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STOCK ASSESSMENT AND FISHERY EVALUATION (SAFE) REPORT FOR THE CALICO SCALLOP FISHERY OF THE SOUTH ATLANTIC REGION

VOLUME I

South Atlantic Fishery Management Council
1 Southpark Circle, Suite 306
Charleston, South Carolina 29407-4699
(843) 571-4366 / FAX (843) 769-4520
email: safmc@noaa.gov
website: www.safmc.noaa.gov

This is a publication of the South Atlantic Fishery Management Council pursuant to National Oceanic and Atmospheric Administration Award No. NA97FC0018

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VOLUME I

prepared by the
South Atlantic Fishery Management Council

SEPTEMBER 1999

Financial assistance for producing this document was provided by grant funds from the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, under Public law 104-208, the Magnuson-Stevens Fishery Conservation and Management Act.

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1.0 INTRODUCTION

The *Guidelines for Fishery Management Plans (602 Guidelines)* published by the National Marine Fisheries Service (NMFS) require that a stock assessment and fishery evaluation (SAFE) report be prepared and reviewed annually for each fishery management plan (FMP). The SAFE reports are intended to summarize the best available scientific information concerning the past, present, and possible future condition of the stocks and fisheries under federal management. Appendix A to the *Guidelines* lists the desired components of SAFE reports as follows: 1) information on which to base harvest specifications; 2) information on which to assess the economic and social condition of persons and businesses that rely on recreational and commercial use of fish resources, including fish processing industries; and 3) any additional economic, social, and ecological information pertinent to the success of management or the achievement of objectives of each FMP.

The SAFE report for the Calico Scallop fishery managed under the Fishery Management Plan for the Calico Scallop Fishery in the South Atlantic was compiled by South Atlantic Council staff with input from NMFS SERO, Florida Department of Environmental Protection, University Researchers and NMFS SEFSC. Our goal was to include the most recent information on issues that have been raised or are likely to be raised during the Council's review of the calico scallop stock and fishery. The detailed information is found in the attached reports and we have only attempted to extract a very brief overview for inclusion in Sections 2, 3, and 4.

A very summary overview of stock status is presented in Section 2.0 Overview of Stock Assessment. Overviews of economic and social status of the fishery are presented in Section 3.0 Fishery Evaluation. This section contains material from the Council's Sustainable Fisheries Act Amendment (SAFMC, 1998d) describing fishing communities. Ecosystem considerations are presented in Section 4.0 Ecosystem Considerations using material from the Council's Habitat Plan (SAFMC,1998a) and Habitat Amendment (SAFMC, 1998b). These sections rely very heavily on the identified Council documents and the following appendixes:

Appendix A. Figures and Tables from the Original Profile and Profile Update.

These figures and tables are from the detailed source documents for the calico scallop fishery that were prepared in 1981 and 1982.

Appendix B. Presentations and Materials Provided by Mr. William Burkhartd, Mr. Roger Newton, Mr., Thomas Brown, and Mr. Allen Scott at the June19, 1995 Scoping Meeting in Palm Beach Gardens, Florida.

This appendix contains input from members of the calico scallop industry given during the Council's scoping process in 1995.

Appendix C. Presentations and Materials Provided by Mr. William Burkhardt at the Florida Marine Fisheries Commission, February 24, 1998 Meeting.

This is material provided by Mr. Burkhardt to the Florida Marine Fisheries Commission during their scoping process.

Appendix D. Calico Scallop Bycatch Information.

This report by the Florida Marine Fisheries Commission quantifies the calico scallop bycatch from a 1991 study.

Appendix E. Response of Scallopers to Proposed Management Measures in the Comprehensive Amendment for Essential Fish Habitat in the South Atlantic.

This report prepared by the Fisheries Economics Office of NMFS discusses scallopers reaction to proposed closed areas in the Council's Comprehensive Habitat Amendment.

Appendix F. Summary report on the Calico Scallop (*Argopecten gibbus*) Fishery of the Southeastern United States.

This paper by William S. Arnold (Florida Department of Environmental Protection) contains the most up to date profile of the calico scallop fishery and biological information.

Appendix G. The Calico Scallop, *Argopecten gibbus*, Fishery of Cape Canaveral, Florida.

Blake and Moyer take a detailed look at the calico scallop fishery of Cape Canaveral Florida.

Appendix H. Price Analysis for Florida and North Carolina Bay Scallops and Southeast Calico Scallops.

This report done by Easley and Prochaska for the Council in 1985 contains detailed economic information on the calico scallop industry in the early eighties.

Appendix I. Florida Rule Package.

This package contains the final rule for calico scallops in the state of Florida passed in 1998 and all background information the state used.

Appendix J. Biological Effects of Scallop Trawling: Estimation of Bycatch Composition, Mortality and Effects on Bottom Communities.

In this report Nelson, Sainsbury and Sager look at calico scallop bycatch in a study done in 1991.

Appendix K. Marine Fishes of the Calico Scallop Community and Inshore Reef Fish Community Off Cape Canaveral, Florida.

In this report Miller identifies fish taken by a calico scallop trawl and those occurring in the inshore reef community.

Appendix L. An Account of the Development and Economic Attributes of the Calico Scallop Fishery.

This appendix contains more detailed yet, older data the Council used when looking at the calico scallop fishery in the eighties.

Appendix M. South Atlantic Fishing Communities as Defined in the Sustainable Fisheries Act Amendment.

This appendix contains information on South Atlantic fishing communities.

Background Information

In the early 1980s, the Council began development of a Calico Scallop FMP based upon requests by industry. A profile of the fishery was developed in 1981(SAFMC, 1981) and updated in 1982 (SAFMC, 1982). Eventually, a draft FMP was completed for consideration. The only management measure included in that draft was an option to specify a minimum harvestable size limit equal to a shell depth of 5/8 inches with a 20% tolerance by volume to increase survival of small scallops. There were other management measures considered, but they were rejected. After considerable deliberation in 1982, the Council chose to forestall any management, based on the conclusion that the industry could self-regulate harvesting of calico scallops.

During 1986, the Council again considered development of an FMP based on requests from the industry. Once again the industry concluded that they could self-regulate themselves. After much deliberation, the Council decided to stop plan development.

The South Atlantic Fishery Management Council decided to revisit calico scallop management and held public scoping during the months of May and June, 1995. There was substantial disagreement among participants within the fishery as to whether management was needed. The recent public scoping again raised questions about stock status, long-term sustainability, and the need for management. Requests for management measures included closure until a minimum count size is reached, return of shell stock to harvesting grounds, and co-management. A fishery management plan was not completed at that time.

The Council completed the Fishery Management Plan for the Calico Scallop Fishery in the South Atlantic Region in 1998 (SAFMC, 1998). The FMP includes measures to establish vessel permits for calico scallop vessels in the EEZ; to identify essential fish habitat for calico scallops; to prohibit harvest of calico scallops in the area bounded to the west by 80° W longitude, to the north by 28° 30' N latitude, to the south by 27° 30' N latitude, and to the east by the 100 fathom (600 feet) depth contour as well as the two satellite Oculina HAPCs; and required vessel monitoring systems on vessels fishing for calico scallops south of the Florida/Georgia border. The FMP was sent to NMFS on October 5, 1998 and is currently under secretarial review.

Issues

Management Authority

Discussion arose from the Calico Scallop Advisory Panel (AP) during the development of the FMP as to whether it would be more appropriate for the Council or the State of Florida to manage the fishery. Although substantial landings have been recorded in North Carolina, the fishery now almost exclusively exists in the waters off Cape Canaveral, Florida with some landings also occurring from Cape San Blas, Florida. During the discussion, the AP felt that getting management measures in place was taking too long and felt that they could support either the State or the Council as long as the process was moving along. Although the Council proceeded with a FMP for the fishery there continues to be discussion about whether the Council could transfer authority to Florida within Amendment 1 to the FMP.

Bycatch

A study estimating bycatch composition and mortality of calico scallop trawls was conducted in 1992 by Nelson, Sainsbury and Sager (Appendix J). In this study a total of 30 species of fish and 25 species of invertebrates were collected. Fishes typical of the bycatch included several species of small founders and soles, various batfishes, and searobins. Other

fishes commonly encountered included planehead filefish and barbfish. The invertebrate bycatch was dominated by two groups, decapod crustacaens and the echinoderms (Nelson, Sainsbury and Sager, 1992). The study suggests that bycatch from calico scallop trawls may have relatively low impacts on species of commercial or recreational importance. The authors also concluded that many species would survive trawling if they were returned quickly to the water but the general practice in the fishery is to sort the catch when the boat has returned to shore, resulting in 100% mortality of the bycatch.

In accordance with the Sustainable Fisheries Act of 1996, the Council addressed the issue of bycatch in the calico scallop fishery and concluded that there was an extreme lack of information regarding bycatch in this fishery and proposed the appropriate data be collected.

Habitat Impacts

In 1998 the Council took action to minimize impacts on habitat by the calico scallop fishery through the Comprehensive Amendment Addressing Essential Fish Habitat and the Calico Scallop FMP. Management measures included identifying essential fish habitat for calico scallops, prohibiting harvest of calico scallops in the area bounded to the west by 80° W longitude, to the north by 28° 30' N latitude, to the south by 27° 30' N latitude, and to the east by the 100 fathom (600 feet) depth contour as well as the two satellite Oculina HAPCs; and requiring vessel monitoring systems on vessels fishing for calico scallops south of the Florida/Georgia border.

The following text is taken from the Fishery Management Plan for the Calico Scallop Fishery in the South Atlantic Region (SAFMC, 1998c).

"Information about calico scallop trawls and their interaction with the bottom habitat is limited. It is obvious that trawling gear contacting the bottom results in damage to the bottom habitat. What is unknown is the extent of damage and the extent to which there are lasting, negative impacts. The fact that trawl gear is designed with material to protect the mesh from friction when in contact with the bottom suggests significant contact between the gear and the bottom.

During the early years of the calico scallop fishery, large quantities of benthic material was removed. Reports were received during committee, Council, and scoping meetings about entire "rocks" being removed. One individual provided a print-out from a depth sounder which indicated a large amount of bottom relief in a particular area prior to the calico scallop fishery. Similar bottom plots after the calico scallop fishery operated in that area indicated a flat bottom.

Bycatch information in the calico scallop fishery from a trip on February 12-13, 1991 is shown in Table 1 [Note: Appendix D]. This information supports interaction between the gear and the bottom.

Amendment 1 to the Snapper Grouper Fishery Management Plan (SAFMC, 1988), presents results of scientific studies examining the long-term impacts of trawl damage. To what extent this information is applicable to the calico scallop fishery is unknown. Given the fact that the "roller-rig" trawls were designed to roll over hard bottom whereas the scallop dredges and trawls are designed to "tickle" calico scallops from the top layer of bottom material suggests the impacts would be larger in the calico scallop fishery.

An important point to keep in mind is the relatively limited area in which the calico scallop fishery operates . To the extent calico scallop trawls damage the bottom habitat, such damage will be limited to the fishing grounds. Any such damage has already taken place and additional damage from calico scallop trawls is not anticipated. In addition, the calico scallop industry and Advisory Panel have endorsed prohibiting calico scallop trawling within the area currently closed to rock shrimp trawls because calico scallop trawling gear is so similar to rock

shrimp trawling gear (see Action 8A.). Further, to ensure compliance with the closure proposed under Action 8 and the existing Oculina Bank HAPC, the industry and the Calico Scallop Advisory Panel support mandatory use of transponders by 100% of the calico scallop vessels fishing in the EEZ off Florida (Action 9). These transponders are to be paid for by the vessels themselves based on their request.

Additional information about the interaction between calico scallop trawls and the bottom habitat is needed. Action 10 outlines activities of the ACCSP which includes a bycatch monitoring program. NMFS should immediately place observers on some of the calico scallop vessels to obtain bycatch and other information. At a minimum, coverage of the one at-sea processor and one other vessel is required.

The Council will continue to monitor the interaction between the calico scallop fishery and the bottom habitat. If additional regulations are necessary the Council will amend the fishery management plan to address the new information."

2.0 OVERVIEW OF STOCK ASSESSMENT

2.1 Stock Identification

The calico scallop, *Argopecten gibbus* (Linne), occurs most often at moderate depths of 18-73 m (59-240 ft) and is restricted generally to the continental shelf of the western North Atlantic and Gulf of Mexico between about 35° N and 20° N latitude (Broom, 1976).

The calico scallop ranges from the northern side of the Greater Antilles, throughout the Gulf of Mexico, to Bermuda and slightly north of Cape Hatteras (possibly Delaware Bay) in waters varying from 2 m (6.6 ft) at Bermuda to 370 m (1,214 ft) on the northern side of the Greater Antilles (Allen and Costello, 1972). Off the Florida east coast, depth of occurrence was 9 to 74 m (30-243 ft) while off North Carolina, south of Cape Hatteras, calico scallops were reported at depths of 13 to 94 m (43-308 ft) (Allen and Costello, 1972). Roe et al. (1971) reported depth distributional differences off Florida, noting scallops south of Cape Canaveral were generally found in shallower water than north of the Cape. However, Sutherland (unpublished report) reported that scallop beds located north of Cape Canaveral were not always found in deeper water than those south of the Cape. The beds usually occur in open marine water rather than estuarine areas (Waller, 1969).

Calico scallop beds are generally distributed on the continental shelf parallel to the coastline. These beds are most abundant off Cape Lookout, North Carolina; Cape Canaveral, Florida; and Cape San Blas, Florida, in the northeastern Gulf of Mexico. On the Cape Canaveral grounds, scallops occur in long narrow bands, or beds, more than 800 m (2,625 ft) long and several hundred meters wide. A calico scallop bed near Cape Lookout, North Carolina, was elliptical and 15 km (9.3 mi) long. Off Cape San Blas, in 1957, a bed 16 km (9.9 mi) long by 8-16 km (5.0-9.9 mi) wide was located (Bullis and Ingle, 1959). The greatest concentrations of these scallops appeared to be near coastal prominences (Allen and Costello, 1972).

Populations of calico scallops were located in 1977 offshore of the South Carolina/Georgia border in 37-45 m (121-148 ft) (Anderson and Lacey, 1979). The scallop bed was elliptical shaped and oriented perpendicular to the coast.

2.2 Biology

The following Section 3 information is taken directly from the Calico Scallop Fishery Management Plan (SAFMC, 1998c).

"3.1.2 Reproduction

Spawning in calico scallops is related to age rather than size, with scallops as small as 19 mm (0-75 in) shell height found to be ripe, based on gonadal color (Roe et al., 1971). Miller et al. (1980) described ovarian development based on color changes for calico scallops on the Cape Canaveral grounds, concluding that "Scallops that set (become attached to substrates) in winter and early spring will spawn one or more times in spring and early summer at ages 4 to 7 months, and will spawn again in winter, spring, and early summer at ages 11 to 18 months. Calico scallops that set in late spring or early summer will spawn the following winter, spring, and early summer at ages 6 to 13 months." Like the bay scallop, the calico scallop may spawn intermittently many times during the ripe period.

Spawning in the calico scallop varies between years, suggesting that changes in water temperature affect spawning. By raising the ambient water temperature from about 20° to 25° C (68° to 77° F) scallops caught on the Cape Canaveral grounds were induced to spawn in the laboratory (Costello et al., 1973). Miller et al. (in press) suggested that movement of cold water

into a calico scallop zone apparently initiates spawning when the bottom water temperature falls below 22.5 °C (72.5° F). In 1970 and 1971, off Cape Canaveral, Florida, spawning intensity was highest from January to May when bottom water temperatures at depths of 18 to 55 m (59-180 ft) ranged from about 15° to 22.5° C (59° to 72.5°F) (Miller et al., in press).

Calico scallops are hermaphroditic, ejecting sperm and then eggs into the water where fertilization takes place. In laboratory induced spawning, sperm is released first and after 30 minutes to an hour eggs are released (Costello et al., 1973).

3.1.3 Age and Growth

Calico scallops have a very short life span, living 18 to 24 months. After fertilization of the scallop eggs, larvae develop which are distributed vertically throughout the water column. Development, as described from laboratory studies, takes 14 to 16 days from fertilization until time of settlement (Costello et al., 1973). Upon setting, the larvae, termed spat, attach to substrates by byssal threads. The spat shells differ in shape and color from those of adult scallops (Allen, 1979).

Growth data of spat caught in traps show that in one month calico scallops can reach 1.5 mm (0.06 in) shell height[1] in two months, 17.0 mm (0.67 in); and 28.0 mm (1.10 in) in three months (Allen, 1979). Scallops reach commercial size, 40 to 45mm (1.87 to 1.77 in) shell height, in six to eight months (Miller and Hudson, unpublished report). However growth rates of spat in traps are affected by location in the water column and by density of spat.
Roe et al. (1971) reported that growth increases rapidly up to about 50 mm (1.97 in) shell diameter. Scallops become senile at 75 to 80 mm (2.95 to 3.15 in) shell diameter, with a maximum size of about 80 mm (3.15 in) and a maximum age not greater than 24 months, averaging 18 to 20 months. Miller and Hudson (unpublished report) presented an age-growth curve (Figure 5-1; Appendix A) derived from scallops spawned on the Cape Canaveral grounds. The scallops in cages averaged 9.3 mm (0.37 in) shell height at 54 days; at six months from spawning, scallops had reached commercial size, 40 mm (1.58 in); mortality of the caged scallops began at 13 months; and maximum age of the year class was 18 to 19 months.

3.1.4 Mortality

Monthly mortality rates range from 12 to 23 percent, depending on seasonal variations (Roe et al., 1971). Factors affecting mortality may be drastic fluctuations in water temperature, predation, or senility. Post-spawning mortality was reported by Carpenter (1967) and Roe et al. (1971) to occur in the northeastern Gulf of Mexico and Cape Canaveral grounds, respectively. For Cape Canaveral, post-spawning mortality averaged 23 percent per month.

"The disappearance of calico scallops from an area is common" (Allen and Costello, 1972) and has been documented by numerous authors. When grounds that were formerly productive contain only empty calico scallop shells, mortality or poor recruitment is indicated.

Bullis and Cummins (1961) reported sudden heavy natural mortality of calico scallops in the northern two-thirds of Cape Canaveral grounds in late winter of 1960, while the southern third of the same grounds contained abundant live scallops. The causes of mass mortality were not known, but it was concluded that factors influencing mortality did not affect all areas

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[1]

Shell Height	Shell Depth
3.5-8.0 mm	27-31%x shell height
19.0-23.0 mm	37-46%x shell height
37.0-65.0 mm	54-64% x shell height

simultaneously. These authors also reported that large, older scallops, possibly at the "end of their life span" had adductor muscles too weak to completely close their shells.

Sutherland (unpublished report) suggested mass mortality off Cape Canaveral between 1971 and 1972 of all sizes of scallops was due to temperature change. During late June and early July of 1977, two areas of mass calico scallop mortality occurred off the South Carolina coast in depths of 31.1 and 32.9 m (102 and 108 ft). The mean shell height at this time was 29 mm (W. D. Anderson, S.C. Marine Resources Center, Charleston, SC, pers. comm.). One mass mortality of calico scallops occurred on the Cape Canaveral beds 8.1 to 9.7 km (5-6 mi) offshore, slightly south of New Smyrna. Scalloping began in October 1980, and by mid-December fishing effort had ceased due to mass mortality.

Documented mass mortalities occurred off Cape Canaveral in early 1989 and again in January and February of 1991. The cause has been attributed to the protozoan parasite, *Marteilia*, but it is not known whether this parasite caused the earlier mass mortalities or not (Arnold, 1995).

3.1.5 Movement Patterns

Calico scallop larvae, being planktonic, occur vertically distributed in the water column. Oceanic currents probably determine the direction of transport of these larvae, with the Gulf Stream system and associated countercurrents important in distribution. Part of the North Carolina calico scallop stock may result from larvae transported northward from the Cape Canaveral grounds by the Gulf Stream (Kirby-Smith, 1970). However, on the Cape Canaveral grounds, bottom current measurements taken during 1970 support the hypothesis that scallop larvae would be likely to remain within the general area. Cyclic flow data demonstrate that for a 16-day larval drift period, the total displacement would be small, varying in experiments from 40 km (25 mi) to 71 km (44 mi) (Leming, 1979). "Surface currents off Cape Canaveral reverse direction to north or south with wind changes, and bottom currents converge toward the Cape from offshore" (Allen, 1979). These current patterns are important in producing repetitive setting of scallop larvae.

After setting, the spat remain attached to the substrate until they grow to about 25 mm (0.98 in) shell height, then detach. The swimming ability of the calico scallop has been observed in the laboratory, by SCUBA divers, and by RUFAS (Remote Underwater Fisheries Assessment System). RUFAS is a remotely controlled underwater sled containing a TV and sequence camera. According to these sources, small scallops swim more readily than large scallops, and adult scallops are able to swim about 46 cm (1.5 ft) off the bottom and resettle 30 cm (1.0 ft) away (Allen and Costello, 1972).

3.1.6 Feeding and Food

The calico scallop feeds by filtering suspended food items from the surrounding water. Laboratory-reared calico scallop larvae were fed unialgal cultures of an unarmored flagellate (*Monochrysis lutheri*) (Costello et al., 1973), and it is assumed that wild scallop larvae consume similar organisms. There is no published information on the food of juvenile or adult calico scallops. However, much of the food of the closely related bay scallop (*Argopecten irradians*) is believed to be "microflora, detritus, bacteria and organic matter," (Davis and Marshall, 1961). When phytoplankton concentrations are extremely low, bay scallops cease to grow, but growth is not influenced by normal variations in phytoplankton concentrations (Kirby-Smith and Barber, 1974).

3.1.7 Predation

There is no information concerning predation on eggs and larvae of the calico scallop. It is assumed that the eggs and larvae are consumed by many plankton feeders.

Many invertebrates and fishes are predators of juvenile and adult calico scallops, as reported by Wells et al. (1964); Roe et al., (1971); Allen and Costello (1972); Porter (1972); Winans (1976); and Schwartz and Porter (1977). The invertebrates include sea stars, gastropod mollusks, squid, octopus, and crabs; the fishes include sharks, rays, and bony fishes. On the North Carolina scallop grounds, Schwartz and Porter (1977) found that 22 species of macroinvertebrates and 24 species of fish fed on calico scallops. However, these investigators did not determine whether the predators were attracted "because of the scallops or because of the activities of the fishery which created available food in the form of broken scallops..."

Predation probably constitutes a large part of calico scallop mortality, occurring during all phases of the life cycle. Little mortality was observed among calico scallops on the Cape Canaveral grounds (Florida) which were held in cages for several months, separated from predators (Miller and Hudson, unpublished report). This fact suggests that predation may be an important cause of mortality of this short-lived mollusk. Large numbers of young calico scallops on the North Carolina grounds were consumed by the sea star (*Astropecten articulatus*) (Porter, 1972). On the Cape Canaveral grounds the sea star, *Asterias* (probably *forbesi*), is abundant, has been observed feeding on adult scallops, and is apparently a major predator (Roe et al., 1971). Adult scallops, particularly, are often heavily fouled by barnacles. Such fouling can prevent complete closure of the valves and provide ready access for predators (Allen and Costello, 1972).

