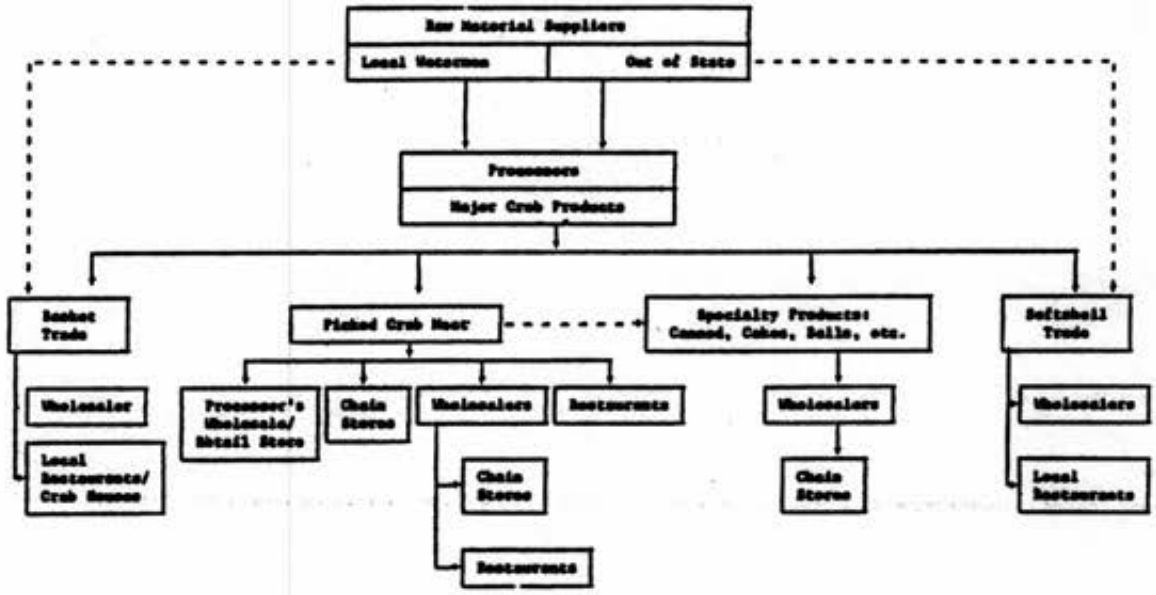

Fig. 7. Major market channels for blue crab products (modified from Dressel et al. 1983).

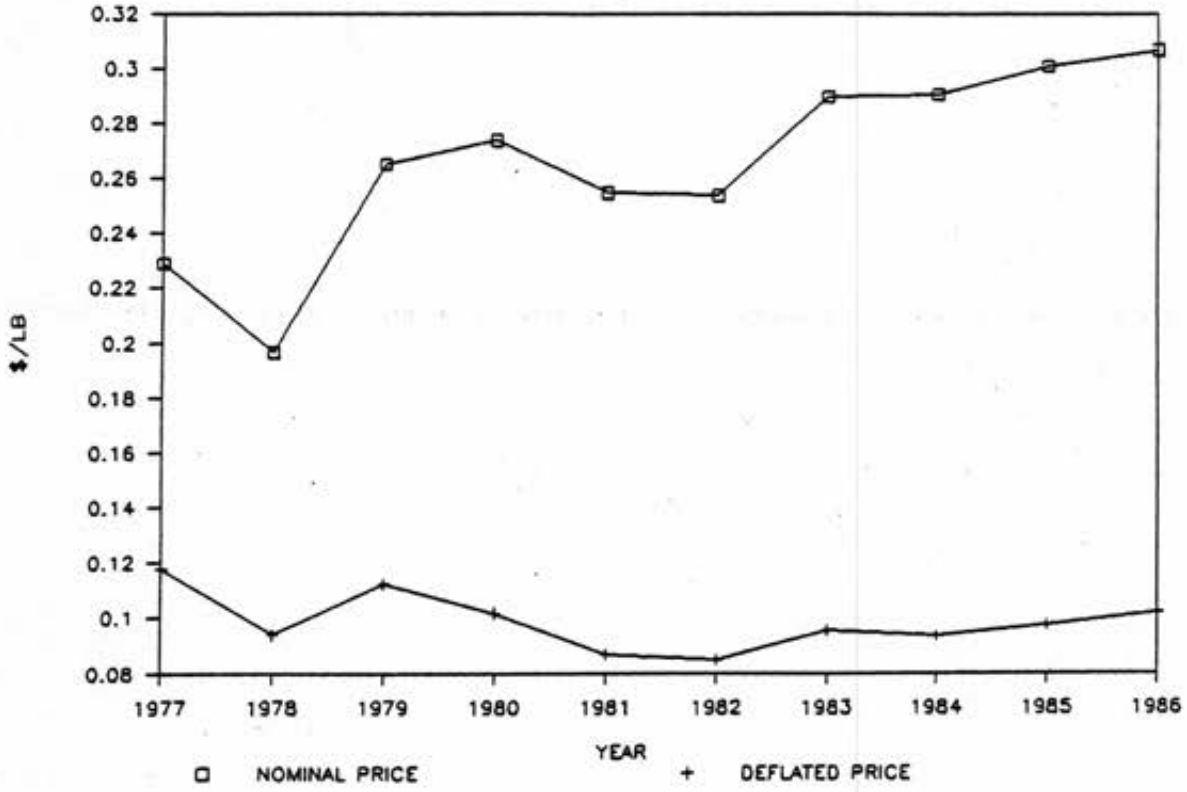

Fig. 8. South Carolina annual exvessel blue crab prices, 1977-1986 (hard crabs only).

crabmeat products in the United States was estimated to be only $0.04 per pound in 1985 (Vondruska 1986). As others (e.g. Dressel et al. 1983) have reported, processors may not be able to pass on significant cost increases to consumers.

D. Competition and Conflicts among Domestic Fishery Participants

There are numerous examples of perceived competition and resultant conflicts, but few documented cases of either. Rhodes and Bishop (1979) discussed the instances which have led to legislation.

1. Spatial Competition

Although the extent of fishing area is large, the best catch rates at any given time may be obtained in relatively small portions of an estuarine system. Most successful commercial crabbers continually move their gear in search of the highest catch rates and most desirable crabs. This sometimes results in several crabbers fishing their gear in close proximity, creating the impression of competition for fishing space. Since the effective fishing range of pots is both unknown and apt to be highly variable, the extent of actual gear competition is not known. Because most crabbers dislike having traps closer than several hundred feet, there is the potential for conflict when such "crowding" occurs. Rhodes and Bishop (1979) noted the attitude of some resident crabbers toward fishing by nonresidents. Some perceived problems were spatial competition and reduced catches when nonresident fishermen moved into an area (Virginia crabbers were singled out because they tend to fish more gear).

2. Competition with Recreational Crabbers

Rhodes and Bishop (1979) also noted that increased recreational crabbing led some commercial fishermen to view such activity as detrimental to their success. The magnitude of the recreational harvest is unknown, as is its composition by gear type. Much casual crabbing occurs from bridges, docks, and similar points of shore access and there may be some competition for legal crabs near such places. Because unlicensed recreational crabbers can legally deploy only two pots per person (head of household), the number of recreational pots in an area relative to commercial gear is usually insignificant.

3. Market Competition

Increasing landings from Texas have been perceived by some local crabbers as responsible for lower prices at certain times.

South Carolina commercial crabbers cannot legally land "sponge" crabs, but processors can purchase such crabs from out-of-state suppliers. Many crabbers view this "sponge" crab ban as discriminatory and serving no practical purpose. They feel that the processors have manipulated the legislation to their benefit, by allowing the processors to purchase cheap product from out-of-state without effective competition from local fishermen.