The calico scallop also is host to commensal and parasitic organisms. Cummins (1971) described a nematode, *Porrocaecum pectinis*, which encysts along the periphery of the adductor muscle. This parasite does not survive freezing and has no effect on taste or texture. After cooking, there is no visual detection of the parasite. Lichtenfels et al. (1980) identified parasitic nematode larvae, *Sulcascaris sulcata*, in the calico scallop. Wells et al. (1964) described the following organisms associated with calico scallops: the gastropod, *Odostomia seminuda*, which penetrates the mantle edge of the scallop, drawing up body fluids; the pea crab, *Pinnotheres maculatus*, which has a commensal relationship with the scallop; the annelid, *Polydora websteri* which penetrates the shell, stimulating the scallop to secrete extra layers of shell; and the annelid, *Ceretonereis tridentata* which is found between shell and mantle in blisters and may be parasitic on the scallop."

2.3 Catch and Catch Per Unit Effort

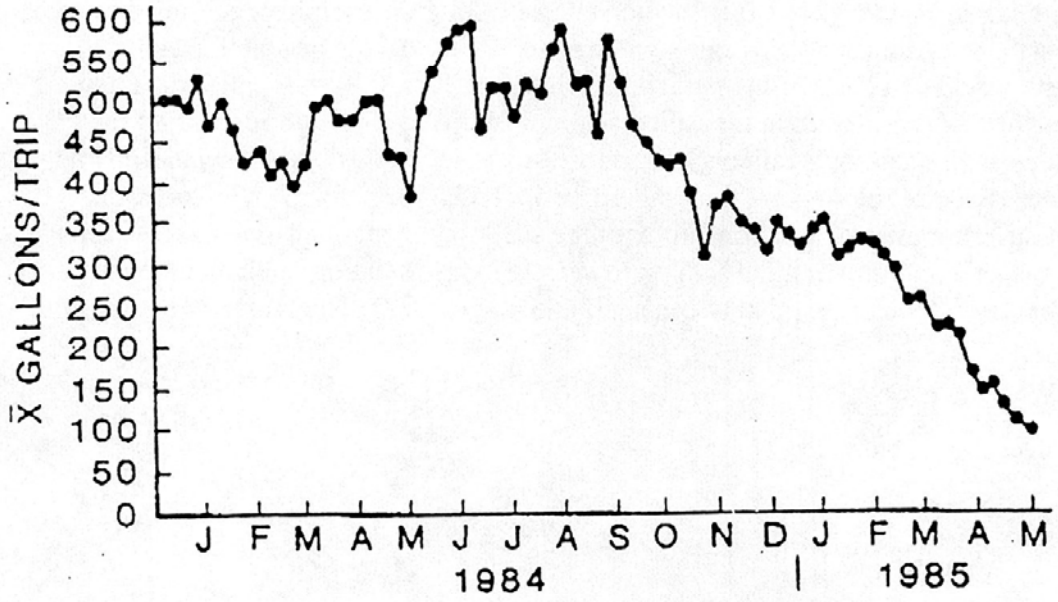
The following text is from Blake and Moyer (1991):

" It has generally been thought that yields off the east coast of Florida are highest in the fall. This is then followed by a decrease in winter and another increase in the spring (Roe *et al.*, 1971). Minimal catches of scallops occur during mid-summer.

The rougher seas of the winter months and hurricanes during the summer months force a temporary reduction in the number of trips per boat. Because the boats are frequently loaded to the point of instability, fishing operations cease in seas of six to eight feet. The efficiency of the fishing gear also diminishes under these conditions.

Thus, total seasonal yields may not be an accurate measure of scallop abundance. A more accurate measure is provided by looking at the number of gallons of scallop meat per trip each week. Weekly average production per trip or catch per unit effort (CUE) for 1984-85 is shown in Fig.1. Catch rates through October 1984 varied from 400-600 gallons per trip with the average being about 500 gallons. After October 1984 catches declined steadily throughout 1985 and fishing efforts were terminated in early summer of 1986. Fishing did not resume until November of 1986.

Figure 1. Weekly Average Production Per Trip for 1984 and 1985 (Source: Blake and Moyer, 1991).



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CALICO SCALLOP SAFE
SEPTEMBER 1999

At the bottom of page 11 the following text should continue after 1974:

survey. In 1970-1971, when standing stock was greatest, surveys showed wide beds, a high percentage of bed occurrence, abundant juvenile populations, and high densities. Scallop beds averaged in excess of 91.4 m (300 ft) in width, regardless of the total bed area, density, or abundance. Large standing stock one year does not ensure stock abundance the next year. Declines and mass mortalities have occurred on the grounds off North Carolina

However, these were not normal fishing years. In the years for which data were available the very high catches were followed by a steady decline and population levels remained low throughout 1985. Table 1 shows a more normal catch per unit effort based on season."

Table 1. Representative Averages of Gallons of Scallop meats Per Trip by Season (Source: Blake and Moyer, 1991)

Season	Mean Gallons/Trip
Fall (Oct. – Dec.)	200–300
Winter (Jan. – Feb.)	200–250
Spring (Mar. – May)	225–350
Summer (June – Sept.)	90–150

2.4 Stock Status

The following Section 3 information is taken directly from the Calico Scallop Fishery Management Plan (SAFMC, 1998c).

"3.1.8 Relative Abundance

Relative abundance of the calico scallop varies with scallop size both within and between areas, seasonally and annually. They are generally most abundant off the Florida east coast near Cape Canaveral, with lesser concentrations near Cape Lookout, North Carolina and Cape San Blas, Florida. Concentrations have also been reported from the eastern Gulf of Mexico between Sanibel Island and Dry Tortugas, and 96.5 km (60 mi) offshore of the South Carolina/ Georgia border. Scallop abundance fluctuates at each area, with good years followed by years when none are available.

The Cape Canaveral scallop grounds are among the largest in the world, extending over 321.8 km (200 mi) from St. Augustine to near Stuart, Florida. Sutherland (unpublished report) made estimates of the calico stock distribution and abundance from data obtained with RUFAS (to visually capture the scallop resource) and tumbler dredges (to obtain samples). He found the bed width was highly variable and ranged from 6.7 to 2,633.5 m (22 to 8,640 feet). Juvenile calico scallop beds in 1970 surveys accounted for almost 4 percent of scallop distribution. Scallop occurrence was uniformly less than 4 percent of completed transect miles.

Abundance estimates of calico scallops larger than 25 mm (0.98 in) on the Cape Canaveral grounds ranged from 1,081.2 million in 1971 to 7.6 million in 1973, averaging 347.9 million (S.D.=353.9) (Sutherland, unpublished report). Abundance was greatest during the 1969-1971 surveys, ranging from 8 to 12 percent of the total miles covered. Although standing stock was lowest in 1973, it increased about 50 times by the 1974

(Lyles, 1969 and Cummins, 1971), in the northeastern Gulf of Mexico (Bullis and Ingle, 1959; Hulings, 1961), and off the Florida east coast (Roe et al., 1971; Sutherland, unpublished report). Off North Carolina the causes of scallop fluctuations have been attributed to mortalities, migration, poor larval transport from elsewhere, and introduction of scallop shucking and eviscerating machines (Schwartz and Porter, 1977), but no one definitive factor has been found to explain why the North Carolina calico scallop beds existed or were productive during certain years.

Relative abundance of calico scallops also varies within areas. Pequegnat and Pequegnat (1968) reported that young scallops in the northeastern Gulf of Mexico were most abundant on fouling panels anchored 18 km (11.2 mi) offshore at 31 m (101.7 ft), while the panels located 3 km (1.9 mi) offshore in 19 m (62.3 ft) and 40 km (24.9 mi) offshore in 46 m (150.9 ft) were less productive. Drummond (1969) showed variations in average abundance of scallops off the eastern Florida coast; catches ranged from 0 to 54 bushels per hour. Sutherland (unpublished report) reported that there was considerable variation in density among scallop beds off Cape Canaveral. In 1976, 15 scallop beds had densities ranging from 0.19 to 29.24 scallops/m^2 (0.23 to 34.97 /yd^2) and averaged 2.97/m^2 (3.55/yd^2; S.D.=10.18/yd^2). There was no consistent pattern to the density of beds; those with high densities occurred adjacent to beds with low densities and were not depth correlated. Scallop abundance south of Cape Canaveral was reported greater than north of the Cape.

3.1.9 Present Condition of the Stock

Because of the large fluctuations in calico scallop abundance, it is difficult to assess the present condition of the stocks. In recent years productive calico scallop beds containing harvestable scallops were located only off Florida. Landings were 15.4 million pounds in 1981, increased to a high of 43.0 million pounds in 1984, declined to zero landings during 1996 , and increased to 1.6 million pounds in 1997 (Tables 2 and 3). There is no reason to believe that the stock is undergoing greater fluctuations now than in previous years.

Table 2. Calico Scallop Landings on the East Coast of Florida. Source: Martha Norris, Department of Environmental Protection, Florida Marine Research Institute, Division of Marine Resources. July 28, 1998. Note: Pounds are in meat weight.

YEAR	POUNDS
1986	1,565,784
1987	10,934,704
1988	12,038,688
1989	3,731,000
1990	874,376
1991	39,000
1992	205,061
1993	498,881
1994	4,989,600
1995	945,093
1996	0
1997	1,545,292

Table 3. Calico Scallop Landings and Exvessel Value in the South Atlantic 1981 - 1996 (Source: Linda Hardy, NMFS, Beaufort Laboratory, July 22, 1998. Note: Pounds are in meat weight.)

YEAR	POUNDS
1981	15,417,756
1982	11,036,112
1983	9,470,942
1984	42,966,920
1985	12,521,311
1986	1,565,784
1987	10,933,064
1988	12,706,752
1989	4,066,521
1990	1,259,159
1991	39,000
1992	205,061
1993	501,793
1994	4,989,600
1995	945,093
1996	0

Note: Landings in the south Atlantic are mainly from the EEZ off Florida. Some landings were reported from the EEZ off North Carolina in some years.

3.1.10 Estimate of Maximum Sustainable Yield (MSY)

The traditional concept of MSY does not apply to the calico scallop fishery because of unpredictable, naturally occurring fluctuations in stock abundance; it is neither possible nor desirable to specify a number for MSY (J. Zuboy, S.E. Fisheries Center, NMFS, Miami, Fla., pers. Comm.). For management purposes, MSY could be set as all calico scallops of commercially processable size that can be harvested in a given year.

Biological and environmental factors associated with stock fluctuations include the following: 1) short life span and high, sometimes mass, mortality; 2) high fecundity and intermittent spawning; 3) rapid growth and early sexual maturity; 4) water-current patterns conducive to repetitive setting of larvae; and 5) water temperature favorable for survival and growth. A preponderance of negative or positive factors can result in large annual fluctuations in stock abundance. Considering the short life span of the calico scallop, harvesting should be vigorously pursued to minimize loss by natural mortality.

Several fishery-related factors minimize the liklihood of recruitment over-fishing. Many scallop beds are not harvested each year because of the vastness of the scallop grounds and the relatively small size and wide dispersion of scallop beds on the grounds. Spawning stock is also provided by scattered individual scallops and scallops which occur in beds at densities too low to harvest economically. Scallops less than about 40 mm (1-6 in) shell height normally are not harvested by the fishery because they are below market size, but scallops as small as 20 mm (0.79 in) are capable of spawning (Miller et al., 1980). When catch rates in commercial bed areas drop below a profitable level, harvesting ceases, leaving the remaining scallops to contribute to stock replenishment.

3.1.11 Probable Future Condition of the Stock

Considering the factors discussed in Section 3.1.10, the calico scallop stocks are expected to remain viable indefinitely unless environmental factors change to a degree which severely affects reproduction and survival."

3.0 FISHERY EVALUATION

3.1 Economic Status of The Fishery

Information in this section was taken from the final fishery management plan for Calico scallops (SAFMC, 1998c, Appendix L). In addition, recent data on landings, imports and exports are included. A detailed account of the history, industry organization, and other economic variables are contained in Appendix L.

Historical Account of the Commercial Fishery

The domestic fishery for calico scallops is entirely commercial. Concentrations of calico scallops and principal fishing areas are located off North Carolina, northeast and southwest of Cape Lookout; off the east coast of Florida from Ft. Pierce northward to the St. Johns River; and in the northeastern Gulf of Mexico between Carrabelle, Florida and Mobile, Alabama (Cummins, 1971) (Figure 8-1; Appendix A). The location and productivity of beds within these three principal fishing grounds fluctuate annually and, to a lesser extent seasonally, and consequently, so does the distribution of fishing effort both within these areas and over the region. In addition to the three traditional fishing areas identified above, some commercial scalloping activity has occurred offshore of Tampa and Key West, Florida, and offshore of the South Carolina/Georgia border.

Natural fluctuations in the abundance of the resource have precluded development of a long-term, directed fishery for calico scallops in many areas where concentrations have been located. Consequently, much of the commercial production has been by shrimp fishermen who have fished for scallops, when they are available, as an alternative to shrimp fishing during poor seasons or as a means of supplementing their income during the off season. An exception to this is off the east coast of Florida where, due to the large size of the Cape Canaveral beds, commercial production has occurred fairly consistently since 1967. In this area, up to 10 factory-type vessels, which were specially equipped for processing calico scallops, were engaged in the fishery intermittently since 1969. During 1980, one factory-type vessel was fishing in the area and plans were made for two more to enter the fishery in the spring of 1982.

During 1980 and 1981, the number of vessels harvesting scallops increased to between 75 and 150. These numbers included 15 processor owned shrimp vessels which had been rigged for use in the calico scallop fishery out of Cape Canaveral. These boats and vessels hailed from home ports along the Gulf of Mexico and the entire East Coast of the U.S. This large increase in number of boats and vessels, combined with the diverse makeup of the new entrants, resulted in conflicts.

More recent information from scoping meetings and the Council's Calico Scallop Advisory Panel indicates there are approximately 25 vessels currently operating in the fishery. Information on the current status of the harvesting sector was provided by two calico Scallop Advisory Panel members, Mr. William Burkhardt (owns an at-sea calico scallop processing vessel), and Mr. David Bates (owns a shell stock calico scallop vessel that makes day trips) through personal communication during the Joint Calico Scallop Committee and Advisory Panel meeting in Charleston, South Carolina on July 30, 1998.

Vessels and Gear

Three basic types of vessels have been used in the calico scallop fishery. They, in turn, have used three types of gear with some interchange of gear between vessel types. These are shrimp trawlers, scallop vessels designed for use in the sea scallop fishery, and specialized calico scallop vessels with processing equipment aboard. The first two vessel types have basically

sought to land shellstock (i.e., intact scallops including shell, viscera, and edible adductor muscle meat after sorting from debris) for processing ashore. The specialized calico scallop vessels are designed to produce scallop meats with the shucking and evisceration done at sea. The gear used has included modified otter trawls, modified sea scallop dredges, and calico scallop dredges (Figure 8-2; Appendix A).

Currently, there are two types of vessels involved in the calico scallop fishery in the South Atlantic region. The Type I vessel is referred to as the at-sea processor. Only one Type I vessel operates in the calico scallop fishery at the present time. All of the calico scallops harvested by this vessel are processed at sea. The second type of vessel, referred to as the Type II vessel, is also called a shell stock vessel, because all the calico scallops harvested are brought to port in the shells. Processing of calico scallops harvested by these vessels is done at shore based facilities. In 1997, 25 Type II vessels reported harvests of calico scallops.

Table 4. Costs and Earnings of At-Sea Processor vs. Shellstock Vessel (SAFMC, 1982).

	TYPE I: AT-SEA PROCESSOR	**TYPE II: SHELL STOCK**
VESSEL LENGTH	85 feet	65 feet - 100 feet
VESSEL AGE (AV.)	15 years	3 - 25 years
LENGTH OF SEASON	Could be throughout the year. There is no defined season. The fishery operates when calico scallop beds are found. Calico scallops live for approximately 48 months.	
DURATION OF TRIP	3 - 5 days	Daily trips (12 - 15 hours)
AV. # OF TRIPS / SEASON	0 - 40 per year	Av. 4 days/week (40 weeks). Could be from 0 - 160 trips.
# OF VESSELS IN FISHERY	1 (1997/1998)	25 (1997). None has entered the fishery in 1998.
CREW SIZE	3 - 6 men	2 -3 men
AV. CATCH /TRIP	500 gal. - 2,000 gal. (shucked). 8 lbs. = 1 gal. (shucked weight)	250 - 300 gal. 8 lbs. = 1 gal. (shucked weight)
AV. EXVESSEL PRICE	$16 / gal. - $32 / gal. (shucked meat)	$4 / gal. - $10 / gal. (shell stock)
AV. REVENUE/TRIP	$8,000 - $32,000	85' vessel: $1,500 / trip 100' vessel: $2,000 / trip
CREW SHARE	30% of gross revenue	30% of gross revenue
BOAT OWNER SHARE	70% of gross revenue	70% of gross revenue
VESSEL OPERATING COSTS	$500 per day	$300 - $500 per trip
VESSEL FIXED COSTS (ANNUAL)	$100,000. Includes annual vessel maintenance, etc.	Depends on vessel size.
BREAK EVEN REVENUE PER TRIP	Av. $2,500 per day	$1,200 -$1,500 per trip

Calico scallop landings by vessel size category from 1994, 1995, and 1997 were provided by Martha Norris, FL DEP (Table 5); there were no landings in 1996. Data were provided for vessels less than 50 feet, 50-59.9 feet, 60-69.9 feet, 70-79.9 feet, and 80-89.9 feet. In order to not show confidential data, landings were combined into the two vessel size categories shown in Table 5. The "Unknown" category includes landings by Florida Salt Water Products Licenses (SPLs) with no associated vessel information. Vessels in the 70-89.9 foot category harvested approximately half of calico scallops landed between 1994 and 1997. In 1994 there were two vessels under 50 feet, one in 1995, and none in 1997. In fact the smallest vessels harvesting calico scallops during 1997 were in the 60-69.9 foot category.

Table 5. Calico Scallop Landings by Vessel Size Category. Source: Martha Norris, Department of Environmental Protection, Florida Marine Research Institute, Division of Marine Resources. July 29, 1998. Note: Pounds are in meat weight.

VESSEL SIZE CATEGORY	YEAR					
	1994		1995		1997	
	POUNDS	# DEALERS	POUNDS	# DEALERS	POUNDS	# DEALERS
UNKNOWN	1,411,480	27	252,784	8	604,768	12
<70 FT	1,319,384	11	161,416	6	67,424	4
70-89.9 FT	2,258,736	17	530,893	10	873,100	11
TOTAL	4,989,600	55	945,093	24	1,545,292	27

Landings/Catches

Calico scallop landings have been extremely erratic in both North Carolina and Florida, largely due to natural fluctuations in the abundance of the resource. In both areas, the history of the fishery has been marked by two to three years of relatively high production followed by years during which production was nil or landings were generally declining (Table 8-2; Appendix A).

In North Carolina, peak landings of 1.86 million pounds occurred in 1966; production was also high (over 1 million pounds) in 1967, 1970, 1971 and 1972. Between 1974 and 1978, no calico scallops were landed in North Carolina.

In Florida, calico scallop landings have occurred consistently since 1967, although production has fluctuated irregularly. Off the east coast of Florida, major production began in 1974 and increased in 1975 to 1.4 million pounds of scallops. Average landings over the next four-year period were approximately 491,000 pounds. In 1980, landings rose to 2.6 million pounds and peaked in 1981 at 14.4 million pounds.

Calico scallop production in the northeastern Gulf of Mexico off the west coast of Florida has been the most erratic of the three major producing areas. Landings increased from 548,000 pounds in 1975 to a peak of 1.8 million pounds in 1976 and declined to 28,000 pounds in 1978.

The only other area where significant commercial landings of calico scallops has occurred is in South Carolina. Concentrations of calico scallops discovered in 1977 off the South Carolina-Georgia border were fished from January to May of 1978; these beds yielded 611,318 pounds of scallops. Beds discovered in 1981 were fished in 1982. Georgia had landings of 87,000 pounds in 1978 and 33,000 pounds in 1979.

In recent years landings in the South Atlantic EEZ has mainly been restricted to the east coast of Florida. Peak landings occurred in 1984 with 42,966,920 pounds of meat landed (Table 6). Over 10 million pounds of meat were landed in the east coast of Florida in 1987 and 1988 but landings have been sporadic since that time ranging from about 5 million pounds in 1994 to no harvest in 1996 (Table 6). Harvesting resumed in 1997, and landings for both 1997 and 1998 only occurred off the East Coast of Florida.

Table 6. Calico Scallop Landings and Exvessel Value in the South Atlantic 1981 - 1998 (Source: Linda Hardy, NMFS, Beaufort Laboratory July 22, 1998; and August 3, 1999). Note: Pounds are in meat weight.)

YEAR	POUNDS	VALUE ($)	PRICE/LB
1981	15,417,756	$14,587,183	$0.95
1982	11,036,112	$11,459,703	$1.04
1983	9,470,942	$11,776,929	$1.24
1984	42,966,920	$23,377,756	$0.54
1985	12,521,311	$11,655,518	$0.93
1986	1,565,784	$2,860,645	$1.83
1987	10,933,064	$11,000,598	$1.01
1988	12,706,752	$9,454,013	$0.74
1989	4,066,521	$3,531,597	$0.87
1990	1,259,159	$2,241,249	$1.78
1991	39,000	$127,149	$3.26
1992	205,061	$768,996	$3.75
1993	501,793	$422,033	$0.84
1994	4,989,600	$2,784,612	$0.56
1995	945,093	$804,628	$0.85
1996	0	$0	
1997	1,545,292	$1,489,200	$0.96
1998	200,058	$327,324	$1.64

Note: Landings in the south Atlantic are mainly from the EEZ off Florida. Some landings were reported from the EEZ off North Carolina in some years.

Relationship Among Harvesting, Brokering and Processing Sectors

Fishermen and vessels involved in the calico scallop fishery are concentrated in North Carolina and Florida, close to areas which have a history of frequent appearance of harvestable quantities of calico scallops, and close to the processors. Nineteen out of 21 calico scallop vessels operating on a regular basis in 1978 and 1979 were from North Carolina. Some of these North Carolina vessels, as well as some Florida vessels, are owned wholly or partly by processors. These companies, engaged primarily in the calico scallop fishery, operate automated scallop processing equipment. Most of the shucking takes place in processing plants although some of this equipment can be mounted on a tractor-trailer rig to be moved to the shore nearest the harvesting location. This expedites rapid shucking which is desirable since calico scallops have a relatively short product life unless frozen.

In Florida, four shucking machines were operating in 1982. The capacity of the processing machines, over 100 gallons of meats per hour, compensates for the small number of machines available for shucking calico scallops. In North Carolina, several machines regularly shuck calico scallops, but other machines are available for use with heavy demand.

The high cost of patented shucking machines requires capital of $150,000 to $200,000 to enter the market. This high investment, plus rapid physical depreciation and/or obsolescence (one or two years), plus sporadic use, partially accounts for the relatively small number of firms in this industry.

In 1978, the cost of preparing an already existing scallop processing plant for operation was given as approximately $6,000 to $7,000. One processor explained that for this sum, the

shucking machines would be overhauled, building made ready for a sanitation inspection, and preparations made for freezer storage of the product.

About 90 percent of the harvest of calico scallops is sold directly to wholesalers in the New York City area, with some products marketed in Boston and Baltimore. Small lots are sold to local restaurants. Wholesale firms distribute the scallops to retail markets.

Scallop shells often have marketable value and have been used in a variety of ways. In North Carolina, for instance, used calico scallop shells sold for about $0.10/bushel seven or eight years ago, to be used for oyster beds, drain fields, and road fill. In Florida, two firms currently use shells to build up low land for resale as homesites.

Assessment of U.S. Harvesting and Processing Capacity

U.S. harvesting capacity is largely determined by the location and availability of scallops which vary constantly (Appendix L). Double-rigged shrimp-type vessels typically make four or five single-day trips per week, weather permitting. Drags are normally of short duration (10 minutes or less). Vessels are paid on a yield basis (i.e., on the amount of meats processed from landed shellstock) which reportedly ranges from two pounds to as much as six pounds per bushel. When large amounts of "trash" (old, broken, or empty shells) are encountered the yield is much lower. Processors started to grade according to size (meat count), with larger meats commanding high prices. It is possible for a good shellstock vessel to produce several hundred 8-pound gallons per day. Currently there are three land-based processors and one at-sea processing vessel (Scoping Meeting Minutes; Appendix B.). This processing capacity is more than sufficient to process the available catch of calico scallops in recent years.

Employment in the entire scallop fishery

Employment in the harvesting sector of the calico scallop fishery depends, to a large extent, on the distribution/abundance of the resource which fluctuates widely on a year-to-year basis. For many, if not most, of these fishermen, scalloping is a part-time and/or seasonal activity which provides a means of supplementing the income they derive from other fisheries. For many fishermen, during 1981, income obtained from fishing for scallops represented as much as 75 percent of the total for the year. During 1981, however, especially in North Carolina where shrimping was poor, a greater proportion of income was derived from processing calico scallops.

A relationship exists between scallop fishermen and shrimpers. Economic conditions in the shrimp fishery determine the number of part-time vessels entering the calico scallop fishery. When shrimp are not being caught, or when the season is over, shrimpers are likely to enter the calico scallop fishery when beds are producing. Employment in other sectors of the fishing industry and the relationship to the calico scallop fishery are presented in the sociological impact section.

Domestic Ex-Vessel Prices

Prices paid to fishermen are determined on a per gallon basis, rather than per pound. However, reported statistics at the ex-vessel level are recorded on a per pound of meats basis so they will be consistent with other reported seafood prices per pound. Prices in this section can be converted to a gallon basis using 8 pounds per gallon.

The ex-vessel prices of calico scallops have increased steadily over the years for which continuous data are available, ranging from $0.20 per pound of meats for the region in 1966 to $1.49 per pound in 1979 (Table 9-1; Appendix A). Prices decreased to $1.40 per pound in 1980 and further decreased to $0.95 per pound in 1981. Prices reached their highest ever in 1991 and

1992 at $3.26 and $3.75 respectively. There was a significant decline in price beginning in 1993, where ex-vessel prices fell below $1.00 per pound until 1998 when average price was calculated as $1.64 per pound.

During the late 1970s and early 1980s ex-vessel prices paid to U.S. fishermen for sea, bay, and calico scallop species generally followed the same upward and year-to-year trends over time. Calico scallop prices have moved in the same direction as bay and sea scallop prices with the exception of only a few years. Extreme price increases occurred for sea and bay scallops between 1977 and 1981 and between 1977 and 1980 for calico scallops, principally due to general inflation. U.S. calico scallop prices increased 87 percent while sea and bay scallop prices increased 127 and 82 percent respectively. However, calico scallop prices decreased significantly in 1981 and are still considerably below other scallop prices. Exceptionally large 1981 calico scallops production caused at least some of the price decline in 1981 (Table 9.1; Appendix A).

The similar price trends among species suggest the three species are substitutes at the consumer level of the market system. Some of the price differentials between species at the fishermen level may be explained by transportation cost differences between production and consumption locations. However, the large differential between calico scallop ex-vessel prices and the other scallop prices is too great to be explained by transportation cost differences. One possible reason for the lower relative prices of calico scallops is a lack of a developed competitive market system because of the relatively small size of the fishery and the extreme variation in annual landings. If this is not the case, then there must be a lower consumer demand for calico scallops than for other scallops.

Demand and Consumption Parameters

A price response equation was estimated for calico scallops by Easley and Prochaska (1985). The final equation form is given as:

$$P=0.126791 - 0.186073Q_1 + 0.005664Q_2 - 0.0110961 + 0.000846Y$$

(-3.15)* (0.92) (-0.89) (6.18)*

$R^2=0.91$ DW 1.84

Years of data = 1965-1980

Numbers in parentheses are "t" statistics

*Significant at the 0.01 level

where:

P = U.S. dockside price of calico scallops in current dollars per pound of meats.

Q_1 = Landings of calico scallops in the U.S. in millions of pounds of meats.

Q_2 = Landings of sea and bay scallops in the U.S. in millions of pounds of meats.

I = Imports of all scallops into the U.S. in millions of product pounds.

Y = Total personal income in the U.S. in current billions of dollars.

Several alternative model formulations were specified and estimated. However, they appeared inferior to the above specification. Current prices and income were used rather than deflated prices for two reasons. First, all of the current profile is presented in current prices and this is the price most frequently used by the industry. Second, models with a real income (deflated) specification do not show the total effects of price and quantity changes. That is, total price changes consist of both a price and real income effect.

Price and Income Parameters

Based on the estimated equation for calico scallops, a million pound increase in the landings of calico scallop meats is associated with a $0.186 decrease (19 cents) in dockside calico scallop prices. This parameter estimate when valued at the means yields a price flexibility for calico scallops of -0.345 which means that a one percent increase in landings is associated with approximately a one-third percent decrease in price. The inverse of the price flexibility coefficient gives an approximated price elasticity of -2.90. Since the elasticity is greater than an absolute one (elastic), a decrease in supply will result in higher prices but lower total revenue to the industry. These findings are consistent with other market demand studies on sea scallops (Altobello et. al., 1977; and U.S. Department of Commerce, 1973).

Using an appropriate one-tail test for this hypothesis results in the conclusion that there is no statistically significant relationship between bay and sea scallop landings and calico scallop prices. Increased scallop imports are estimated to have a negative effect on calico scallop prices, however this parameter was not statistically different from zero. There could be multicollinearity among imports, and quantities of bay and sea scallop landings, which could account for the insignificant parameters on these variables.

Estimated income parameters for both the price-supply calico scallop show a positive relation between income levels and scallop consumption. Based on the calico scallop equation, a one billion dollar increase in total U.S. per capita personal income is associated with a $.000846 increase in calico scallop prices. This parameter estimate yields an income flexibility estimate of 1.34 which means that each one percent increase in total personal income is associated with a 1.34 percent increase in calico scallop dockside prices.

Imports, and Exports

The trend in imports is illustrated in Table 7. Except for relatively small downturns, quantities imported (product weight) have shown an upward trend from 1955 through 1977. Imports fell considerably from 1977 quantities of just under 30 million pounds to the 1980 quantity of just under 21 million pounds.

Table 7. U.S. Imports of Scallops 1975-1998. All product forms are combined (Source: Data downloaded from the Foreign Trade Section of the NMFS web site.)

Year	Pounds	Dollars	Price
1975	19,696,015	$37,183,329	$1.89
1976	25,200,124	$ 53,016,436	$2.10
1977	29,723,808	$ 53,040,144	$1.78
1978	28,307,492	$ 72,829,312	$2.57
1979	25,102,651	$ 84,905,869	$3.38
1980	20,841,297	$ 82,002,232	$3.93
1981	26,172,153	$112,708,936	$4.31
1982	20,816,431	$73,012,470	$3.51
1983	34,207,705	$158,665,113	$4.64
1984	27,213,276	$117,296,457	$4.31
1985	41,947,228	$147,069,864	$3.51
1986	47,815,467	$192,558,009	$4.03
1987	39,857,184	$162,272,710	$4.07
1988	31,972,096	$115,705,536	$3.62
1989	40,926,057	$139,914,337	$3.42
1990	39,935,111	$131,561,184	$3.29
1991	29,595,487	$111,367,873	$3.76
1992	38,754,342	$160,209,462	$4.13
1993	51,955,017	$219,181,426	$4.22
1994	56,684,610	$216,872,816	$3.83
1995	48,339,727	$174,791,787	$3.62
1996	58,725,027	$198,798,644	$3.39
1997	60,204,654	$238,121,731	$3.96
1998	53,088,693	$221,115,522	$4.17

Appendix L contains a detailed account of the upward movement in US import prices and domestic scallop prices during the late 60s and early 70s, which coincided with large apparent increases in import demand resulting from reduced domestic landings. Import prices, increased substantially in the 1978-81 period, and reached an all time high of $4.64 per pound in 1983 (Table 7). In the early 1990s scallop imports fell slightly and increased in the late 1990s to a record high of 60.2 million pounds in 1997.

US scallop export figures contained in table x includes all product forms. The combined figures indicate that from 1985 to 1989 scallop exports increased steadily but remained less than 1 million pounds per year. However, there was substantial growth in the early 90s, where over 6 million pounds were exported. Exports fluctuated between 2.6 and 6.9 million pounds throughout the mid and late 1990s. Average nominal price per pound varied between $3.10 and $4.50 during the entire period for which data is available (1985 to 1998).

Table 8. U.S. Exports of Scallops 1985-1998. All product forms are combined (Source: Data downloaded from the Foreign Trade Section of the NMFS web site.)

Year	Pounds	Dollars	Price
1985	603,924	$2,452,887	4.1
1986	814,466	$3,645,990	4.5
1987	846,734	$3,680,583	4.3
1988	666,928	$2,808,159	4.2
1989	1,992,734	$6,793,936	3.4
1990	6,413,616	$19,674,033	3.1
1991	6,262,007	$21,330,775	3.4
1992	2,974,853	$12,240,415	4.1
1993	2,659,325	$10,636,619	4.0
1994	3,513,121	$13,324,947	3.8
1995	3,519,861	$12,821,797	3.6
1996	3,449,046	$13,582,013	3.9
1997	6,956,187	$28,584,409	4.1
1998	4,892,525	$18,184,272	3.7

In summary, the size and share of calico landings relative to the magnitudes of U.S. consumption would lead to the conclusion that in most years it would not have much impact on prices or trade flows, except for perhaps some temporary regional effects. However, for years similar to 1981 when large quantities are landed, price effects may be more pervasive. Timing of landings relative to those of other species could then become more important in maximizing economic returns to harvesting calico scallops, and at the same time, minimizing adverse effects on prices of other species in the region (such as bay scallops).

Economic implications of proposed measures in the Calico Scallop Fishery Management Plan

The Council approved a number of actions under the Calico Scallop Fishery Management Plan (SAFMC, 1998c), which was sent to NMFS for formal review by the Secretary of Commerce on October 5, 1998; the plan has not been implemented as of this date. The following discussion addresses the council's approved actions that may have economic impacts on this fishery.

Action 5 would establish a vessel permit for the calico scallop fishery: This would allow for the universe of vessels in this fishery to be known. It will facilitate implementation of the proposed VMS system. Assuming calico scallop vessels do not have multiple permits, cost to the industry is estimated at $1,125 annually. This estimate would be less since some of the vessels in this fishery own multiple permits.

Action 8A would prohibit harvest of calico scallops in the area bounded to the west by 80°W. Longitude, to the north by 28°30' N. Latitude, to the south by 27°30' N. Latitude, and to the east by the 100 fathom (600 feet) depth contour. Input from the Calico Scallop Advisory Panel indicates there will be some level of impact but the fishermen are willing to accept the proposed area closure given the need to protect habitat.

Action 8b would prohibit harvest of calico scallops in the following two Satellite Oculina HAPCs: (1) Satellite Oculina HAPC #1 is bounded on the north by 28°30'N. Latitude, on the south by 28°'29'N. Latitude, on the east by 80°W. Longitude, and on the west by 80°3'W. Longitude; and (2) Satellite Oculina HAPC #2 is bounded on the north by 28°17'N. Latitude, on the south by 28°'16'N. Latitude, on the east by 80°W. Longitude, and on the west by 80°3'W. Longitude

Industry officials indicated at the Joint Calico Scallop Committee and Advisory Panel meeting held on July 29-30, 1998 in Charleston, South Carolina that the bulk of their harvest comes from statistical area 732. The level of calico scallop landings from these two 1 mile by 3 mile areas is unknown but is likely minimal based on input from the Calico Scallop Advisory Panel.

In a separate effort nine calico scallop vessel owners were contacted by NMFS for their opinions on the impacts of these closed areas. These vessel owners operate 13 of the 27 vessels currently in the scallop fishery. Vessel owners speculated that economic losses would be less than 5% for 7 of these vessels, and greater than 5% for four of the vessels (Appendix E). One vessel owner did not provide an opinion because of his uncertainty due to lack of experience in this fishery.

Action 9 would require the use of an approved vessel monitoring system by calico scallop vessels. This would enhance monitoring and enforcement of closed areas. Set up cost to the industry is estimated between $1,900 to $6,700 per vessel depending on the system utilized. Assuming there are 25 vessels in this fishery, set up cost to industry would be between $46,750 and $166,800.

Research and Data Needs

Statistical reporting requires no additional funding from either Federal or State agencies. This information presently is being collected by the States of North and South Carolina, Georgia and Florida, and the National Marine Fisheries Service. This information is necessary for the Councils to monitor the fishery in the future. An updated situation and market outlook should be conducted for this fishery which would require the following information, most of which is currently collected by federal or state agencies:

1. Total Landings By Month By Area.
2. Ex-Vessel Value; Annual Wholesale Value; and detailed Price Information.
3. Landings and price information on domestic landings of bay and sea scallops.
4. Boats and Vessels : General Characteristics; Number of Crew; Gear Type and Size.
5. Shore Facilities.
6. Employment.

Scallop Imports and Exports.

3.2 Social Evaluation

Data on the social and cultural framework of domestic calico scallop fishermen were not available through written sources. Therefore, most of the information gathered has been through personal interviews conducted by Peter Fricke and Albert Rhodes of the Plan Development Team, and John Maiolo of the East Carolina University. This material was included in the Profile Update of the Calico Scallop Fishery in 1982 (SAFMC, 1982). Recent data are not available. Appendix M contains more detailed data on fishing communities in the South Atlantic.

Ethnic Character, Family Structure, and Community Organization

Ethnic Character

The captains and crews of the vessels regularly fishing for calico scallops are white and drawn from the basic Anglo-Saxon stock of the south Atlantic coastal plain. No women work as captain or crew in the harvesting sector. Some of the vessels which enter the fishery on an occasional basis (often when shrimping is poor) have black captains and crew members, but the proportion of minority group members who participate in the fishery is very small.

Minority groups are under-represented in the processing sector as well (insofar as the number of minorities who work in processing plants represent a smaller proportion than their proportions in the communities). Fewer than 10 percent of the processing/packing employee groups are non-white and no minority group members own any of the processing facilities. In most areas, more than two-thirds of the sorting/packing employees are women. In North Carolina the number approaches 80 percent.

Family Structure

Participants in the harvesting and processing sectors generally have strong community ties. In the past, strong family ties have been prevalent as well. However, the sudden change (increase) in the pursuit of the fishery has impacted on the recruiting of both harvest and processing personnel. Primary group ties have not been able to produce a sufficient labor supply to captain and crew the boats, or to provide processing personnel.

This phenomenon is not unusual in fisheries undergoing expansion. Fission (the breakdown of family networks) in periods of rapid growth, and fusion (the recombination of family networks) in periods of stability or declines has been documented. During the fall of 1981, a notable amount of recruiting for captains, crew, and processor personnel was occurring outside the networks considered to be traditional.

Community Organizations

The complex social organization of communities on the east coast of Florida where fishermen comprise only a small fraction of the population has few similarities to the small integrated rural coastal communities that characterize areas in North and South Carolina, Georgia, and the northeast Gulf of Mexico. These communities have been defined as metropolitan/non-metropolitan communities. In the former, size, complexity and density are associated with secondary and tertiary manufacturing as the key functions in the socioeconomic structure. In the latter are seen small population centers, a diverse but primary production economy and low density. In both cases fishing can produce significant amounts of revenue but the proportions to the total are quite different (e.g., Port Canaveral, Florida. vs. Morehead City, North Carolina). Even the nature of the occupational structures may not appear to be all that different in some respects, but may produce entirely different outcomes. For example, the number of full-time fishermen in Carteret County, North Carolina is insignificant, yet they

generate a significant proportion of county income (about $25 million annually). The main implication of the differences noted is that a shift in fishing opportunities may have nearly identical impacts on dissimilar communities at one level, e.g., number of fishermen, economics, etc., yet quite different impacts at another level, e.g., proportion of total revenues to the communities involved.

Age, Education, and Experience of Commercial Fishermen

In the harvesting sector, the median age of the scallop fishermen is estimated to be approximately 37 years old. About one out of eight are in the age range 20-30, and probably less than four percent of the active captains are over 50 years old.

The median education of the fishermen is about the eleventh grade; less than a third have finished high school. A few attended college. Younger fishermen have slightly more education.

The processing sector includes a few men who are older than boat crewmen and some women who are younger than these crews. As a group there is greater variability in age among processing employees, but the average education is about the same as in the harvesting sector.

Employment Opportunities and Unemployment Rates

Employment opportunity in the calico scallop fishery is limited. The cost of entry, defined as the cost of equipping and manning a boat and loss of earnings during the switch from other fisheries, may deter many from entering the fishery. Fishermen, in 1978, estimated the cost of modified nets to be around $3,500 per vessel, and the cost of extra crew needed to be the equivalent of two deckhands shares. Loss of earnings during the changeover varied according to season and species sought, but was approximately two fishing days, with estimates ranging from one day to five days. For the calico scallop fishery, no licenses are needed, but landing permits are required in some ports, and fees charged by dock owners are said to be higher for nonlocal boats.

The relative constancy of employees in the harvesting sector also limits entry into the fishery. There is little turnover of those employed full-time. When calico scallop beds have been depleted in an area, processors often pay boat crews to search for scallops elsewhere.

In the event of collapse or severe curtailment of the calico scallop fishery, some captains and crews might find employment in the shrimp fishery. In the event of a decline in this and related fisheries, persons regularly engaged in calico scallop fishing would have difficulty finding alternative employment because of low levels of educational attainment, non-transferable skills and the depressed labor market. Table 11-1(Appendix A) shows the general trends in fishery employment overall during various years. This information is general in nature and that component directly related to the calico scallop cannot be determined. However, it is useful in presenting an overall picture of fishery employment.

The processing sector requires about 12 to 30 persons, mostly semi-skilled, to operate the shucking-packing equipment, sorting and handling, and on-site generators for each site where scallops are being processed. Also, truck drivers are employed (through contractual agreements) for moving the mobile equipment and for carrying the product to market. In the event of a decline in the calico scallop fishery, these laborers and truck drivers would be able to work for other fisheries, such as shrimp processors. Number of plants and employment in the processing and wholesale sectors of the fishing community as a whole in the South Atlantic and Gulf regions are shown in Table 11-2 (Appendix A). Once again, that proportion associated with the

calico fishery is unknown and usually very small; however, in North Carolina it can reach as high as 40 percent in the spring (J. Maiolo, East Carolina University, N.C. pers. comm.).

In a 1978 survey in North and South Carolina, and Georgia, fishermen were asked the following three questions about calico scallop fishing: Question A: "Would you like to fish for calico scallops if the opportunity came about?" Question B: "Would you contact a dealer or buyer if a bed were found nearby?" Question C: "Do you think you would be able to arrange with a buyer for the sale of your catches?" The results are shown in Table 11-3 (Appendix A).

There appears to be a relationship between desire to participate in the fishery and previous calico scallop activity in that port. The answers to Question C, on whether fishermen would be able to get a landing agreement, show a realistic assessment of the situation with regard to the supply of scallops and the capacity of the shucking machines.

Economic Dependence on Commercial or Marine Recreational Fishing and Related Activities

As indicated above, the full-time core participants in the calico scallop harvesting sector are heavily dependent upon the fishery. The regions are for the most part in what have been described as economically depressed areas where there are few opportunities for alternative employment (see list of landing ports, Section 3.4.7). In the event of sustained shortages and/or high costs of energy, the tourist industry would offer even less employment opportunity than it does at present. Charter or headboat fishing does not seem to be an alternative livelihood for calico scallop fishermen, who lack capital to purchase boats for this purpose, even if the demand were to increase. Cursory study suggests that the present fleet of charter or party boats would absorb any increase in demand for charter or headboat fishing.

Distribution of Income Within Fishing Communities

Crews and skippers are normally paid on a share system, and this, combined with the natural fluctuations in the availability of the scallop, can lead to periods of high earnings followed by periods in which little or no money is earned. During periods of time when calico scallops are very abundant, fishermen can earn more money in the calico scallop fishery than in most other fisheries in the region.

However, due to fluctuations in abundance of calico scallops, this relationship probably would not hold true on an annual basis. Refer to Section 3.6.1 for discussion of the investments made by processors. Those working in the processing sector usually earn higher than minimum wage, with time-and-a-half for overtime. In the past, in North Carolina some calico scallops were hand shucked and these workers were paid on a per unit basis, varying between $2.50 and $3.00 per gallon of shucked meat (J. Maiolo, East Carolina University, N.C.; pers. comm.). Truckers are paid by the load on a contractual basis; the amount ranges between $400 and $1,600.

Updated Social and Cultural Information

Florida's eastern coastline is made up largely of metropolitan counties with relatively few rural counties remaining. This is primarily due to dramatic increases in population for Florida's coastal counties over the past 50 years. Because they are largely metropolitan, fishing communities here may be subsumed into these larger metropolitan areas and difficult to identify.

The information shown in Tables 9 and 10 represent only the readily available information for the State of Florida and does not constitute definitions of communities or their dependence.

Table 9. Number of Fishers and Mean Annual Income for Florida in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of fishers			
Male	2,698	2,844	5,544
Female	111	270	381
Total	2,809	3,116	5,925
Mean Annual Income ($)			
Male	$23,288	$11,794	$17,388
Female	$17,285	$11,511	$13,193
Total	$23,051	$11,770	$17,118

Table 10. Number of Captains of Fishing Vessels and other officers and Mean Annual Income for Florida in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of Captains			
Male	430	633	1,063
Female	26	25	51
Total	456	658	1,114
Mean Annual Income ($)			
Male	$25,993	$21,274	$23,183
Female	$8,487	$15,420	$11,885
Total	$24,995	$21,052	$22,666

At present, the primary fishing grounds and landing areas for calico scallop are Florida's east coast and in particular Brevard County. Earlier research indicated that communities with some connection to the calico fishery on the east coast of Florida included Mayport, Port Canaveral, and St. Augustine. For the purposes of this plan, only demographic data for Brevard county will be included until more detailed, recent information on the fishery and its social and cultural components can be included (Tables 11 and 12).

Table 11. Population and Economic Information for Brevard County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Brevard				
	Population	435,546	443,337	450,238
	Personal Income (Thousands of $)	$8,564,204	$8,938,218	$9,341,030
	Per Capita Pers Income ($)	$19,663	$20,161	$20,747
	Personal Income Fishing (Thousands of $)	$3,600	$4,690	$3,797

Table 12. Number of Industries in Agriculture, Fishing, and Mining, and the Number of Individuals in Farming, Fishing, and Forestry for Brevard County, Florida for 1970, 1980, and 1990. Source: MARFIN Socio-demographic Database.

County		1970	1980	1990
Brevard				
	Agriculture, Fishing, and Mining	1394	2279	3585
	Farming, Fishing, and Forestry	764	1772	3369

Data Requirement for Social Impact Assessment

If the Council considers limited access in future management of the calico scallop fishery, it will become necessary that some minimum set of socio-economic data be collected to allow for as complete an analysis of the impacts as possible. Therefore it is recommended that the following social data at a minimum be collected prior to consideration of any limited access system:

1. Number of participants and their age, education, and marital status.

2. Years fishing and family history of fishing participation.

3. Percent of total household income from commercial fishing (include total household income).

4. Effort by species and month and gear type (include all species fished and location to assess multi-species nature of calico scallop fishermen).