4. Conflict among Commercial Crabbers

Spatial competition appears to be the major cause of this problem, which usually manifests itself in the form of pot theft or tampering. Commercial crabbers tend to fish in particular "home" areas and resent intrusion in the form of gear set by another crabber. Accepted procedure is for the "resident" crabber to move a few of the "intruder's" pots, usually those closest to his gear. If the warning goes unheeded, more severe measures are taken, such as cutting a few buoy lines. Occasionally the process escalates, with both parties cutting lines, stealing pots, etc. Sometimes reports of large-scale pot theft, affecting several nonfeuding crabbers in the same area, are made. Then fishermen usually suspect an outsider of putting together a string of stolen gear for his use.

5. Conflict between Commercial Crabbers and Recreational Interests

Rhodes and Bishop (1979) noted that commercial crabbers blamed increased recreational activity for increased theft of crabs from their pots. Division personnel in the field have noted that recreational boaters and/or fishermen will often pull a few commercial pots to obtain crabs. If the pots are latched and reset in the same place, this represents little more than a minor annoyance (in practical, if not ethical terms). Widespread pilfering or serious theft, such as raiding pots systematically, can be a major problem for the commercial crabbers, particularly when the gear is also taken.

The principal legislative response to the problem of pot theft has been the passage of buoy

identification requirements and a prohibition against pulling pots at night. Although these measures assist law enforcement personnel in making a case, they are probably not very effective deterrents to pot theft.

Pot buoys are sometimes considered a hazard by boaters, particularly in areas where water skiing is popular. This has been addressed by several legislative measures, including those preventing placement of pots near public boat ramps and seasonal area closures (e.g. in Chechessee, Pawley's Island, and Midway Creeks). The Beaufort Gazette (April 17, 1978) also noted that waterfront property owners have sought restrictions on commercial potting in some areas.

6. Conflict between Commercial Crabbers and Shrimp Trawlers

One of the minor issues of the sound and bay closure controversy is the interaction between fixed (crab) and mobile (trawl) gear in confined areas. Legislation to minimize such conflicts has included the prohibition of trawling in some areas.

Incidental landings of blue crab by trawlers are considered a problem by some commercial crabbers. Trawl-caught crabs tend to be more damaged and have a high sand content, thus they generally bring a low price. They are also caught principally in summer, when demand is low. Although the reported commercial catches of shrimp trawlers have been very low, many landings go unreported. Most trawl-caught crabs are mature females, which some crabbers think may adversely affect recruitment.

V. Condition of the South Carolina Fishery

A. Current Status of the Stocks

There have been no direct surveys of population abundance, thus there are no fishery-independent estimates of the status of the stocks. Assessment must be based largely on the recent trend in commercial landings of hard crabs, which can be influenced by numerous factors that are not stock-related. The current status of the blue crab resource in South Carolina is therefore rather speculative.

Commercial landings in recent years have been well below the 30-year average (Figure 1). The 1984 harvest was the lowest since 1968, although landings increased slightly in both 1985 and 1986. Preliminary data for 1987 suggest a level (through mid-summer) comparable to 1986, although crabbers have reported high catch rates and increased abundance. They contend that current landings are being curtailed because of low prices. Years of very low production have occurred at intervals of six or seven years and have been followed by recovery to "normal" levels. This trend thus suggests that commercial landings in the next few years will continue to improve, in the absence of abnormal climatic conditions, outbreaks of disease, or atypical economic conditions.

Experimental catches by Division research vessels have also declined in recent years. Analysis of samples for legal, sublegal, and "sponge" crabs indicates that all three groups have declined in abundance since 1981. This decline appears to be most pronounced in the southern statistical district, particularly in Port Royal and Calibogue Sounds. Catch rates there dropped significantly in 1983's surveys and have remained low since then. Experimental catch rates in the central part of the state, however, have shown no discernible decline. If the blue crab stock in the southern area is more depressed than that in the central part of the state, the difference may be due to the difference in river discharge in the two areas. The Cooper and Santee Rivers drain areas well inland, which results in a greater discharge rate in the central zone. Rivers in the southern zone have relatively small drainage areas. Droughts, such as those of recent years, may then be especially severe in their impact on estuarine organisms in the southern zone.