5. Job skills and employment history (job training).

6. Perceived opportunities for alternative employment.

7. In addition, the Magnuson-Stevens Act now requires that impacts upon fishing communities be considered as the Council deliberates taking action. There is an important need for community level data for social and economic impact assessment. Linking permit data files with census data may be one avenue to explore in providing the necessary information for this type of analysis.

A further recommendation is that the NMFS review and implement the "Southeast Social and Cultural Data and Analysis Plan" as this would address many of the current data needs. In addition, the ACCSP Technical Source Document IV contains detailed social and economic data needs and draft survey instruments. Social and economic data collection projects should at least collect the minimum data elements.

3.3 Research Needs

The following list of research needs is from the Calico Scallop FMP. Additional economic and social research needs can be found at the end of those sections (Sections 3.1 and 3.2) in this SAFE report.

1. Growth and mortality factors need further quantification to refine the critical size estimates.
2. The size frequency of individual calico scallop beds as they are fished, mature, and die is needed to further refine the minimum size specified.
3. There is a lack of information concerning the percentage of calico scallops that can be opened during an at-sea processing operation. The Council supports this research need because it addresses one of the issues and can be completed in a relatively short period of time and at low cost.
4. Survival rate of released calico scallops is required to further evaluate at-sea processing. There is at present only one boat processing at-sea but this could increase in the future. This research need addresses one of the issues and should be undertaken in the very near future given the low cost and short time frame required.
5. Information is needed to address the following areas concerning parasitic nematodes: (1) occurrence of the nematode; (2) survival of the nematode; (3) effect of processing, food handling, reconditioning and associated problems; and (4) consumer perception. Research on the parasitic nematode is aimed at addressing one of the issues and should be supported. Florida Sea Grant and the calico scallop fishing industry have expended some effort in this area.
6. The effect of ocean disposal of at-sea processing waste on the scallop beds should be investigated. Concern has been expressed that this could increase calico scallop losses due to predators. This addresses Issue Number 4 and given the potential increase in at-sea processing more information is needed by the Councils to properly evaluate the situation.
7. The effect of the removal of such a large quantity of hard substrate (shells) that could provide attachment sites for spat settlement should be investigated. This addresses one of the issues and it is recognized that this is a long-term research effort.

4.0 ECOSYSTEM CONSIDERATIONS

4.1 Introduction

As a result of the Sustainable Fisheries Act Amendment to the Magnuson-Stevens Fishery Conservation and Management Act in 1996, the Councils and the NMFS have been mandated to use an ecosystem approach in managing the Nation's fisheries. The Council has taken the first step with the submission of the Habitat Plan (SAFMC, 1998a) identifying and describing in detail essential fish habitat (EFH) for species managed throughout the South Atlantic and with the submission of the Comprehensive Habitat Amendment (SAFMC, 1998b) amending all existing FMP's to include descriptions of EFH and EFH-habitat areas of particular concern (EFH-HAPCs). By including an Ecosystems Considerations section in the required SAFE reports, existing data regarding the effects of a fishery on the ecosystem will be provided to the Council on a species by species basis while emphasizing the need for a new level of information. This section will also provide the Assessment Group with a forum in which to express their ecosystem concerns for a specific fishery. In addition to receiving information from various scientist , information concerning ecosystem issues has also been gathered through discussions with the Calico Scallop Advisory Panel and other people familiar with the fishery and has been included in this section.

While incorporating ecosystem concerns into stock assessment reports is a new approach for this Council, this approach has been taken by the North Pacific Fishery Management Council for several years. A copy of their ecosystems chapter has been included as Appendix E [Note:SAFMC,1999] and is an example of the way the ecosystem approach can be used in annual SAFE reports. Another supporting document detailing new ideas and approaches to holistic management is the report to Congress from the Ecosystem Principles Advisory Panel of the NMFS [Note: Appendix F, SAFMC,1999], appointed by the National Academy of Sciences. Congress charged NMFS with establishing this panel to assess the extent that ecosystem principles are used in fisheries management and research and to recommend how such principles can be used to improve our Nation's management of living marine resources.

Ecosystem considerations presented in the interim final rule to implement the essential fish habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act).

Overview of EFH FMP Amendment Guidelines

The themes of sustainability and risk-averse management are prevalent throughout the Magnuson-Stevens Act, both in the management of fishing practices (e.g., reduction of bycatch and overfishing and consideration of ecological factors in determining optimum yield [OY]) and in the protection of habitats (i.e., prevention of direct and indirect losses of habitats, including EFH). Management of fishing practices and habitat protection are both necessary to ensure long-term productivity of our Nation' s fisheries. Mitigation of EFH losses and degradation will supplement the traditional management of marine fisheries. Councils and managers will be able to address a broader range of impacts that may be contributing to the reduction of fisheries resources. Habitats that have been severely altered or impacted may be unable to support populations adequately to maintain sustainable fisheries. Councils should recognize that fishery resources are dependent on healthy ecosystems; and that actions that alter the ecological structure and/or functions within the system can disturb the health or integrity of an ecosystem. Excess disturbance, including over-harvesting of key components (e.g., managed species) can alter ecosystems and reduce

their productive capacity. Even though traditional fishery management and FMPs have been mostly based on yields of single-species or multi-species stocks, these regulations encourage a broader, ecosystem approach to meet the EFH requirements of the Magnuson-Stevens Act. Councils should strive to understand the ecological roles (e.g., prey, competitors, trophic links within food webs, nutrient transfer between ecosystems, etc.) played by managed species within their ecosystems. They should protect, conserve, and enhance adequate quantities of EFH to support a fish population that is capable of fulfilling all of those other contributions that the managed species makes to maintaining a healthy ecosystem as well as supporting a sustainable fishery. Councils must identify in FMPs the habitats used by all life history stages of each managed species in their fishery management units (FMUs). Habitats that are necessary to the species for spawning, breeding, feeding, or growth to maturity will be described and identified as EFH. These habitats must be described in narratives (text and tables) and identified geographically (in text and maps) in the FMP. Mapping of EFH maximizes the ease with which the information can be shared with the public, affected parties, and Federal and state agencies to facilitate conservation and consultation. EFH that is judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation, should be identified as "habitat areas of particular concern" (HAPC) to help provide additional focus for conservation efforts. After describing and identifying EFH, Councils must assess the potential adverse effects of all fishing-equipment types on EFH and must include management measures that minimize adverse effects, to the extent practicable, in FMPs. Councils are also directed to examine non-fishing sources of adverse impacts that may affect the quantity or quality of EFH and to consider actions to reduce or eliminate the effects.

(ii) EFH determination.

(E) Ecological relationships among species and between the species and their habitat require, where possible, that an ecosystem approach be used in determining the EFH of a managed species or species assemblage. The extent of the EFH should be based on the judgment of the Secretary and the appropriate Council(s) regarding the quantity and quality of habitat that is necessary to maintain a sustainable fishery and the managed species' contribution to a healthy ecosystem.

(11) Review and revision of EFH components of FMPs.

This information should be reviewed as part of the annual Stock Assessment and Fishery Evaluation (SAFE) report prepared pursuant to § 600.315(e).

4.2. Essential Fish Habitat and Essential Fish Habitat -Habitat Areas of Particular Concern Designations

Essential fish habitat is defined in the Act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The definition for EFH may include habitat for an individual species or an assemblage of species, whichever is appropriate within each FMP.

For the purpose of interpreting the definition of essential fish habitat: "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are utilized by fish. When appropriate this may include areas used historically. Water quality, including but not limited to nutrient levels, oxygen concentration and turbidity levels is also considered to be a

component of this definition. Examples of "waters" that may be considered EFH, include open waters, wetlands, estuarine habitats, riverine habitats, and wetlands hydologically connected to productive water bodies.

"Necessary", relative to the definition of essential fish habitat, means the habitat required to support a sustainable fishery and a healthy ecosystem. While "spawning, breeding, feeding, or growth to maturity" covers a species full life cycle.

In the context of this definition, the term "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities. These communities could encompass mangroves, tidal marshes, mussel beds, cobble with attached fauna, mud and clay burrows, coral reefs and submerged aquatic vegetation. Migratory routes such as rivers and passes serving as passageways to and from anadromous fish spawning grounds should also be considered EFH. Included in the interpretation of "substrate" are artificial reefs and shipwrecks (if providing EFH), and partially or entirely submerged structures such as jetties.

The Habitat Plan (SAFMC, 1998a) presents the habitat requirements (by life stage where information exists) for species managed by the Council. Available information on environmental and habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity of the managed species is included.

Essential Fish Habitat for Calico Scallops

The essential fish habitat for calico scallops is the unconsolidated sediments including hard sand bottoms, sand and shell hash, quartz sand, smooth sand-shell-gravel, and sand and dead shell in 43 - 308 ft (13 - 94 m) with concentrations occurring on the Cape Canaveral grounds (Stuart to St. Augustine, Florida) and sporadically occurring northeast and southwest of Cape Lookout, North Carolina in 62 - 102 ft (19 - 31 m), and offshore of the South Carolina/Georgia border in 121 - 148 ft (37 - 45m). In addition, the Gulf Stream is an essential fish habitat because it provides a mechanism to disperse calico scallop larvae.

Essential Fish Habitat-Habitat Areas of Particular Concern for Calico Scallops

There is insufficient knowledge of the biology of calico scallops to identify HAPCs at this time. As information becomes available, the Council will evaluate such data and identify HAPCs as appropriate through framework.

4.3 Description of Habitat

Substrates required by calico scallops vary with scallop size. Under natural conditions, the spat usually attach to dead or living mollusk shells (Allen and Costello, 1972). However, spat has been found attached to navigation buoys (Waller, 1969) and plastic floats (Pequegnat et al., 1967). Allen (1979) reported that young calico scallops attach to a variety of materials in addition to calico scallop shells. Young scallops were found among attached hydroids, but it was not determined that spat attach to hydroids or erect bryozoans before attaching to shell. The dependence of spat on shell for setting and survival has not been studied.

Larger, unattached scallops have been reported from bottoms of hard sand (Rivers, 1962), sand and shell (Cummins et al., 1962), quartz sand (Hulings, 1961), smooth sand-shell-gravel (Struhsaker, 1969), and sand and dead shell (Drummond, 1969). Sutherland (unpublished report) described the environment of the scallop grounds off Cape Canaveral as consisting of shell fragment sands predominantly. Shelf sediments off Cape Canaveral average 60 percent calcium carbonate content; conversely, shelf sediments off Georgia average only 10 percent. High

carbonate sediments off Cape Canaveral lie along the western boundary of the northerly flowing Gulf Stream and southern flowing counter currents.

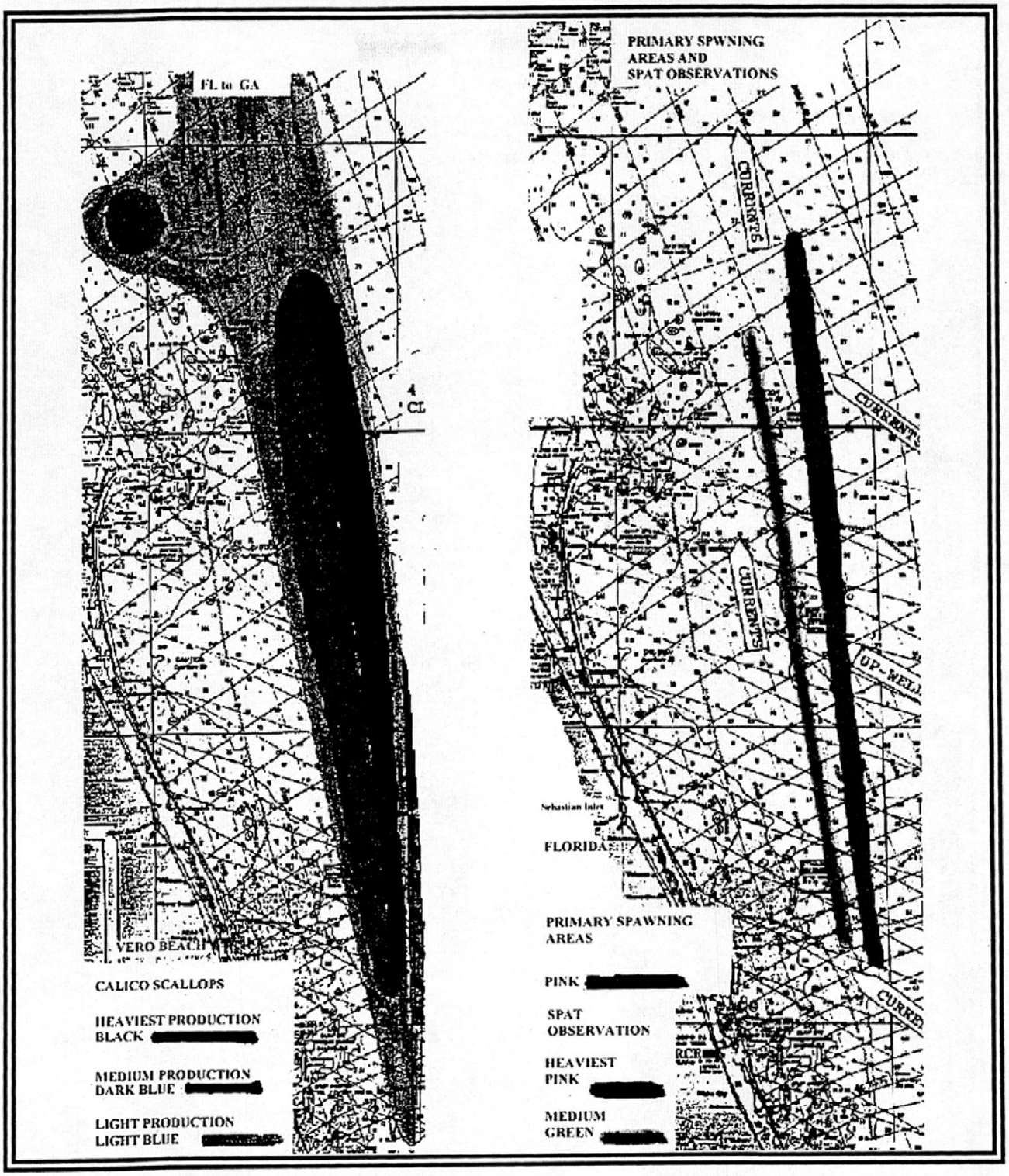
Salinities of areas where calico scallops occur range between 31‰ and 37‰. However, in the laboratory at Florida State University, small scallops taken from waters off Panama City, Florida, have been grown at a salinity range of 25‰ to 30‰ (R.W. Menzel, Fla. State Univ., Tallahassee, Fla.; pers. comm.).

Depths of the heaviest concentrations of calico scallops off Cape Canaveral from 1960-1967 ranged from 26-49 m (85-161 ft), as recorded by exploratory fishing cruises (Miller and Richards, 1980). The most productive area of the shelf in the South Atlantic Bight for calico scallops occurs in the open shelf zone at 33-40 m (108-131 ft), an area with stable warm temperatures (Miller and Richards, 1980). Inshore waters (to 18 m or 59 ft) are cooled below 15°C (59°F), and offshore waters (55 m or 180 ft) are subjected to cold water intrusions off Cape Canaveral, Florida, leaving the intermediate shelf zone with warm temperatures (Miller and Richards, 1980). This warm shelf zone had temperatures ranging from 20° to 23°C (68°-73°F) during February-March 1973 and was bounded on both sides by colder water (Mathews and Pashuk, 1977). Deep, cold water intrusions may have favorable impacts on calico scallops by initiating spawning and producing an abundance of phytoplankton for food, or unfavorable impacts by lowering temperatures below 15°C (59°F), causing mortalities of scallops (Miller et al., 1981). Off Cape Canaveral, bottom temperatures ≤ 15°C (59°F) occurred in depths as shallow as 40 m (131.2 ft) (Leming, 1979).

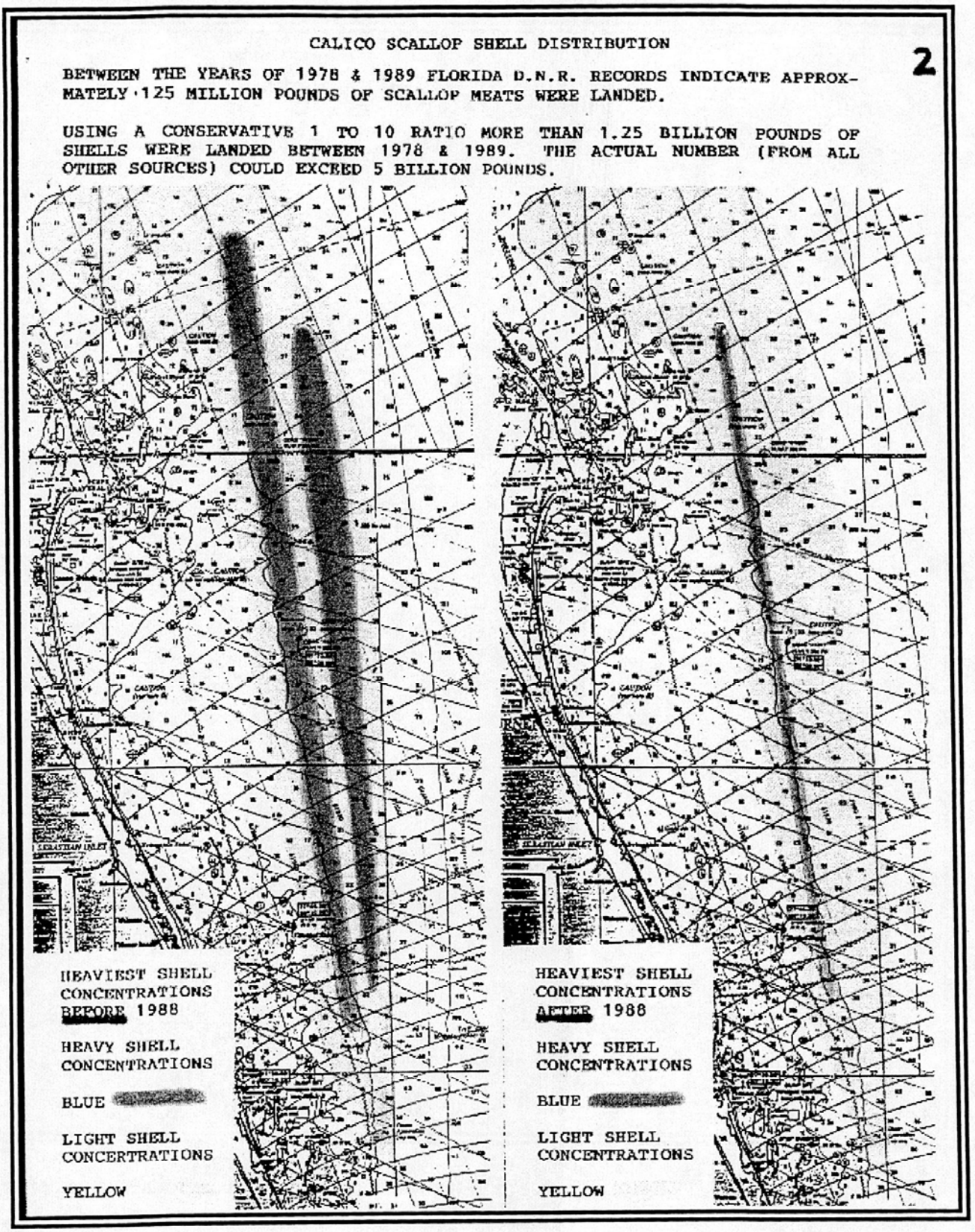
Relative abundance of the calico scallop varies with scallop size both within and between areas, seasonally and annually. They are generally most abundant off the Florida east coast near Cape Canaveral, with lesser concentrations near Cape Lookout, North Carolina and Cape San Blas, Florida. Concentrations have also been reported from the eastern Gulf of Mexico between Sanibel Island and Dry Tortugas, and 96.5 km (60 mi) offshore of the South Carolina/ Georgia border. Scallop abundance fluctuates at each area, with good years followed by years when none are available.

The Cape Canaveral scallop grounds are among the largest in the world, extending over 321.8 km (200 mi) from St. Augustine to near Stuart, Florida. Sutherland (unpublished report) made estimates of the calico stock distribution and abundance from data obtained with RUFAS (to visually capture the scallop resource) and tumbler dredges (to obtain samples). He found the bed width was highly variable and ranged from 6.7 to 2,633.5 m (22 to 8,640 feet). Juvenile calico scallop beds in 1970 surveys accounted for almost 4 percent of scallop distribution. Scallop occurrence was uniformly less than 4 percent of completed transect miles.

Figures 51a and 51b were provided by representatives of the calico scallop industry during scoping meetings and public hearings on calico scallop management and present recent calico scallop harvest areas/distribution, spawning locations, and shell distribution off southeast Florida. Additional information on calico scallop biology, harvest and distribution is presented in the Calico Scallop Fishery Management Plan (SAFMC, 1998e)



(Figure 51a in SAFMC, 1998b) Calico scallop spawning areas and fishing grounds (Source: William Burkhardt, Calico Scallop Advisory Panel.)



(Figure 51b in SAFMC 1998b). Calico Scallop shell distribution (Source: William Burkhardt, Calico Scallop Advisory Panel.)

Habitats Identified in the Habitat Plan Which Constitute the Ecosystem Used by Managed Species including Calcio Scallops

A. Marine/Offshore Essential Fish Habitat

Marine offshore habitats include live/hard bottom, coral and coral reefs, artificial/manmade reefs, pelagic *Sargassum* and water column habitat. Section 3.2 presents individual detailed descriptions including species use of these habitats.

Live/Hard Bottom Habitat

Major fisheries habitats on the Continental Shelf along the southeastern United States from Cape Hatteras to Cape Canaveral (South Atlantic Bight) can be stratified into five general categories: coastal, open shelf, live/hard bottom, shelf edge, and lower shelf based on type of bottom and water temperature. Each of these habitats harbors a distinct association of demersal fishes (Struhsaker 1969) and invertebrates. The description of this essential fish habitat presented in Section 3.2.1.2 of the Habitat Plan (SAFMC, 1998a), segregates the region into two sections: a) Cape Hatteras to Cape Canaveral; and b) Cape Canaveral to the Dry Tortugas. These regions represent temperate, wide-shelf systems and tropical, narrow-shelf systems, respectively. The zoogeographic break between these regions typically occurs between Cape Canaveral and Jupiter Inlet.

Covered by a vast plain of sand and mud underlain at depths of less than a meter by carbonate sandstone is relatively unattractive to fish. Live/hard bottom, usually found near outcropping shelves of sedimentary rock in the zone from 15 to 35 fathoms and at the shelf break, a zone from about 35 to 100 fathoms where the Continental Shelf adjoins the deep ocean basin and is often characterized by steep cliffs and ledges. The live bottom areas constitute essential habitat for warm-temperate and tropical species of snappers, groupers, and associated fishes including 113 species of reef fish representing 43 families of predominately tropical and subtropical fishes off the coasts of North Carolina and South Carolina.

The distribution of live/hard bottom habitat in the south Atlantic region is presented in the hardbottom maps in Section 3.2. of the Habitat Plan (SAFMC, 1998a) These geographic coverage's are a compilation of the four state bottom mapping effort in the South East Monitoring and Assessment Program (SEAMAP). The Florida Marine Research Institute developed uniform ArcView coverage's of hard bottom habitat (including coral, coral reefs, live/hard bottom, and artificial reefs) as a 1998 SEAMAP program and provided it to the Council for inclusion into the south Atlantic essential fish habitat distribution data base and GIS system.

Coral and Coral Reefs

Coral reef communities or solitary specimens exist throughout the south Atlantic region from nearshore environments to continental slopes and canyons, including the intermediate shelf zones. Habitats supporting corals and coral-associated species are discussed below in groupings based on their physical and ecological characteristics. Dependent upon many variables, corals may dominate a habitat, be a significant component, or be individuals within a community characterized by other fauna. Geologically and ecologically, the range of coral assemblages and habitat types is equally diverse. The coral reefs of shallow warm waters are typically, though not always, built upon coralline rock and support a wide array of hermatypic and ahermatypic corals, finfish, invertebrates, plants, and microorganisms. Hard bottoms and hard banks, found on a wider bathymetric and geographic scale, often possess high species diversity but may lack hermatypic corals, the supporting coralline structure, or some of the associated biota. In deeper waters, large elongate mounds called deepwater banks, hundreds of meters in length, often support a rich fauna compared to adjacent areas. Lastly are communities including solitary corals. This category often lacks a topographic

relief as its substrate, but instead may use a sandy bottom, for example. Coral habitats (i.e., habitats to which coral is a significant contributor) are divided into five categories - solitary corals, hard bottoms, deepwater banks, patch reefs, and outer bank reefs. The order of presentation approximates the ranking of habitat complexity based upon species diversity (e.g., zonation, topographic relief, and other factors). Although attempts have been made to generalize the discussion into definable types, it must be noted that the continuum of habitats includes many more than these five distinct varieties.

The ecological value, function and distribution of this essential fish habitat is described in Section 3.2.1.2. the Habitat Plan (SAFMC, 1998a) The distribution of live/hard bottom habitat in the south Atlantic region is presented in the hardbottom maps in Section 3.2 the Habitat Plan (SAFMC, 1998a).

Water Column

Specific habitats in the water column can best be defined in terms of gradients and discontinuities in temperature, salinity, density, nutrients, light, etc. These "structural" components of the water column environment are not static, but change both in time and space. Therefore, there are numerous potentially distinct water column habitats for a broad array of managed species and life-stages within species.

The discussion of the ecological function of water column habitat and importance to managed species is presented in Section 3.2.3.2 the Habitat Plan (SAFMC, 1998a).

4.4 The Effects of Fishing Gear on the Ecosystem and Prior Council Action

Pursuant the guidelines implementing the essential fish habitat provisions of the Magnuson-Stevens Act, conservation and enhancement measures implemented by the Council may include ones that eliminate or minimize physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem. The Council has implemented restrictions on fisheries to the extent that no significant activities were identified in the review of gear impact conducted for the NMFS by Auster and Langton (1998) that presented available information on adverse effects of all fishing equipment types used in waters described as EFH. The Council has already prevented, mitigated, or minimized most adverse effects from most fisheries prosecuted in the South Atlantic EEZ.

The Council considered evidence that some fishing practices are having an identifiable adverse effect on habitat, and addressed these in the Comprehensive Habitat Amendment (SAFMC, 1998b). The Council has already used many of the options recommended in the essential fish habitat guidelines for managing adverse effects from fishing including: fishing equipment restrictions; seasonal and aerial restrictions on the use of specified equipment; equipment modifications to allow the escape of particular species or particular life stages (e.g., juveniles); prohibitions on the use of explosives and chemicals; prohibitions on anchoring or setting equipment in sensitive areas; prohibitions on fishing activities that cause significant physical damage in EFH; time/area closures including closing areas to all fishing or specific equipment types during spawning, migration, foraging, and nursery activities; designating zones for use as marine protected areas to limit adverse effects of fishing practices on certain vulnerable or rare areas/species/life history stages, such as those areas designated as habitat areas of particular concern; and harvest limits.

More specifically, the Council has protected habitat essential to managed species by regulating fisheries to reduce or eliminate the direct or indirect impacts of fishing. With the implementation of the Coral Fishery Management Plan (GMFMC and SAFMC, 1982) and

subsequent amendments to that plan, the Council has protected coral, coral reefs, and live/hard bottom habitat in the south Atlantic region by establishing an optimum yield of zero and prohibiting all harvest or possession of these resources which serve as essential fish habitat to many managed species. Another measure adopted by the Council and implemented through the coral plan was the designation of the Oculina Bank Habitat Area of Particular Concern, a unique and fragile deepwater coral habitat off southeast Florida that is protected from all bottom tending fishing gear damage. The Council has also prohibited the use of the following gears in the snapper grouper fishery management plan to protect habitat: bottom longlines in the EEZ inside of 50 fathoms or anywhere south of St. Lucie Inlet Florida, fish traps, bottom tending (roller-rig) trawls on live bottom habitat, and entanglement gear. Also established under the snapper grouper plan is an Experimental Closed Area (experimental marine reserve) where the harvest or possession of all species in the snapper grouper complex is prohibited. Other actions taken by the Council that directly or indirectly protect habitat or ecosystem integrity include: the prohibition of rock shrimp trawling in a designated area around the Oculina Bank, mandatory use of bycatch reduction devices in the penaeid shrimp fishery, a prohibition of the use of drift gill nets in the coastal migratory pelagic fishery; and a mechanism that provides for the concurrent closure of the EEZ to penaeid shrimping if environmental conditions in state waters are such that the overwintering spawning stock is severely depleted. With the Calico Scallop FMP, the Council is proposing to: (1) Action 8A would prohibit harvest of calico scallops in the area bounded to the west by 80°W. Longitude, to the north by 28°30' N. Latitude, to the south by 27°30' N. Latitude, and to the east by the 100 fathom (600 feet) depth contour; (2) Action 8b would prohibit harvest of calico scallops in the following two Satellite Oculina HAPCs: a) Satellite Oculina HAPC #1 is bounded on the north by 28°30'N. Latitude, on the south by 28°'29'N. Latitude, on the east by 80°W. Longitude, and on the west by 80°3'W. Longitude; and b) Satellite Oculina HAPC #2 is bounded on the north by 28°17'N. Latitude, on the south by 28°'16'N. Latitude, on the east by 80°W. Longitude, and on the west by 80°3'W. Longitude; (3) Action 9 would require the use of an approved vessel monitoring system by calico scallop vessels.

4.5 Endangered Species and Marine Mammal Acts

The Sustainable Fisheries Act of 1996 established certain requirements and standards the Councils and the Secretary must meet in managing fisheries under the Magnuson-Stevens Act. Implementing the provisions in the SFA will not have any negative impacts on the listed and protected species under the Endangered Species Act (ESA) and Marine Mammals Protection Act (MMPA) including:

	Whales:	Date Listed
(1)	Northern right whale- *Eubalaena glacialis* (ENDANGERED)	12/2/70
(2)	Humpback whale- *Magaptera novaeangliae* (ENDANGERED)	12/2/70
(3)	Fin whale- *Balaenoptera physalus* (ENDANGERED)	12/2/70
(4)	Sei whale- *Balaenoptera borealis* (ENDANGERED)	12/2/70
(5)	Sperm whale- *Physeter macrocephalus* (ENDANGERED)	12/2/70
(6)	Blue whale- *Balaenoptera musculus* (ENDANGERED)	

	Sea Turtles:	Date Listed
(1)	Kemp's ridley turtle- *Lepidochelys kempii* (ENDANGERED)	12/2/70
(2)	Leatherback turtle- *Dermochelys coriacea* (ENDANGERED)	6/2/70
(3)	Hawksbill turtle- *Eretmochelys imbricata* (ENDANGERED)	6/2/70
(4)	Green turtle- *Chelonia mydas* (THREATENED/ENDANGERED)	7/28/78
(5)	Loggerhead turtle- *Caretta caretta* (THREATENED)	7/28/78

	Other Species Under U.S. Fish and Wildlife Service Jurisdiction:	Date Listed
(1)	West Indian manatee- *Trichechus manatus* (ENDANGERED)	3/67
	(Critical Habitat Designated)	1976
(2)	American crocodile - *Crocodulus acutus* (ENDANGERED)	9/75
	(Critical Habitat Designated)	12/79

5.0 LIST OF PREPARERS

The following individuals comprise the SAFE Team:

Kerry O'Malley, Fishery Biologist , South Atlantic Fishery Management Council
Dr. Vishwanie Maharaj, Fishery Economist, South Atlantic Fishery Management Council
Gregg T. Waugh, Deputy Executive Director, South Atlantic Fishery Management Council
Roger Pugliese, Fishery Biologist, South Atlantic Fishery Management Council
Michael E. Justen, NMFS Southeast Regional Office
Dr. Peter Eldridge, NMFS Southeast Regional Office

The following individuals previously employed by the Council prepared the material on fishing communities:

Michael E. Jepson, Fishery Cultural Anthropologist
Dr. Theophilus R. Brainerd, Fishery Economist

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7.0 APPENDICES

Appendix A. Figures and Tables from Original Profile and Profile Update

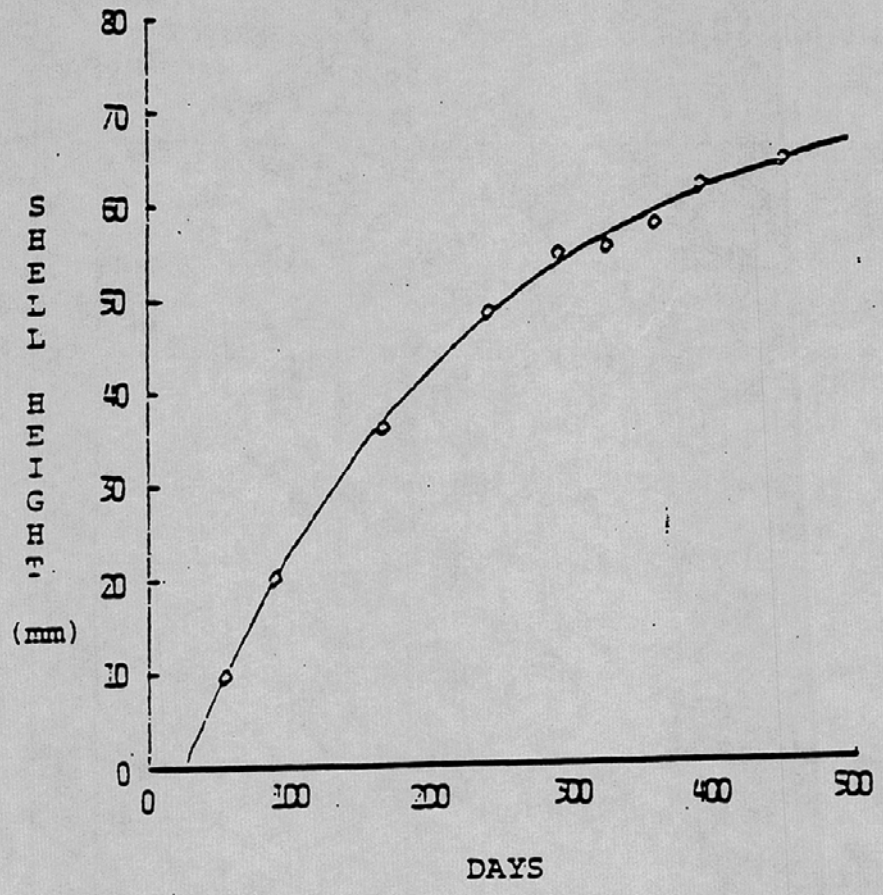


Figure 5-1. Growth curve of calico scallop, Argopecten gibbus, derived from spat set within a known time period and raised until the age class had nearly expired (J. Zuboy, 1979, NMFS, Southeast Fisheries Center, Miami Laboratory, Miami, Fla. in Miller and Hudson, unpublished report)

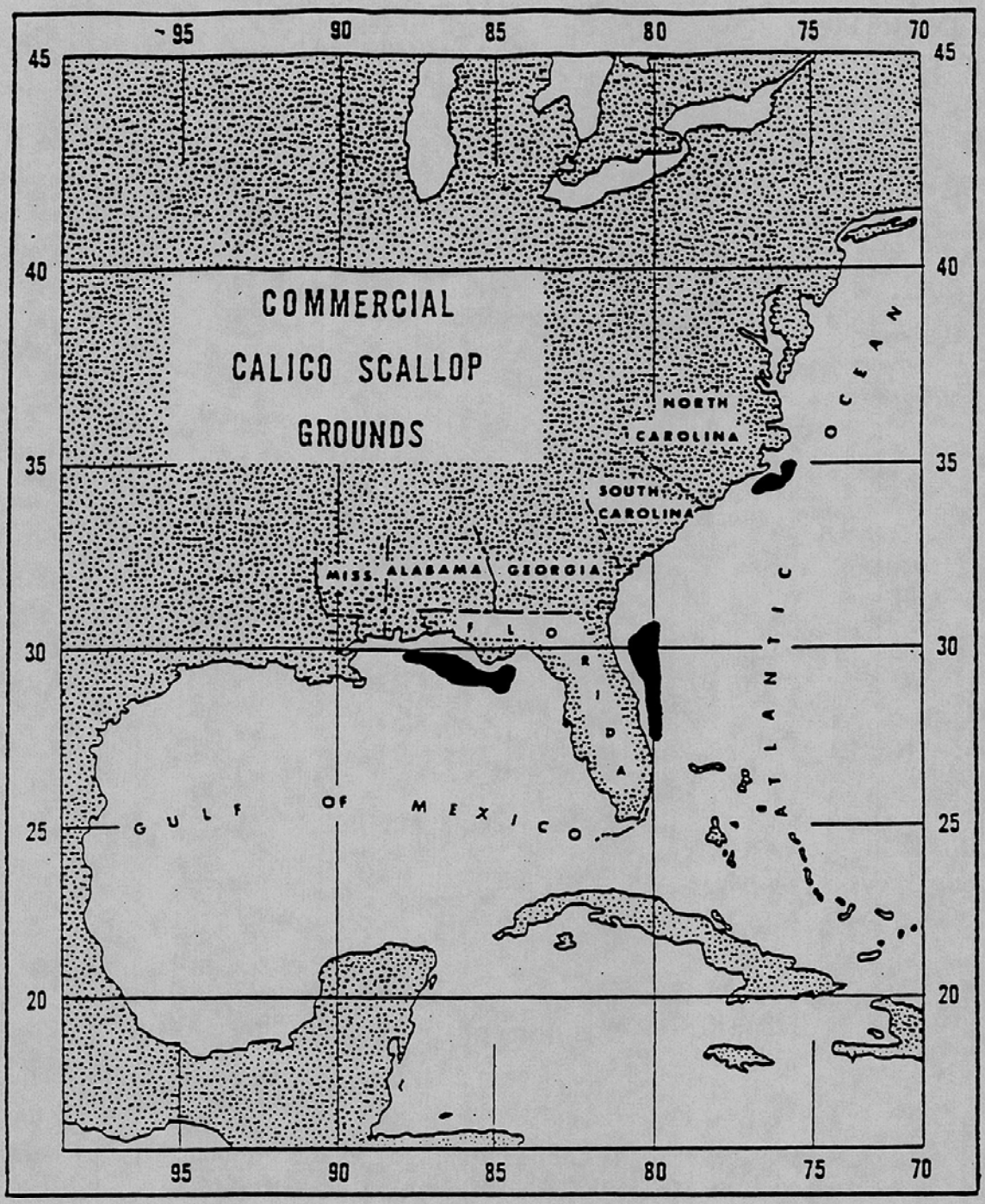


Figure 8-1. Areas where commercial concentrations of calico scallops have been located. (Source: Cummins, 1971)

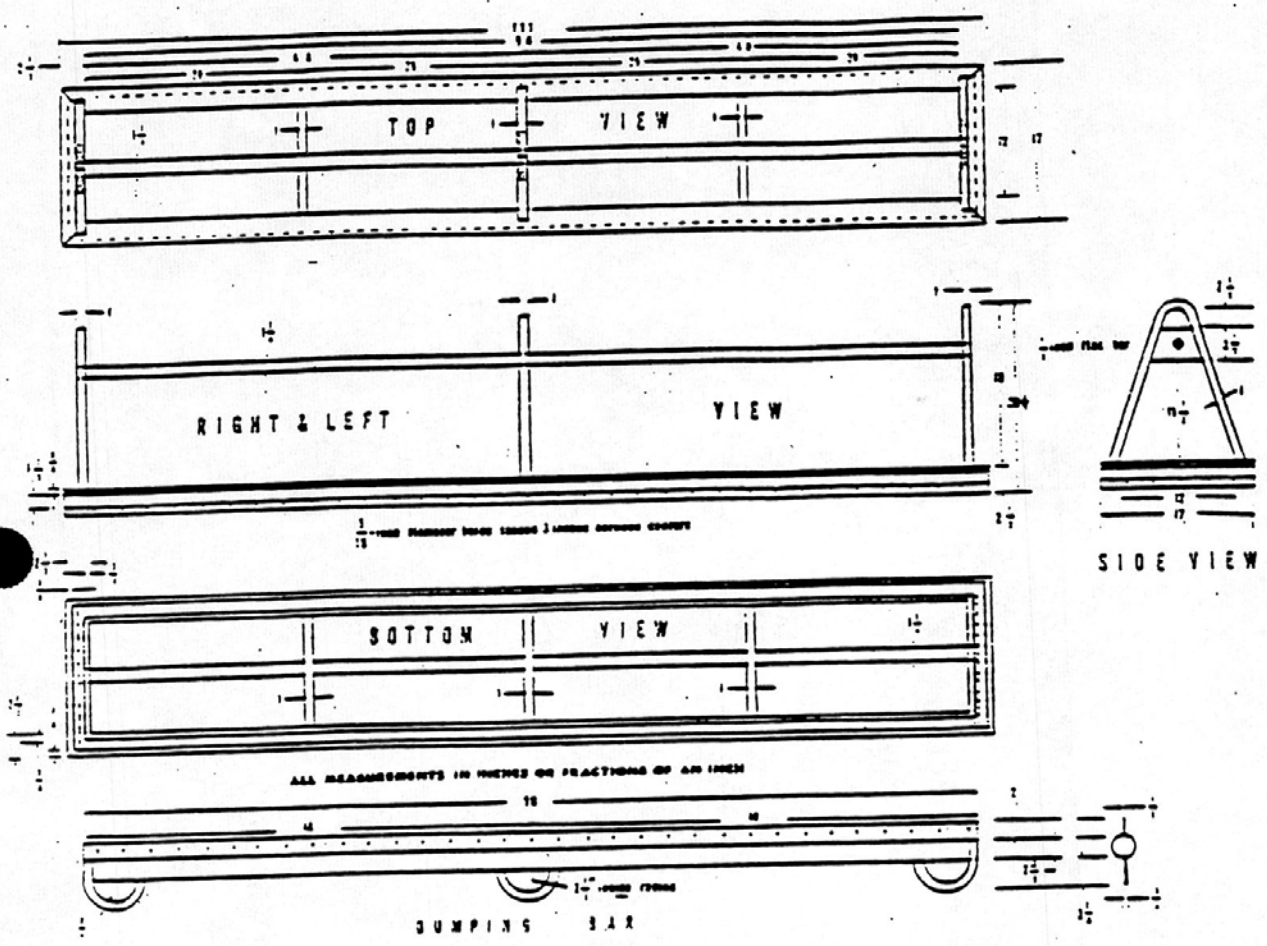


Figure 8-2. Calico scallop dredge diagram. (All measurements in inches or fractions of an inch.) (Source: Cummins, 1971)

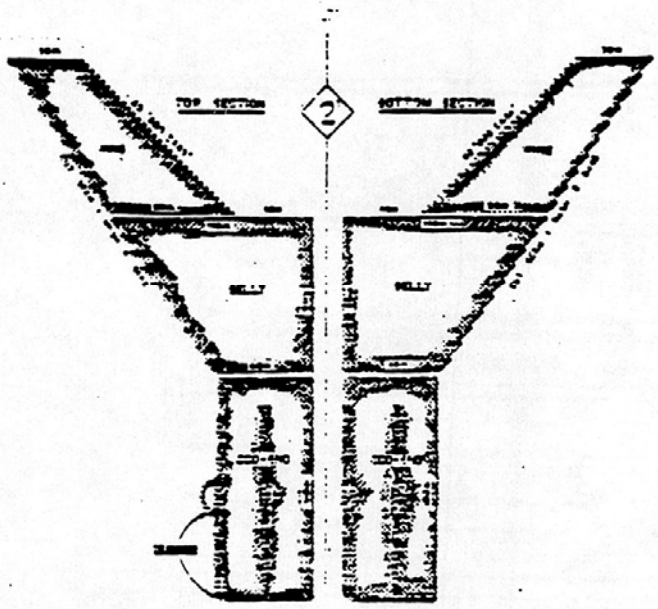


Figure 8-3. A 25-foot North Carolina type scallop trawl. (Source: Rivers, 1962)

Table 8-1 Number of vessels and gear types employed in the calico scallop fishery, by area, 1970-1978. (Source: NMFS, Fishery Statistics of the U. S.)

	North Carolina		Florida East Coast		Florida West Coast		# o
	# of vessels	Gear used	# of vessels	Gear used	# of vessels	Gear used	
1970	15	tr	6	3 dr; 3 tr	-	-	
1971	18	tr	3	2 dr; 1 tr	-	-	
1972	20	tr	9	3 dr; 6 tr	1	dr	
1973	20	tr	1	tr	-	-	
1974	-	-	10	tr	-	-	
1975	-	-	13	tr	30	tr	
1976	-	-	15	tr	50	tr	
1977[a]	-	-	13	tr	36	tr	
1978[b]	-	-					

Key: dr = dredge

tr = trawl

a Preliminary estimates

b Data for Florida not yet available

c 1978 was first year of scallop fishery off South Carolina

Table 8-2. Regional landings (in thousands of pounds of meats) of calico scallops, 1959-1979. (Source: NMFS, Fishery Statistics of the U.S.; NMFS Fisheries of the U.S.)