At present, there are no indications of widespread occurrence of "gray crab" disease, which has previously been implicated as a major cause of reduced landings and, presumably, abundance. Coastal waters appear to be generally free of pollution, relative to previous years, according to recent Division and DHEC water quality analyses. The principal concern is the level of rainfall. The first half of 1987 has been slightly wetter than the long-term average, but the forecast is for a hot summer and early fall, with below-normal precipitation. The months of September through November are believed to be a critical time for the development of young crabs, spawned the previous spring. Thus, persistent drought conditions this fall could adversely impact the survival of this year's young-of-the-year. Abnormally high mortality could then reduce recruitment in the 1988 fishery.

B. Socio-Economic Considerations

At present, economic conditions in the state are relatively stable and unlikely to result in any significant impact on employment in the commercial

harvesting sector.

One element important at the state level is the projected trend in sales to the "basket" trade (graded, live crab) for shipment to northern markets vs that to local processors. Although the reporting problem clouds interpretation, it appears that a greater percentage of the hard crab production is being diverted into the "basket" trade. This has two ramifications. It compels local processors to seasonally import crab (up to 40% of the live crabs used by instate plants have been brought in from other states), which may increase their costs and narrow their profit margin. The second aspect is that the gross value of the crabs being landed in South Carolina may be increased through greater use of grading and more flexible marketing. The major benefactors would be the crabbers, who could maximize the value of their catch by grading, selling the "number ones" and some "number twos" to the "basket" buyers, and reserving only the lower-valued, "picking" crab for local processors.

C. Factors Affecting Landings

In South Carolina, no quantitative production models have been developed to explain the contributions to variability in annual landings that are attributable to factors such as abundance, alternative employment opportunities, exvessel prices, etc. Pronounced changes in abundance obviously have an impact on annual harvests, but moderate fluctuations may not be directly reflected in the landings. Within a rather wide, middle range of levels of abundance, the landings may be more influenced by fishery-independent factors than by stock level.

Market disposition of the catches probably has had an increasing impact on reported landings. Hard crabs sold to local processors have probably been reported rather accurately. As previously noted, crabs that have been graded and shipped in the "basket" trade, particularly by the fishermen themselves or small, independent dealers, probably have been significantly under-reported. If the market incentive for grading and shipping in the "basket" trade continues to increase, then conceivably the reported landings could become less reliable as an indicator of the total harvest.

D. Management Implications

Accurate and complete reporting of all commercial landings is essential to the effective management of the blue crab fishery, particularly if landings are treated as a major index of abundance. A false evaluation of the status of the stocks, due to misleading landings data, could result in unwarranted restrictions on fishing effort and catch levels or the failure to institute necessary management measures. It would also be desirable to obtain some reasonable estimate of the annual recreational harvest, although this would be very difficult to accomplish at practical levels of effort and expense.

The importance of a stable estuarine habitat to the long-term productive capacity of the blue crab resource has been frequently mentioned. Pronounced perturbations could have significant impacts on specific year classes. Permanent alternations, such as from impoundment or marsh filling, almost certainly would lower the productive capacity of the resource by reducing the amount of habitat available to it. In each case, the carrying capacity of the estuarine environment will have been degraded. Maintenance of the estuarine habitat, with minimal adverse environmental disturbances, is probably the most beneficial, though indirect, management strategy.

Direct management measures may be needed to address conflicts between the various user groups as well as problems associated with the resource. The growing population of marine recreational users, in both consumptive and nonconsumptive activities, increases the potential for interaction between crabbers and other users. In isolated cases, it may become advisable to prohibit crab potting in confined areas of heavy boating usage. Although it is not likely to be needed in the near future, a limit on the number of pots per fisherman may become necessary. This is a common form of effort limitation that often has been one of the first direct measures imposed on other commercial trap fisheries.

Finally, there are short-term, fishery-independent but stock-related, conditions that cannot be addressed through any form of management. The impacts of droughts and disease have been fairly well-defined and can be very substantial, impacting all users of the resource across the board. For these, there are no corrective measures except time.

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