Year	North Carolina	Florida-East Coast[a]	Florida-West Coast	Regional Total
1970	1,574	259		1,833
1971	1,285	289		1,574
1972	1,050	302		1,352
1973	556	2		558
1974		1,131[b]		1,131
1975		1,444	548	1,992
1976		427	1,842	2,269
1977		636	478	1,114
1978		450	28	1,176[d]
1979	43	450	708	1,234[e]
1980	-	2,582		2,582
1981[c]	244	14,394		14,641

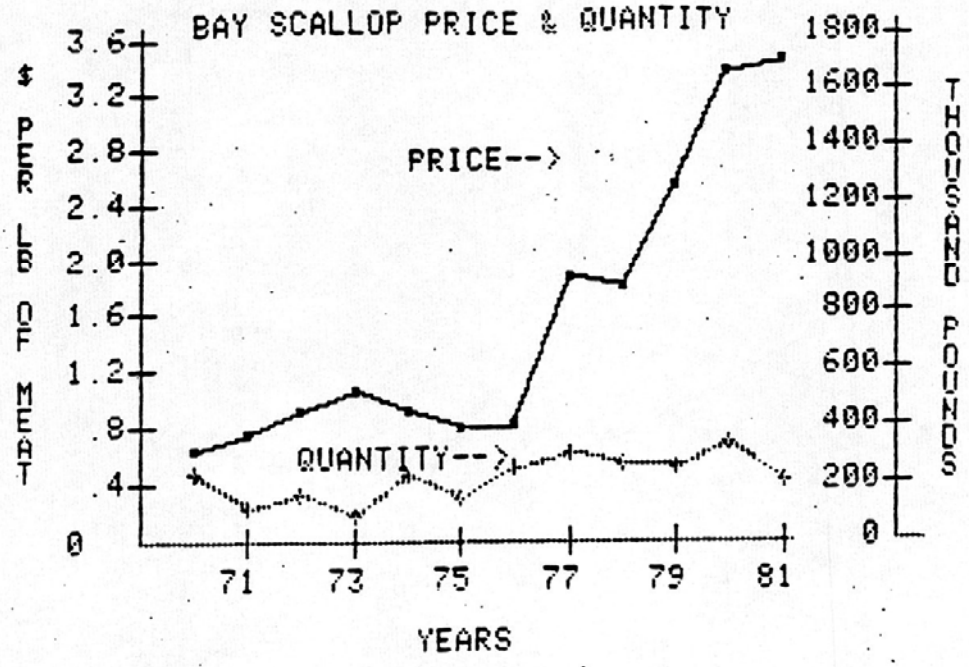
a Scallops caught off the Florida east coast in 1970, but landed in Georgia, are included in the pounds landed

b Calico scallops (56,960 lbs.), originally reported in "Current Fisheries Statistics" as bay scallops, are included in the 1974 Cape Canaveral landings

c Preliminary estimates only

d Regional landings in 1978 include 611,000 pounds landed in South Carolina and 87,000 pounds in Georgia

e Regional landings include 33,000 pounds landed in Georgia in 1979 and 3,000 pounds in 1981



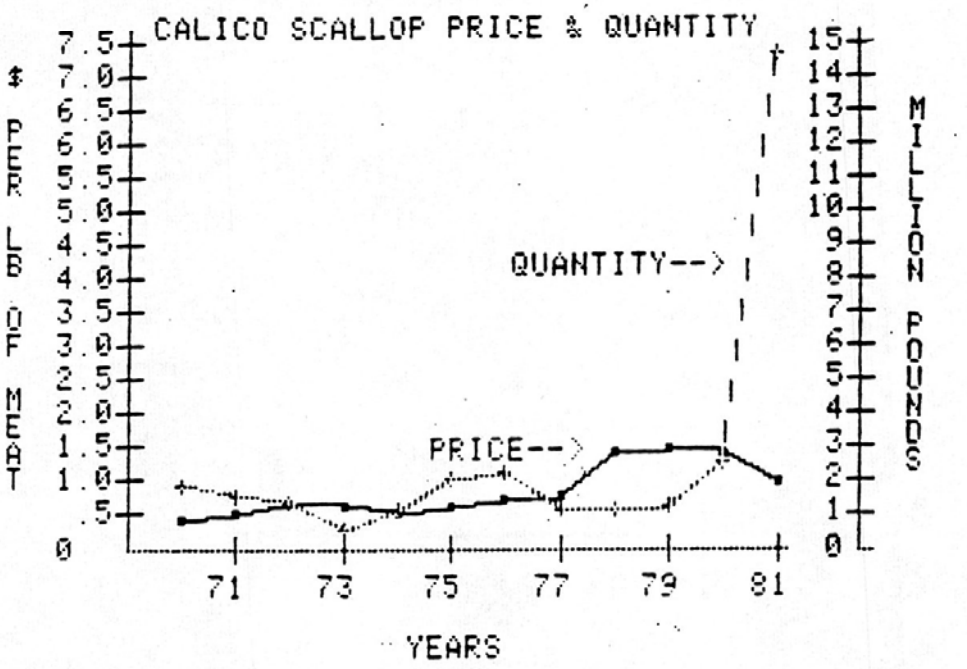


Figure 9-1. Ex-vessel price and quantity movements for calico and bay scallops in the Gulf and South Atlantic, 1970-1981. (Source: based on Tables 9-1 and 9-2)

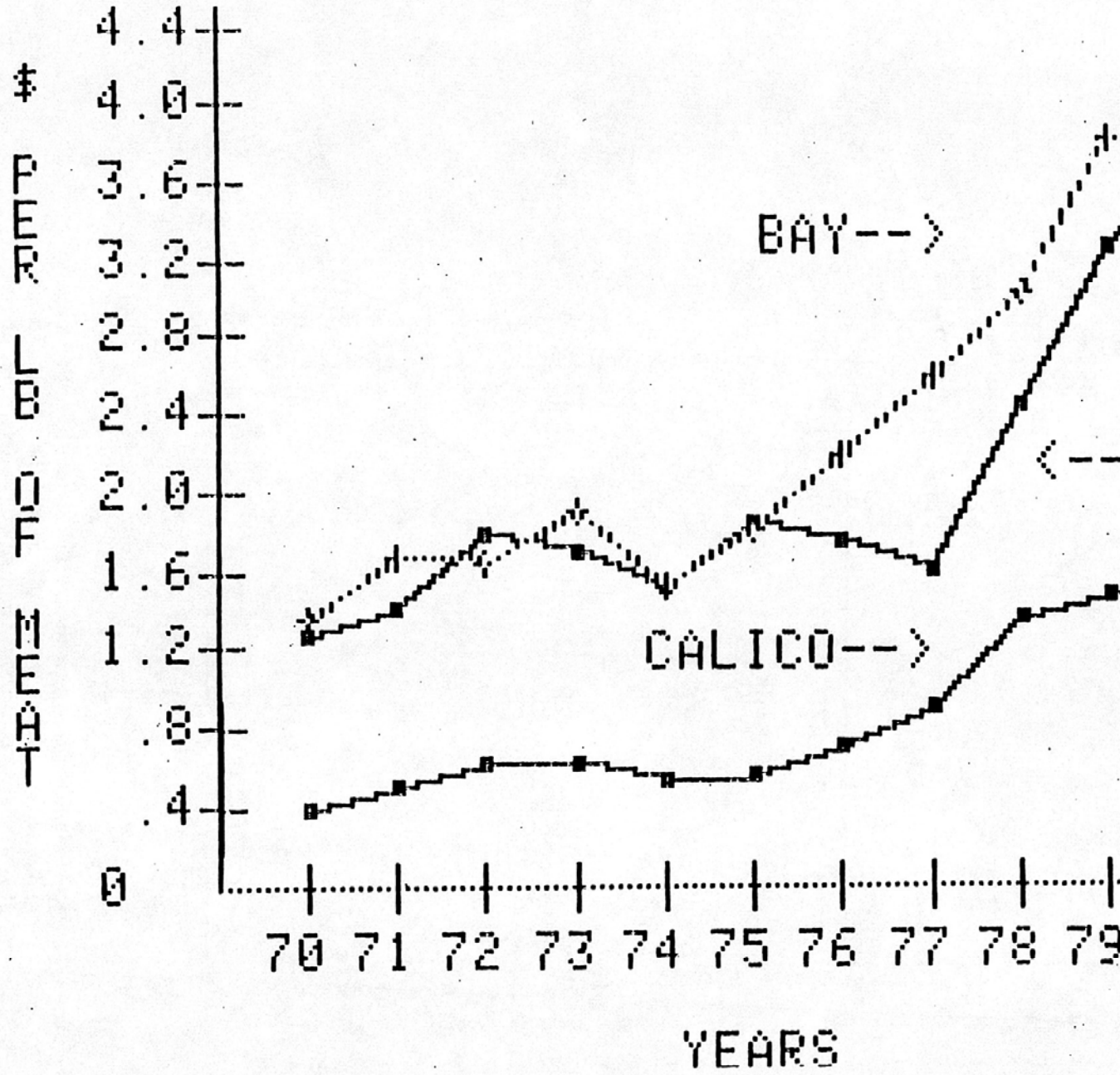


Figure 9-2. U.S. ex-vessel prices for bay, sea, and calico scallops, 1970-1981. (Source: Based on Table 9-3)

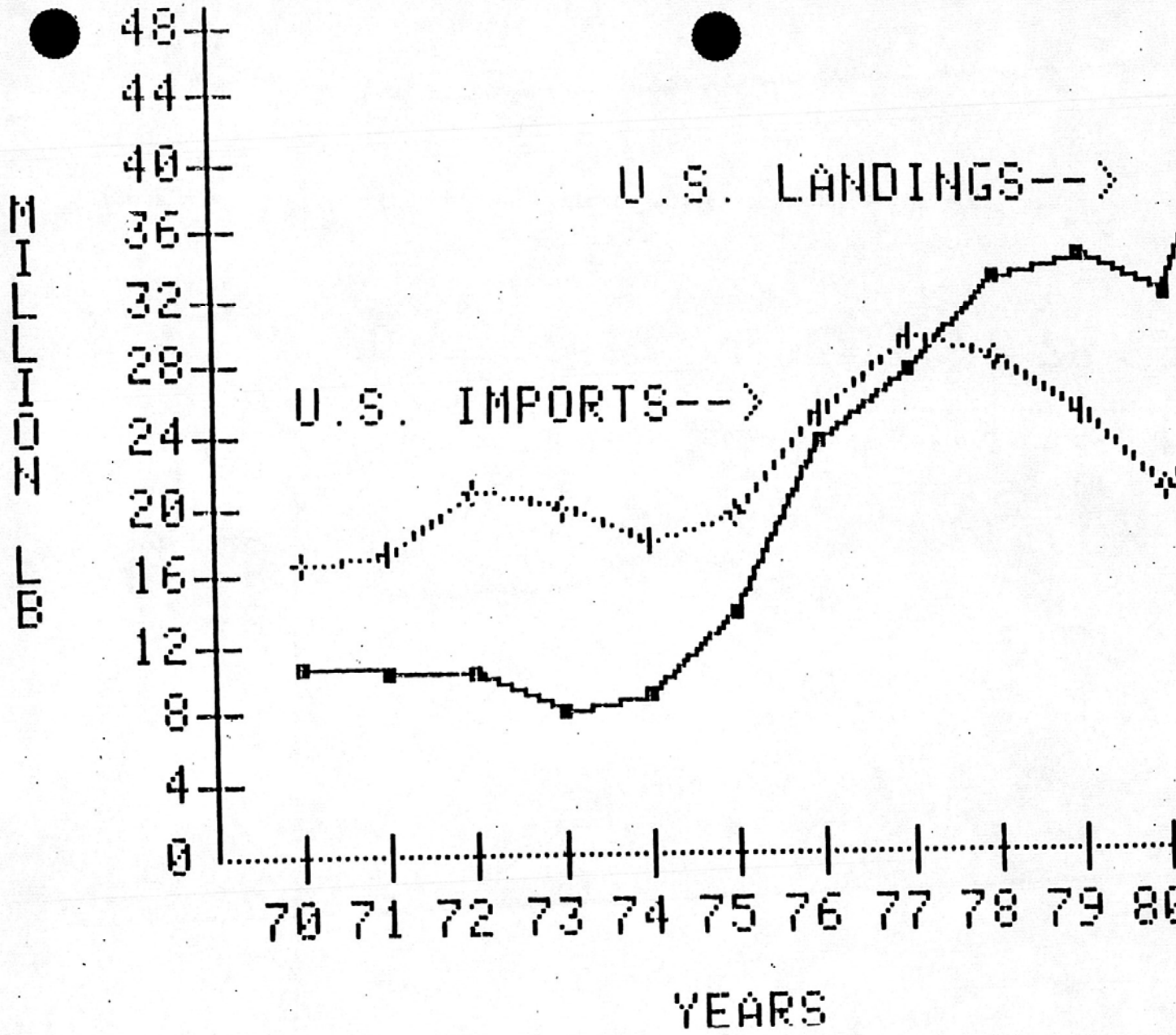


Figure 9-3. U.S. scallop landings (all species) compared with U.S. imports, 1970-1981. (Source: based on Tables 9-10 and 9-11)

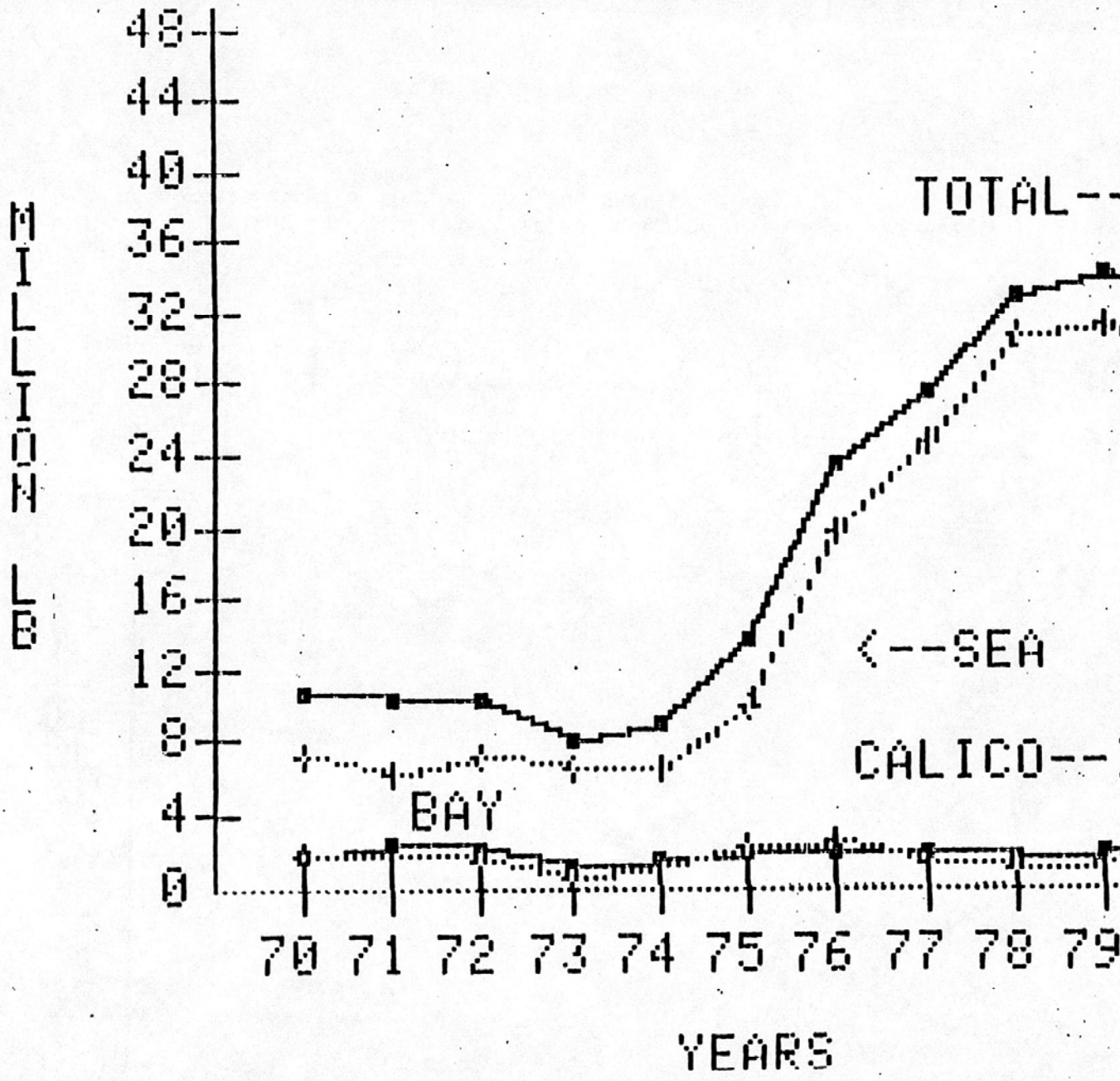


Figure 9-4. U.S. landings of sea, bay and calico scallops. (Source: based on Tab

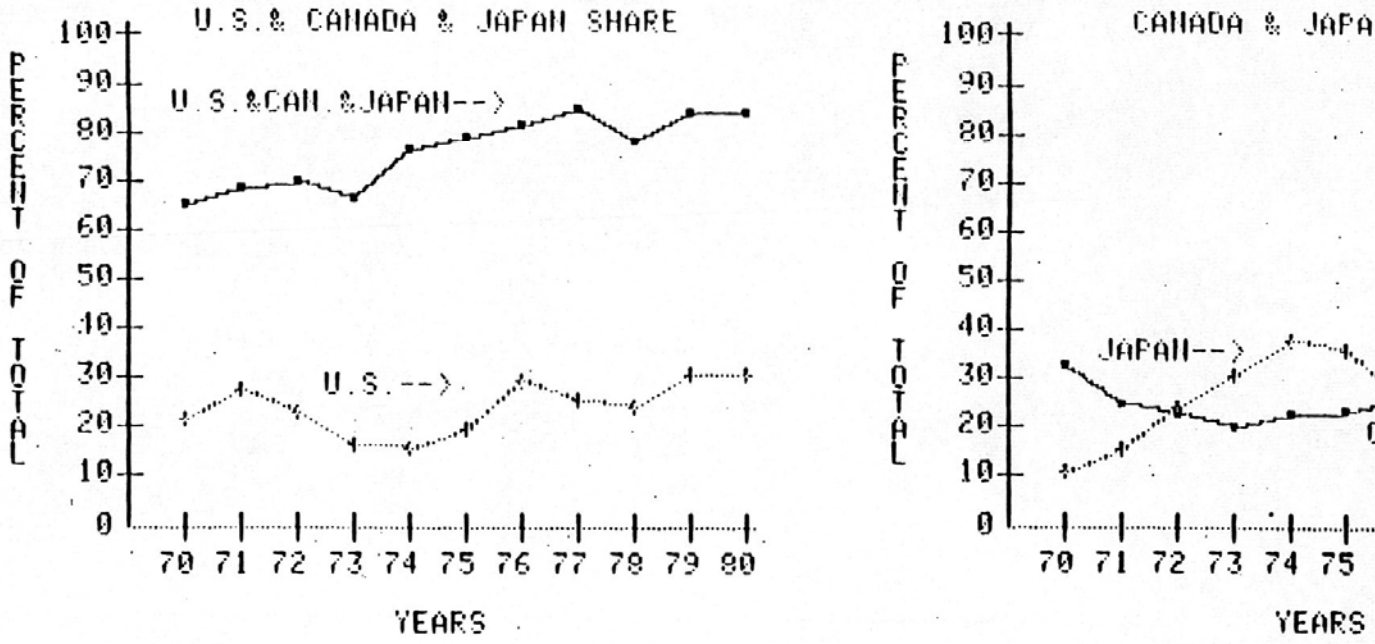


Figure 9-5. Share of total world landings: U.S., Canada, and Japan, 1970-1980. (Source: based on Table 9-14)

Table 9-1. Quantity, value and ex-vessel price of calico scallop landings by state, 1970-81. (Source: N
of the U.S. 1959-1975; NMFS, Fisheries of the U.S., annual issues, and personal communicati

	North Carolina			Florida (E. Coast)			Florida (W. Coast)			
Year	Quantity	Value	Price	Quantity	Value	Price	Quantity	Value	Price	Quanti
	Quantity in 1,000 pounds; Value in 1,000 dollars; Price in dollars per pound of meat									
1970	1,574	499	.32	196	196	1.00				1,83
1971	1,285	432	.34	289	370	1.28				1,57
1972	1,050	493	.47	302	407	1.35	(1)	(1)		1,35
1973	556	354	.64	2	2	1.00				55
1974				1,131	611	.54				1,13
1975				1,444	899	.62	548	350	.64	1,99
1976				427	398	.93	1,842	1,223	.66	2,26
1977				636	503	.79	478	334	.70	1,11
1978				450	710	1.58	28	42	1.50	1,17
1979	43	81	1.88	450	697	1.55	708	1,013	1.43	1,23
1980[b]	-	-	-	2,582	3,606	1.40	-	-	-	2,58
1981[b]	244	307	1.26	14,394	13,597	0.94	-	-	-	14,64

[a] Includes the following totals for Georgia (1,000 pounds and 1,000 dollars):

Year	Quantity	Value	Price
1970	63	34	.54
1978	87	118	1.36
1979	33	45	1.38
1980[b]	—	—	—
1981[b]	3	3	1.00

and for South Carolina (1,000 pounds and 1,000 dollars)

Year	Quantity	Value	Price
1978	611	803	1.31

[b] Preliminary estimates

Table 2. Quantity, value and ex-vessel price of bay and sea scallop landings by state, 1970-81. (Sc
Statistics of the U. S., 1959-1975; NMFS, Fisheries of the U. S., annual issues, and persona
Snell).

Year	North Carolina			Florida (W. Coast)			C
	Quantity	Value	Price	Quantity	Value	Price	
	------Quantity in 1,000 pounds; value in 1,000 dollars; Price in dollars per pound of meat						
				BAY			
1970	130	91	.70	104	56	.54	
1971	60	42	.70	48	39	.81	
1972	128	110	.86	35	40	1.14	
1973	37	33	.89	53	63	1.19	
1974	220	199	.90	16	18	1.13	
1975	135	105	.78	14	16	1.14	
1976	248	194	.78	14	24	1.71	
1977	257	509	1.98	46	58	1.26	
1978	218	389	1.78	49	91	1.86	
1979	193	514	2.66	62	137	2.21	
1980	328	1,107	3.38	11	29	2.64	
1981	189	656	3.47	22	63	2.86	
				SEA			
1976	1,107	1,432	1.29				
1977	657	954	1.45				
1978	1,976	4,457	2.26				
1979	1,694	4,898	2.89				
1980[b]	861	2,979	3.46				
1981[b]	125	478	3.82				

a Regional total includes 2,000 pounds of bay scallops worth $4,000 for the Florida East Coast in 1978
b Preliminary Estimates

Table 9-3. Annual ex-vessel prices of sea, calico and bay scallops in the U.S., South Atlantic and Gulf regions, 1970-81. (Source: Derived from NMFS, Fishery Statistics of the U. S., 1970-1976; NMFS, Fisheries of the U. S., annual issues).

	Sea Scallops		Calico Scallops		Bay Scallops	
Year	U. S.	Region[a]	U. S.	Region[a]	U. S.	Region[a]
	dollars per pound of meats					
1970	1.28	—	.40	.40	1.36	.63
1971	1.41	—	.50	.51	1.67	.75
1972	1.80	—	.63	.67	1.64	.92
1973	1.70	—	.64	.64	1.92	1.07
1974	1.52	—	.55	.54	1.53	.92
1975	1.85	—	.58	.63	1.81	.81
1976	1.77	1.29	.70	.71	2.19	.83
1977	1.62	1.45	.92	.75	2.60	1.87
1978	2.46	2.26	1.37	1.42	3.04	1.80
1979	3.28	2.89	1.49	1.49	3.83	2.55
1980[b]	3.84	3.46	1.40	1.40	4.02	3.35
1981[b]	3.67	3.82	0.95	0.95	3.62	3.41

— indicates data are not available because of no landings or minimal amount of landings.

[a] Region includes all states included under the jurisdiction of the South Atlantic and Gulf of Mexico Fishery Management Councils.

[b] Preliminary data

Table 9-4. Wholesale prices for U.S. sea, bay and calico scallops and estimates of value added in (Source: Computed from Table 9-8 and NMFS, Processed Fishery Products, annual summa

	Shucked, Fresh and Frozen					Frozen Specialties	
	Sea[a]	Bay	Calico			All Scallops	
Year			Wholesale Value	Dockside Value[b]	Value Added in Processing[c]	Breaded, raw and cooked	Other
	dollars per gallon					dollars per pound	
1970	10.98	13.52	7.71	3.18	4.53	1.43	1.15
1971	12.08	14.81	8.67	4.08	4.59	1.53	1.29
1972	16.56	16.40	12.07	5.33	6.74	1.71	(d)
1973	16.36	16.87	10.20	5.10	5.10	1.71	(d)
1974	14.06	12.18	(d)	4.38	—	1.70	(d)
1975	18.53	23.77	16.56	5.02	11.54	1.90	(d)
1976	16.54	21.53	18.53	5.60	12.93	2.04[e]	(d)
1977	15.54	23.91	19.69	7.39	12.30	2.04[e]	(d)
1978	22.44	30.07	23.30	10.98	12.32	2.54[e]	(d)
1979	29.99	34.98	24.04	11.90	12.14	3.12[e]	(d)
1980	32.72	40.08	26.31	11.17	15.14	3.65[e]	(d)

a Reported in pounds and converted to gallons using conversion factor of 8 pounds per gallon.

b Computed from Table 9-10 by using conversion factor of 8 pounds per gallon.

c Includes cost of processing plus profit margin. Assumes no weight gain or loss from la processed meat weight.

d Included with unclassified data. No estimate available.

e Beginning in 1977, breaded, raw and cooked scallops were reported separately for bay, ca Prices per pound for these years are:

Year	Bay	Calico	Sea
1977	2.13	1.60	2.09
1978	2.76	2.48	2.55
1979	2.86	2.53	3.18
1980	3.73	2.84	3.68

Table 9-5. Aggregate and per capita consumption (meat weight) of scallops in the U.S., 1970-81. (Sourc
Commerce, 1973; NMFS, Shellfish Market Review, Annual issues).

Year	All Scallops		Sea Scallops		Cali
	Aggregate	Per capita	Aggregate	Per capita	Aggregate
	million pounds	pounds	million pounds	pounds	million pounds
1970	27.4	.134	23.9	.119	3.5
1971	28.4	.138	24.5	.119	3.9
1972	29.1	.140	25.9	.124	3.4
1973	27.0	.129	25.4	.121	1.6
1974	29.1	.137	26.5	.125	2.6
1975	34.0	.160	30.1	.141	3.6
1976	46.1	.215	42.2	.189	3.9
1977	56.6	.261	53.8	.248	2.8
1978	62.4	.286	60.1	.275	2.3
1979	58.9	.268	55.9	.251	3.0
1980	52.9	.233	49.3	.219	3.6
1981	66.5	.290	51.2	.225	15.3

a Consumption through 1972 is based on reported sea scallop and all scallop consumption. Bay and cal
the difference. A comparison of calculated bay and calico consumption with reported landings of
landings were consumed or assumed consumed (i.e. no ending stocks or the stocks did not differ fr
estimates for 1973-1981 are based on production of bay and calico scallops. All scallop consumpti
Situation and Outlook Report; therefore, for these years consumption of sea scallops was calculate
large level of calico production in 1981, the estimate of bay and calico scallops may be high for 1981.

Table 9-6. Socio-economic characteristics of scallop consumers in the U.S., 1969. (Source: U.S. Department of Commerce, 1973).

Item	Pounds per capita	Item	Pounds per capita
Race		**Occupation**	
Negro	.061	Professional & semi-professional	.069
White	.086	Proprietors, managerial	.048
Other	.400	Clerical & sales	.099
Not specified	.161	Craftsmen, foremen	.083
		Head operative	.027
		Service workers & laborers	.097
Religion			
Catholic	.125		
Jewish	.238		
Protestant	.069	**Education**	
Other	.153	Less than 4 yr. High School	.042
Not specified	.000	Less than 4 yr. College	.099
		College graduate	.040
		Head, not specified	.000
Per Capita Income			
under 1000	.030		
1000-1999	.085	**Region**	
2000-2499	.064	New England	.188
2500-3000	.075	Middle Atlantic	.112
3000-3499	.068	East North Central	.060
3500 and over	.142	West North Central	.009
		South Atlantic	.051
		East South Central	.000
		West South Central	.163
		Mountain	.163
		Pacific	.058

Table 9-6.1. Socio-economic characteristics of U.S. Households Consuming Scallops in 1977-78.

Item	Pounds Per Household	Item	Pounds Per Household
Urbanization		**Income**	
Central City	.409	0-9,999	.268
Suburban	.445	10,000-19,999	.295
Non Metro	.440	20,000-29,999	.775
		30,000-39,999	1.098
		40,000-49,999	1.989
		50,000-Over	3.070
Season		**Race**	
Spring	.648	White	.467
Summer	.332	Black	.238
Fall	.482	Other	.232
Winter	.293		
Region		**Education**[a]	
Northeast	1.259	Elementary	.059
North Central	.188	High School	.443
South	.168	College	.633
West	.174		

Source: Preliminary analysis. Computation by Fred Prochaska and Walter Keithly, University of Florida, from U.S.D.A. Household Food Consumption data tapes for 1977-78.

[a] Education is for the female homemaker. Each education class represents the maximum attained. For example, Elementary includes those with no education and also those which have completed elementary school. High School refers to one or more years of high school education completed.

Table 9-7. Supply and utilization of all scallops in the U.S., 1970-81. (Source: NMFS, Shellfish Market Review, various issues).

Year	Supply				Utilization	
	Beginning Stocks	Landings	Imports	Total	Ending Stocks	Apparent Consumption
	million pounds product weight					
1970	2.2	10.8	16.8	29.8	2.4	27.4
1971	2.4	10.2	17.4	30.0	1.6	28.4
1972	1.6	10.4	20.8	32.8	3.7	29.1
1973	3.7	8.0	19.8	31.5	4.5	27.0
1974	4.5	9.1	18.1	31.7	2.6	29.1
1975	2.6	13.7	19.7	36.0	2.0	34.0
1976	2.0	23.7	25.2	51.5	4.9	46.1
1977	4.9	27.8	29.8	62.5	5.9	56.6
1978	5.9	33.3	28.4	67.6	5.1	62.4
1979	5.1	34.1	25.2	64.4	5.5	58.9
1980	5.5	29.7	20.9	56.1	3.1	52.9
1981	3.1	45.6	26.2	75.0	8.5	66.5

Table 9-8. Quantity and value of U.S. processed scallop products, 1970-80. (Source: NMFS, Fishery Statis of the U.S., 1970-1976; NMFS, Processed Fishery Products Annual Summary, 1975-1980.)

	Shucked, Fresh and Frozen						Speci	
	Bay		Calico		Sea		Breaded, raw and cooked	
Year	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Valu
	(gals.)	($)	(gals.)	($)	(pounds)	($)	(pounds)	($)
1970	214,301	2,896,804	193,554	1,492,417	2,647,320	3,631,974	8,496,117	12,168
1971	186,191	2,756,758	179,100	1,552,665	1,810,322	2,732,883	9,260,444	14,136
1972	57,546	943,800	165,970	2,003,791	3,361,076	6,958,088	8,804,871	15,063
1973	29,744	501,679	74,626	760,910	2,871,593	5,873,435	8,267,897	14,118
1974	240,146	2,925,082	(1)	(1)	2,299,638	4,043,623	6,738,836	11,461
1975	87,000	2,068,000	394,000	6,525,000	5,217,000	12,082,000	12,082,000	14,939
1976	132,000	2,843,000	204,000	3,781,000	11,895,000	24,154,000	10,326,000	21,007
1977	85,000	2,032,000	140,000	2,756,000	17,407,000	33,808,000	10,499,000	21,422
1978	114,000	3,428,000	71,000	1,654,000	17,683,000	49,597,000	12,177,000	30,886
1979	114,000	3,988,000	161,000	3,871,000	11,730,000	43,967,000	10,807,000	33,723
1980	113,000	4,530,000	307,000	8,078,000	10,985,000	44,935,000	6,426,000	23,454

(1) Included with unclassified

a Bay scallop figures include calico

b Sea, breaded (raw & cooked) included

c Bay, calico and sea scallops reported separately beginning in 1978. Calico scallops represented 25, 6 of breaded, raw, cooked product in 1978, 1979 and 1980 respectively.

Table 9-9. Average yield of scallops by species and state in the South Atlantic region. (Source: NMFS, Fishery Statistics of the U.S., 1970-1976.

	North Carolina			Georgia			Florida		
Year	Bay	Calico	Sea	Bay	Calico	Sea	Bay	Calico	Sea
1970	6.00	4.00			3.67		4.38	3.50	
1971	3.53						4.68	2.67	
1972	6.00	3.45					5.22	2.69	
1973	6.00	3.05					4.81	2.70	
1974	5.50						5.02	2.70	
1975	5.50		6.10						
1976	5.50		6.85						
1977	5.50		7.50					2.35	

Table 9-10. U.S. landings[a] of scallops 1970-1981. (Source: U.S. Department of Commerce, 1973; NMI U.S., 1970-1976; NMFS, Fisheries of the U.S., 1977-1981.)

Year	Sea[b]		Bay		Calico		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Val
	Thousands of Pounds and Dollars							
1970	7,304	9,353	1,700	2,321	1,833	729	10,837	12,
1971	6,337	8,981	2,315	3,846	1,574	802	10,226	13,
1972	',017	12,817	2,032	3,772	1,352	900	10,401	17;
1973	6,400	10,817	1,014	2,025	558	356	7,972	13,
1974	6,444	9,923	1,499	2,103	1,131	619	9,074	12,
1975	10,063	18,335	1,648	3,402	1,992	1,249	13,703	22,
1976	19,853	34,985	1,590	3,007	2,268[d]	1,621	23,711	39,
1977[c]	25,012	40,584	1,703	4,426	1,111[d]	1,026	27,826	46,
1978[c]	30,976	76,346	1,371	4,166	948[e]	1,301[e]	33,295	81,
1979[c]	31,466	103,206	1,774	6,798	1,234[e]	1,836[e]	34,447	111,
1980[c]	28,752	110,429	968	3,894	2,582[e]	3,606[e]	32,302	117,
1981[c]	30,277	111,216	670	2,427	14,641	13,907	45,588	127,

a Pounds of meats

b Including Alaska after 1967

c Preliminary data subject to change when published in Fishery Statistics of the U.S.

d These data are slightly different than those in Table 8-2. However, the amounts shown in ea are as reported in the cited sources. The differences are small and are due to the preliminary r the data.

e Personal communications, E. Snell.

Table 9-11. U.S. imports (product weight) of scallops, 1970-1981. (Source: U.S. Department of Commerce, 1973; NMFS, Fishery Statistics of the U.S., 1972-1976; NMFS, Fisheries of the U.S., 1977-1981).

Year	Quantity (1,000 pounds)	Value (1,000 dollars)	Average Price (dollars per pound)
1970	16,830	19,666	1.17
1971	17,389	21,932	1.26
1972	20,820	36,194	1.74
1973	19,833	33,625	1.70
1974	18,100	28,106	1.55
1975	19,737	37,183	1.88
1976	25,253	53,016	2.10
1977	29,786	53,040	1.78
1978	28,367	72,829	2.57
1979	25,155	84,906	3.38
1980	20,887	82,002	3.93
1981	26,227	112,709	4.30

Table 9-12. U.S. imports (product weight) of scallops by country of origin, 1970-1981. (Source: U.S. Department of Commerce, 1973; NMFS, Shellfish Market Review, 1972-1981.)

Year	Canada	Iceland	Japan	U.K.	Other	Total
			(1,000 pounds)			
1970	11,700	169	150	2,213	2,598	16,830
1971	10,295	1,083	99	2,683	3,227	17,387
1972	9,400	1,600		3,300	6,500	20,800
1973	10,607	1,118	106	4,016	3,986	19,833
1974	12,117	838	125	2,757	2,263	18,100
1975	14,976	861	84	2,421	1,395	19,737
1976	20,547	257	91	3,003	1,360	25,253
1977	26,216	1,529	44	1,279	718	29,786
1978	24,333	1,412		906	1,716	28,367
1979	19,922	2,064		1,353	1,816	25,155
1980	15,281	1,569	57	1,357	2,623	20,887
1981	19,106	1,982	645	1,792	2,702	26,227

Table 9-13. World consumption and landings of scallops, 1970-1981. (Source: U.S. Department of Com of Fishery Statistics, Vol. 42 (1976) and Vol. 50 (1980); NMFS, Shellfish Market Review, Nov 1982.)

	Country								
	U.S.		Canada		Japan		France		Au
Year	Landings	Cons.[a]	Landings	Cons.[b]	Landings	Cons.	Landings	Cons.	Landing
	(million pounds live weight)								
1970	69.7	191.7	107.8		36.4	34.8	26.5	29.5	11.9
1971	90.6	205.9	89.5		56.4		37.5		20.1
1972	95.5	211.0	96.4		102.8		38.8		22.5
1973	70.3	195.8	89.3		135.8		55.8		11.0
1974	79.3	211.7	116.5		193.8		45.5		11.7
1975	120.5	246.3	147.0		221.7		46.0		6.7
1976	233.1	334.2	205.9		209.9		46.5		3.8
1977	228.2	410.4	257.6		279.2		46.0		3.3
1978	290.9	452.5	241.2		280.8		37.1		8.8
1979	271.2	427.0	197.4		272.0		22.2		10.4
1980	249.7	383.5	155.2		272.3		34.6		12.3
1981	364.8	482.1	190.1[c]		b		b		b

a U.S. consumption, 1971-81, estimated using product weight and conversion factor of 7.25; product-w Shellfish Market Review.

b Data not yet available.

c Estimated from data in Shellfish Market Review.

Table 9-14. Share of world landings accounted for by U.S., Canadian, and Japanese landings, 1970-1980. (Source: computed from Table 9-13)

Year	Share of World Landings				Total World Landings
	U.S.	Canada	Japan	Canada, U.S., Japan	
	(percent of total)				million pounds live weight
1970	21.3	33.0	11.1	65.4	327.0
1971	27.7	24.9	15.7	68.3	358.8
1972	22.6	22.8	24.3	69.7	422.9
1973	15.9	20.2	30.7	66.8	442.5
1974	15.6	22.9	38.1	76.6	509.3
1975	19.4	23.7	35.8	78.9	620.0
1976	29.5	26.0	26.5	82.0	790.9
1977	25.4	28.8	31.2	85.4	896.0
1978	24.0	25.3	29.5	78.8	952.7
1979	30.9	22.5	31.0	84.4	878.6
1980	31.1	19.3	33.9	84.3	802.9

Table 11-1. Fishery employment, craft, and establishments, various years, 1955 1980. (Source: NMFS, Fisheries of the U.S., 1981).

Item	1955	1960	1965	1970	1976	1980
			Number			
Persons employed:						
Fishermen	144,359	130,431	128,565	140,538	173,610	193,00
Processing and wholesaling (2)	97,825	93,625	86,864	86,813	93,609	103,44
Total	242,184	224,056	215,429	227,351	267,219	296,44
Craft used:						
Vessels (3)	11,796	12,018	12,311	13,591	16,875	18,90
Motor boats	58,218	56,889	63,828	71,570	84,445	92,80
Other boats	1,952	8,150	3,393	2,000	1,501	1,50
Total	71,966	77,057	79,532	87,161	102,821	113,20
Shore establishments:						
New England States	532	568	532	537	503	47
Mid-Atlantic States	1,230	1,133	1,109	832	768	71
South Atlantic States	449	454	443	432	522	66
Gulf Coast States	642	743	847	817	726	84
Pacific States	421	381	420	402	362	41
Alaska	179	134	137	108	182	20
Inland States (4)	671	772	673	564	511	24
Other (5)	-	22	24	43	43	1
Total	4,124	4,207	4,185	3,735	3,617	3,57

(1) Estimated for fishermen and craft.
(2) Average for season.
(3) Craft 5 net tons and over as documented by U.S. Coast Guard.
(4) A partial survey was made for some inland States in 1980.
(5) Data for 1955 are not available. Data for 1960 and 1965 include Hawaii only. Data other years include American Samoa, Hawaii, and Puerto Rico. A partial survey was made Hawaii in 1980.

Table 11-2. Processors and wholesalers: Plants and employment for the S Atlantic and Gulf Regions, 1980. (Source: NMFS, Fisheries of U.S., 1981.)

State and area	Processing			Wholesale			Total	
	Plants	Employment average		Plants	Employment average		Plants	Employme
		Season	Year		Season	Year		Season
	Number							
South Atlantic:								
North Carolina	109	2,714	1,745	225	909	608	334	3,623
South Carolina	20	703	439	119	690	350	139	1,393
Georgia	16	1,578	1,278	44	309	188	60	1,887
Florida East Coast	58	1,387	1,116	77	596	540	135	1,983
Total	203	6,382	4,578	465	2,506	1,686	668	8,888
Gulf:								
Florida West Coast	176	4,928	4,141	162	432	388	338	5,360
Alabama	51	1,738	1,179	17	166	89	68	1,904
Mississippi	43	1,889	1,357	16	119	85	59	2,008
Louisiana	117	4,228	2,853	121	580	478	238	4,808
Texas	51	1,800	1,364	91	1,090	780	142	2,890
Total	438	14,583	10,894	407	2,387	1,820	845	16,970

Table 11-3. Affirmative replies to questions about participation in the calico scallop fishery. (Source: P. Fricke, unpublished data.)

Question A: "Would you like to fish for calico scallops if the opportunity came about?"
Question B: "Would you contact a dealer or buyer if a bed were found nearby?"
Question C: "Do you think you would be able to arrange with a buyer for the sale your catches?"

State	Question A No. of responses (% of reponses)	Question B No. of responses (% of responses)	Question C No. of responses (% of responses)	No. of Persons Questioned
North Carolina	23 (45%)	20 (39%)	14 (28%)	51
South Carolina	29 (63%)	25 (54%)	11 (24%)	46
Georgia	25 (69%)	19 (53%)	5 (14%)	36
TOTALS	77 (58%)	64 (48%)	30 (23%)	133

Appendix B. Presentations and Materials Provided by Mr. William Burkhardt, Mr. Roger Newton, Mr. Thomas Brown , and Mr. Allen Scott at the June 19, 1995 Scoping Meeeting in Palm Beach Gardens, Florida.

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

PUBLIC SCOPING MEETING

POTENTIAL OPTIONS FOR CALICO SCALLOP MANAGEMENT
Palm Beach Gardens, Florida
June 19, 1995

DRAFT SUMMARY MINUTES

Mr. Love called the public scoping meeting to order. Other members of the council were present (list of attendees attached). Mr. Michael Jepson, SAFMC Cultural Anthropologist, and Cindy Glaser, Staff Recording Secretary, were also present. Mr. Love covered the intent and purpose of the scoping meeting and instructed the individuals attending to keep their comments to the potential options for calico scallop management.

Mr. Jepson provided an overview of the scoping document covering the potential options for management of the calico scallop fishery (attached).

Mr. Love opened the meeting for public comment.

Mr. Bill Burkhardt. I have been a calico scallop fisherman for the past 15 years out of Cape Canaveral. I've prepared the following charts:

Poster 1, Chart A
I have prepared a chart of the calico scallop grounds as I see them. They continue to the Jacksonville, Florida border. It gets less and less as you go north and in the last few years we haven't had too many, but previously we caught a lot more of them. I've shown the heaviest production in black, the next heaviest, medium production, in dark blue and the lighter production in light blue. The furthest down we go is about 10 miles before the St. Lucie mound, and I don't know that we've ever caught any scallops below the area I've shown. We used to catch scallops in the HAPC area before it was designated as a HAPC area and right now. I would propose that we have a closed area similar to the rock shrimp grounds and give up the strip which is the same strip that the rock shrimp fishermen will give up. This area here has not produced scallops for a few years and it may never produce again; who's to know. I put it in there because it was one of our better producing areas. There have been one or two isolated places mostly inshore of this. However, offshore, I don't know of any place where we caught scallops offshore where I've shown this outline. This is the 28/30 line that goes into Cape Canaveral. This is the 28 line and this is the 80 line which everybody is familiar with; the rock shrimp proposed closed areas. For enforcement purposes, I would not be opposed to having a transponder requirement within 4 miles of this area, but I don't feel it would be necessary up in the other areas.

This is only my proposed closed area and I don't represent anyone other than myself.

Ms. Shipman asked if the hatched box Mr. Burkhardt has corresponds to the rock shrimp industry AP's proposed option?

Mr. Burkhardt said yes. As I remember it, the outer edge was still under discussion.

Ms. Shipman said it's just a 100-fathom curve.

Mr. Burkhardt said he drew it at 4 miles rather than the 100 fathoms and I would probably suggest that for the rock shrimp also if I was asked.

Ms. Shipman asked if, from what he is showing, do they have any production to the east of the closure area?

Mr. Burkhardt said, to my knowledge, we have never caught scallops out in the area of the shelf break or cones which is about 2 or 3 miles from where we have ever scalloped. We get closer as we get down further but up in this area, there is about a 2 or 3-mile buffer zone where the bottom just gets too hard for us to tow before the shelf break. There is a discrepancy in the chart of probably 2 to 3 miles where if a fishermen were to look at this chart and this area and take the bottom depth, he would believe that he fishes further out here. The chart has thrown a lot of people off and will probably continue to throw them off in the future unless they actually get their LORAN and plot it on a chart like he has. They will see that this is actually the furthest that we go.

Ms. Shipman asked, based on that, what percent of his production would he say would be eliminated by that closure area?

Mr. Burkhardt said several percent; maybe less than 5.

Ms. Shipman said so, to his knowledge, it would have a minimal impact on his industry?

Mr. Burkhardt said the area in black is our most productive area and it is possible to get a better scallop that is over that 80 line. It's possible that would be the only scallops we can find. In that case, it could be 100%. They are not like shrimp where they may move out. When the scallop is older, he would normally stay put. This could be a problem.

Dr. Kimmel asked if he is a rock shrimper as well as a calico shell fisherman.

Mr. Burkhardt said yes. When there were no scallops, I was forced into rock shrimp.

Dr. Kimmel asked if he fished the same area for the rock shrimp and the calico scallops?

Mr. Burkhardt said very similar; basically the same grounds. The offshore grounds are identical. The rock shrimpers don't quite go in as far as we do. Our grounds use to go another 50 to 75 miles past this. Our grounds are bigger to the north and less to the south and, to my knowledge, we've never caught scallops below down where I've shown here; where the rock shrimp continue down for another 50 miles.

Dr. Kimmel asked what the difference is between a calico scallop net and a rock shrimp net?

Mr. Burkhardt said the doors would be approximately the same and in some cases identical. The net is a little bit smaller and a little heavier. It has three ticklers instead of one and it has a bigger mesh, 3" 84-thread as compared to 1 1/2" to 2" 15 or 20 threads.

Dr. Kimmel said the calico scallop net is rigged so that it hugs the bottom real close to get the scallops that are truly benthic dwelling animals.

Mr. Burkhardt said it's a heavier fishing net than a shrimp net.

Mr. Love asked if the scallop net is reversible. In other words, you could actually turn it over and use the other side?

Mr. Burkhardt said that is correct. It's identical top and bottom, whereas, a shrimp net has an overhang. A scallop net does not catch fish near as readily as a net with overhang; that's to make it dig more. A shrimp net fishes very light and a scallop net basically fishes heavy.

Poster 1, Chart B

Mr. Burkhardt said this chart is my opinion of where the primary spawning areas are and where I have observed the most spat. It somewhat corresponds with our heavier production areas. There is a thicker shell bed inshore at 27 fathoms and at 20 fathoms are two heavy shell beds. This is the area that most spat can be observed and most shells (probably 50%) come from these two areas. It is my opinion this particular area is the key to scallop spawning. The currents generally come from the Gulfstream and go north. It's my opinion that if the scallops spawn up to the north, there would be no way for the spat to come back down south. Probably the more southern end is the most important part of our spawning area. This shell bed is probably not that well understood, but it probably has more importance than anyone would believe. The spat has to have a shell to attach to or it probably will die. If a spat landed inshore where there is very few shell and it could not find a shell to attach to, he would die. The shell bed is extremely important for the spawning of the scallops. The prevailing currents are always in the northerly direction. On the surface even more so. It probably ranges from still to north. Still meaning it is not likely that the currents travel south and take spawn from up north and deposit it down south. It is generally agreed the spawning goes from south to north. There are nutrient upwellings that come from the Gulfstream which may play an important part. It is my opinion this particular area is our spawning area. The shells that the baby scallops attach to are somewhat protected from predators in this shell bed. This shell bed can be up to 6" thick. The offshore seems to be the most productive. In fact, our production in 1994 came from this dark area, which in my opinion is the most important part of the spawning process.

Dr. Kimmel asked how long he has been fishing for scallops and rock shrimp?

Mr. Burkhardt said he has been fishing for scallops for 15 years and rock shrimp for 5 years.

Dr. Kimmel said he knows if a net is pulled over an *Oculina* coral head, then the coral is probably going to be damaged; if not, then broken all to pieces.

Mr. Burkhardt said it's possible.

Dr. Kimmel said he's wondering if the bottom habitat 15 years ago was any different than the bottom habitat is today? In other words, has the pulling of shrimp or calico scallop trawls across the bottom created habitat where now you are finding a pretty good fishery?

Mr. Burkhardt asked if the question is, have we damaged some of the habitat?

Dr. Kimmel said that is part of it but he is wondering if the *Oculina* coral natural growth, way back when, was much more widespread than now or just a little bit?

Mr. Burkhardt said the *Oculina* coral is probably 99% in the shelf break which is outside of our grounds. It's outside by several miles. We have a few hard bottom areas inside our trawling areas specifically 27 fathom. There is a strip right inside the HAPC area and up to the north, in 27 fathoms, there is a hard bottom strip which they fish along side of but not over. I do not believe there is much *Oculina* coral on these inshore grounds. I was there 15 years ago and didn't see any then, thus I don't think it was a heavy coral area that has now been destroyed by the scallopers. I would say it never had the *Oculina* coral on it.

Dr. Kimmel said that's what he was looking for.

Mr. Doyle asked what percentage of fish he catches and sells when he is scalloping?

Mr. Burkhardt said there is very little fish caught in a scallop net; maybe some little pinfish, spot and croaker occasionally. As far as snapper grouper or any of the top fish, none to sell. At the most the crew would find some flounders to bring home.

Mr. Doyle asked what about the shrimp people? Do they bring in fish?

Mr. Burkhardt said surprisingly little as far as the snapper grouper or the king fish and top fish. Sometimes not enough for the group to bring home to eat.

Mr. Doyle said he has seen them working out there at night at 120 to 150 feet and the last few years, he hasn't been able to catch any porgy fish out there on the big rocks. He was just wondering what happened to them. He thought that maybe they were being brought into the Cape where somebody has been dragging them up.

Mr. Burkhardt said he doesn't believe the scallop boats are catching the fish and selling them. There would be an occasional fish they would take home, but he doesn't believe they are being sold as bycatch to scallops.

Mr. Doyle said he had some people in the shrimp business that could catch any kind of fish at night when they were dragging if they wanted to.

Mr. Burkhardt said I can only answer what I've seen. He hasn't seen very many fish in a scallop net. The design of the net is such with no overhang that the fish can just move away from it. The net is probably only 1 1/2 feet off the bottom. The tickle is about 3 feet ahead of the net and it's only a rare occasion that we would get a fish in a scallop net.

Mr. Doyle asked if he has seen any nets in the area that rolls the bottom and catches fish?

Mr. Burkhardt said I'm not familiar with it.

Poster 2, Charts A & B

Mr. Burkhardt said these charts describe the shell bed that he's called the calico scallop shell distribution. I've used 1988 as a point in time. Before 1988 the heaviest shell beds were in 20 fathoms and just inshore of 27 fathoms. In my opinion, they were 6 inches thick and this was what gave us the good scalloping in years before that. I've indicated the heavy shell concentration in blue and the light shell concentrations in yellow. The light being, if you towed the net for half an hour, you might see a few bushels and in this area, prior to 1988, in 5 or 10 minutes in certain areas, you could fill the net to where it was completely full. As I said before, I believe this shell bed was an important part of the spawning cycle and it has changed since. In the years of the heavy scalloping during 1980 and 1988, the change was that if you go out now in the same area, 20 fathoms has maybe half the amount of shell and if you go offshore inside of 27 fathoms, you can tow for an hour and not get a bushel. These shells have been completely taken and, I believe, that is one of the major problems why we don't have as many scallops today as we had 10 years ago. Between the years of 1978 and 1989, the Florida Department of Natural Resources records indicate approximately 125 million pounds of scallop meat was landed. Using a conservative 10 to 1 ratio of meat versus shell weight, more than 1.25 billion pounds of shells were landed between 1978 and 1979. That's from the Department of Natural Resources records. Those records were not complete back in those years. They are more complete today but, in my opinion, the true

amount of shells that were harvested exceeded 5 billion pounds. This is what we have today, and I believe that is one of our major problems in the scallop industry; our shell bed is no longer where it used to be.

Ms. Shipman asked where most of it is going; the construction industry?

Mr. Burkhardt asked shell?

Ms. Shipman said yes.

Mr. Burkhardt said it goes for landfill.

Ms. Shipman said a lot of it goes north for driveways as well.

Mr. Burkhardt said it goes to various sources. I think it has changed from year to year. In my opinion, the shell should stay in the ocean. That shell bed probably took a million years to get to that point and once it is gone, so will the scallops be gone.

Ms. Shipman asked if he can see any difference in the depth contour in where he's working from the removal of the shell?

Mr. Burkhardt asked if she meant with a depth recorder?

Ms. Shipman said yes.

Mr. Burkhardt said he doesn't believe we have the ability by our doors and trawl to actually affect the depth of the shell bed, but I do think we did skim off a few inches of the shell that was part of a shell bed that took a million years to build.

Ms. Shipman asked what his proposal would be on how to rebuild that habitat?

Mr. Burkhardt said it's on the next chart.

Poster 3, Photo A, Drawing B, C and D

Photo A
Mr. Burkhardt said this is a photo of a shellstock vessel. It's probably typical. It has a full load of scallops. The scallops have shell in them and the shell content or percentage of shell can range from 10% shell and 90% scallops to 90% shell and 10% scallops, if things are bad. Typically the boat goes out for a one-day trip and can make 4 to 6 trips a week. That would be considered a 3/4 load or pretty close to a full load. The gallon content could be anywhere from 100 gallons to 500 or even more if there is a good yield in the scallops.

Drawing B
This is the unloading equipment on land and the key piece is a trash separator which is a revolving drum. The scallops go through, the trash falls through and the clean scallops go out the one end and the mud, grit,
dead shell and bycatch would go through a conveyer to a truck to a landfill.

Drawing C
The clean scallops, by a conveyer, go into a steam box, highly adjustable and very critical and then into another shell separator which is a revolving drum which separates the clean shell from the scallop meats The clean shell also would be trucked to a landfill.

Drawing D
The scallops with the eviscera on would go into what is called an eviscerator which are counter-rotating rollers. They are 4 feet long, abrasive and they pull the eviscera off. The eviscera goes with water to a disposal site and mostly the clean scallops roll off the end. This piece of machinery on big scallops may take 2 bushels to make a gallon and as the scallops get smaller, you need more and more bushels to make a gallon of scallops. At 300 to 400 count, you may need 10 bushels and possibly 20 or 30 bushels. We get far more yield out of the bigger sizes and as they get smaller, the yield goes down.

The same components are on a processor vessel. The major difference between a processor vessel and a shell stock vessel is the bycatch shell goes overboard and in a land plant it goes to a landfill. They're the 4 major areas in which they operate.

Mr. Spitsbergen asked how many processing vessels there are?

Mr. Burkhardt said today there is one. In the last 10 years, there have probably been 5 or 6.

Mr. Spitsbergen asked which boats are processing at sea right now?

Mr. Burkhardt said today, the industry is shut down, but there is only one right now that is capable in Cape Canaveral and that's mine.

Poster 4, Drawing A, B and C

Drawing A
Mr. Burkhardt said this is a drawing of a calico scallop processor vessel and is a typical design. It is basically what most of them have looked like. The processing equipment is not shown in detail but he's shown an area. The equipment is identical, maybe smaller, and works identical to landfill equipment. The major difference is the catch would be put into a hopper, run through a separator and the mud shell, grit, dead shell and the bycatch go overboard within a few minutes. The clean scallops would be put in a pile to age a few hours before being put into the processing. At that point, the clean shell from the processing would go overboard and the waste water in the eviscera would go overboard. The vessel may be the same size as a shell stock boat, and in some cases, they will convert a shell stock boat.

Drawing B
The adjustable separator is designed to do the following. It selects a targeted scallop size by the width of the bars in the separator. It's adjustable. The operator can choose whatever size scallop he wishes to harvest and the others go overboard and are returned immediately to the sea alive. The small scallops, under the targeted size, the attached spat and other species bycatch all go overboard where most of it lives. Some of the fish with an air bladder would not live. There's no evidence in towing in the same area of the dead shellfish, crabs, or sawfish that were put over from the day before or week before. The advantages are reduced weight which improves vessel safety, it improves product quality. The mud that would be in this pile is a source of bacterial buildup, especially in the summer in the heat. It reduces or eliminates same species or other species

bycatch. It also returns the shell to the original bed rather than moving it off to someplace where the bed will not be productive.

Drawing C
He has given a side view of the separator which shows the same hopper, with an overboard chute.

Mr. Love asked how the hopper is loaded?

Mr. Burkhardt said he dumps the net directly into it. He has had two processor boats. The first boat was 60 feet and it had a little knuckle boom and the second one has a hopper whereby the hopper is big enough to put two nets full so they are clean by the time the next net comes up. There are many methods that can be used.

Mr. Love asked if there was very much bycatch in it, would it have skates, etc., that would clog up this equipment?

Mr. Burkhardt said it's not designed to clog up. If a big fish was to get in this, the operator would simply pick it out and throw it over.

Mr. Love said what he's getting at is how much fish is going in this hopper if you just dump the bag into it?

Mr. Burkhardt said there is very little fish in the scallop operation in itself. We use a 3-inch net and a good portion of them pass through. Just the design of the net doesn't catch fish. It's such a small opening, so low to the bottom and so narrow, that fish seem to go around this. Most of the bycatch we see would be bottom dwelling such as crabs and other types of shellfish, sawfish, etc.

Mr. Love asked if you could have a few stingrays and skates?

Mr. Burkhardt said yes, it's possible.

Mr. Floyd asked why they age the scallops?

Mr. Burkhardt said they've tried to put them immediately through the processing equipment and when they are fresh out of the water, they don't open nearly as well. The yield is down. It seems like after a few hours out in the air, especially in the heat, they open up more easily.

Mr. Floyd said they die?

Mr. Burkhardt said you want to get them before the point of dying, but weakened.

Dr. Kimmel remarked that Mr. Burkhardt said it takes 3 or 4 hours for them to age, but yet you are going to put the shell hash back down in the same areas. He asked if they anchor up during this process?

Mr. Burkhardt said the shells are produced at 2 points. When we are catching them which may be 50% of the shell, they go immediately overboard. The other 50%, more or less, are in the pile and we can either process at the same time we're catching or we can anchor the boat so that roughly 50% of the shell would go out in the cleaning process while the other 50% would go out in the processing.

Ms. Shipman asked how many crew people does he have working the assembly line?

Mr. Burkhardt said it varies from 2 to 7. They can work pretty well around the clock with from between 4 to 7.

Ms. Shipman asked how long his drags are?

Mr. Burkhardt said when scalloping is good, 10 to 15 minutes and when it's poor, up to an hour and possibly 2 hours. On the average, 20 minutes to half an hour is normal.

Poster 5, Graphs A, B, C, D and E

Graph A

Mr. Burkhardt said the figures in these graphs were provided by the Florida Department of Natural Resources which is their old name. They've changed their name, but the records still indicate Florida Department of Natural Resources. He has included these figures in a graph which shows the years. They are more complete in the later years and as you go back further, there is more error in the reporting. This is in million pounds and our best year is slightly over 40 million pounds. The other years were in the 10 to 15-million pound range. Based on the records they provided me, it started sometime back before 1978. I'm sure they had effort before that and I've shown the arrow to indicate effort. We have a 7-year history since the decline and since 1988 we've had a serious decline where our average catch now is 7 million pounds, less than 8, in 7 years. We're down from approximately 10 to 20 million pounds a year to a 1-million pound average. It's my opinion that part of that problem is the shell bed depletion described earlier and the other part of the problem is that the average count size used to be 100 to 150 count when they started back in 1978, 79 and 80. We gradually worked our way up to 125 and 175 count in these years. As it started getting worse, we started taking smaller scallops and went from 150 to 200 count and today, with scallops being in real short supply, we now take 200 to 300 count and sometimes smaller. We simply do not wait for them to grow like we used to and that is a major problem. We've got two problems here, shell bed depletion and taking scallops too small. It's very possible we are taking too many in this top area where there is not enough escapement for spawning. The bottom of the chart shows where industry starts, industry builds and, at this point, industry reduces. At one point in 1992 we were down to one processor on land and, he's not sure if in 1992 or 1993, but one processor on the water. We ended up with 3 on land and 1 in the water in 1994. 1995 has very little production.

Mr. Floyd asked what the time lag is he's talking about waiting for the 200 to 300 count to go to the smaller count?

Mr. Burkhardt said the range is 78 to 95 which is about 18 years.

Mr. Floyd said he's talking about in a scallop's life, how much longer would it take you to have to wait for those 200s to turn into 100s?

Mr. Burkhardt said a 100 to 150 count scallop would be anywhere from 1 1/4 years to 1 1/2 years. They live to be up to 2 years and then they go to about 75 count. More normal would be 100 count in about 18 months. You take a 200 to 300 count scallop, he is probably 8 to 9 months old and if he was left to grow another 3 to 9 months, he would be in the 100 to 150-count range.

Graph B

The second chart reflects North Carolina landings. The landings the North Carolina Department of Marine Fisheries sent me were not complete in the previous years. I'm going to estimate that it actually started in 1955 and I have indicated an arrow where I've estimated the effort. The highest

years were just under 2 million pounds. We have had a 20-year history since the decline. Once we have a decline, we have almost the identical situation if we discount the last few years. This chart can almost go on top of the other one on a smaller scale. What I believe happened here is the shell bed depletion stopped the spawning cycle and that's the same problem we have here. North Carolina scalloping is regulated by laws. They have a 150 count landing law and I'm not sure what year it was put in. It was probably put in when they saw the problem. It might have been too late as they did nothing to save the shell bed, but they have used 150 count as their average. They do not allow landing until they reach 150 count.

Mr. Spitsbergen said they don't specifically have a landing count size. We sample it. They have authority to open and close landings. What they did is go out and sample and see what the size was, hold the season until they thought they got a reasonable size and then opened it. Usually we were even shooting for something better than 150 count; usually closer to 100 count if they could get it. They don't have a law on the size.

Mr. Burkhardt said not a specific law but I've been there every time they have had an opening for the last 15 years and it seemed like they let them grow to at least 150 count; probably 125 is more like it.

Mr. Spitsbergen said it's more of what they were shooting for.

Mr. Burkhardt said these are the same identical scallops that are caught in Cape Canaveral. Some people think they don't grow in Cape Canaveral. What it really amounts to is, we just try to take them too fast. Some people think there is mortality at a younger age; up until the age of 6 months mortality can be high. The whole scallop bed can disappear but, after 6 months mortality, I have never seen. Natural mortality a few percent a year yes, but as far as older scallops dying, I simply have not seen it. I think we just don't let them grow enough.

Graph C
Mr. Burkhardt said this chart which he put together doesn't really show anything in actual fact but shows the total scallops available and stocks reported by research which go all the way back for years; even before the first plant was built. After we have had a strong effort here, with escapement being low, we have what I see as a crash. I believe that the decline is caused mostly by shell bed depletion.

Graph D
This is a blow up of 1994. It is approximately 6 million pounds landed. If you were to take the total amount, part of the count was 150 to 200 count but a far majority was 200 to 300 count. I don't know what the landings were in 1995. I estimated myself at 200,000, and it might even be less than that.

Graph E
The total combined is probably slightly over 6 million pounds. This is strictly what I believe could be had if we let them grow to 100 and 150 count. I believe we could have caught a little bit less in 1994 by letting them grow to 100 and 150 count and then we would have had the rest of these 200 to 300 count still growing, still catching them and we probably could have caught another 5 million pounds in 1995. I believe 5 million and 5 million is 10 million and that we threw away 4 million pounds by catching them too small in 1994.

Dr. Kimmel asked what he would do to keep fishing larger calico scallops down? How would you verbalize an option to control this problem?

Mr. Burkhardt said he has that on his next chart.

Ms. Shipman asked when was the disease problem; the parasite infestation. Where does that fall on his chart?

Mr. Burkhardt said in one of these years, we had a few scallops off Sebastian Inlet that didn't amount to a lot. The boats that were still here waiting for scallops to return knew there were some scallops there and they started seeing a die off. Some of the scientists went out and monitored them and found a parasite. I don't believe that we would have had more than a small year like 1990. It wasn't that the whole ocean had died off but rather a particular little bed that may have produced a couple hundred thousand pounds.

Mr. Hartig asked if he could take a count size and correspond it to when the scallops start to spawn?

Mr. Burkhardt said the scallops spawn 3 times in their life time. In the early spring is the predominant spawn, in the fall and once in their later life which would be the next year if they haven't already been torn up.

Mr. Hartig asked is there a count size? Will 200 count scallops spawn?

Mr. Burkhardt said even a smaller scallop is capable of spawning. It all depends on when he spawned and a lot of other conditions. The spawning does not take place at exactly the same time every year. There are conditions such as water temperature, size of the scallop, and health of the scallop. In fact, sometimes trawling over a scallop bed will cause the bed to spawn prematurely. I've seen that already where you apparently crack the shells and it just starts some process of releasing into the water which causes them to spawn. I've seen them spawn because we started to work on them.

Attachment 6
Mr. Burkhardt said this is an outline of what I see are the key problems. They are not necessarily in any order or order of importance. I have also indicated the goals and objectives and how to achieve them.

Mr. Love said he didn't say anything about limited entry. He asked if he thought there were too many vessels in it at one time and that had something to do with it?

Mr. Burkhardt said that would be his opinion.

Mr. Floyd said in his summary he didn't say anything about returning of the shells. He asked if they do that in North Carolina?

Mr. Burkhardt said in Carolina, no; he has two things he would recommend to solve the problem. One, return the shells and two, fish responsibly.

Mr. Floyd asked if North Carolina experiences the same shell bottom reduction that he has?

Mr. Spitsbergen said he doesn't know what to tell him because they had good populations. To some extent, that happened during milder winters and then they had some cold winters and then after the calico scallop fishery dropped off. After a few warm winters, they picked right up. He related it more to water temperature than he did to depletion of shell material out there. They

haven't had that big of a fishery and it is pretty spread out up in that area. He may have a good point; he just didn't relate it to shell material.

Ms. Shipman asked if the 150 count was for the bay scallop fishery or calico fishery?

Mr. Spitsbergen said that's for the calico fishery. They don't specifically have a meat count, but they go out and sample.

Ms. Shipman asked how far off?

Mr. Spitsbergen said probably 15 to 20 miles. They go out and sample and when they feel the abundance and size is reasonable, they open the fishery.

Ms. Shipman asked if they open the fishery in federal waters?

Mr. Spitsbergen said they open landings. They can catch them wherever they want, but they can't land them in North Carolina.

Mr. Thomas Brown, manager of U.S. Fresh Corp. We're a land based calico scallop processor. I don't know quite where to start since Bill gave his presentation. Bill, as he stated earlier, is the only ocean going vessel that processes at sea. Presently there are 3 land processors at Cape Canaveral. Using Bill's graph on #5, in 1984 there was quite an abundance of calico scallops caught. At that time there was approximately 6 land based operations in Cape Canaveral, 3 land based operations in St. Augustine, and 1 land operation in Darian, Georgia. At that time, I was the manager at Darian. We offloaded our scallops on the north end of the territory up in Jacksonville. There were probably approximately 200 vessels fishing the grounds at that time. We fished for approximately 8 months and just like you turned a light switch off, they quit. We didn't fish them completely out. When I say that we quit, we had to because of the economics of it. The boats couldn't survive off the amount of catch they were bringing in to the docks.

During those years, the prices of calicos were pretty high. We could get probably $30 to $40 a gallon for scallops. We did have times we were fighting for customers and we lowered the price; one plant against another and scallops got down as low as $10 a gallon. With that amount of scallops, there had never been any amount of scallops caught like that before and thus the market was fairly limited that year. At the end of the 84/85 season, the import business sprung up and scallops started showing up from all over the world into the United States from Panama and Peru. At that time, it was a small scallop just like our scallops and it fit right into our market that we had established for the industry.

In October of 1988, there was a parasite that hit the coast of Cape Canaveral and it did, in his opinion, wipe out all of the scallops. Our boats would come into the docks fully loaded and in a matter of two weeks, they would go from 200 to 300-gallon trips to nothing. The scallops would be dead when they picked them off the bottom and that was attributed to the parasite that hit the bottom. During that time, the rock shrimp industry started developing something strong. With the calico industry downsizing the number of boats from in 1984 to approximately 200 boats, the season started getting to where there were only maybe 30 or 40 boats operating from the land bases. A lot of the people went out of business because of the span of time there, regardless of whether it was a lack of scallops or lack or poor judgment on a lot of the land based owners and their investments. Quite a few of them went bankrupt. In 1988, when the bed died off, they moved to the west coast of Florida, the panhandle, and started producing quite a bit of scallops in the panhandle. Somewhere in the middle of 1989 was when we quit scalloping in the panhandle.

The rock shrimp fishery came full fledged. Before there wasn't enough market to utilize all the rock shrimp and normally back then if rock shrimpers found the calico beds, they would basically stay away from them; they wouldn't drag them because they didn't want to chafe and destroy their gear. Since 1987/1988 when the larger influx of boats and market picked up, the rock shrimp boats have become a large number of boats in the ocean fishing. They drag everywhere now, as far as over the beds. That may be how some attribute the decline in our scallops; it's just his opinion. They do take shells from the ocean and put them in a landfill. Along with the parasites, maybe removal of the shells from the ocean and an influx of more boats dragging on the bottom may be a reason for a part of the decline in scallops.

Regarding our economics, the pricing part of it, the Chinese have come on strong with a smaller scallop that has taken over the market that we left for them. In my opinion, I really don't know what the answer would be to the industry as far as any type of management. I know there has been only one successful processor at sea and that's Bill. There have been quite a few people who have tried. Most of them have been companies that build the boats and put them out with a crew. Bill being the owner and operator of it, he has a lot more at stake than a lot of the other companies. I don't see a whole bunch of scallop processors offshore coming about because you're just not going to get the quality of people that will run this type of an investment. That's why we have the land bases. We employ a lot of people and we have good and bad seasons, the same as every fishery does. Whether it is attributed to depletion of shells or more boats on the bottom, he's not qualified enough about the bottom out there. If we don't have southeastern currents, they don't have the plankton coming up off the shelf; they don't grow; we've seen scallops that never grow to where we could shuck them, where they stay the size of a dime or nickel and then just die off. I've seen scallops where they should normally be 100 count and they would still only be 150 or 200 count. It's hard for him to say we need a shell size because he doesn't know if a shell size would serve the purpose.

During the 1980s Dr. Norm Blake was our marine biologist that did all the studies. He's very knowledgeable and did a lot of research during those years. We tried monitoring water temperatures and that made a big difference. We could see where they would die off when the temperatures of the water would change. You would have a 10 degree change in water temperature and the scallops would die off. There's really no rhyme nor reason that I've been able to come up with why we don't have a steady supply of scallops. One year we have 40 million pounds landed and shucked and another year we don't have but 1 million pounds. I'm just not qualified to answer that. I'm not a marine biologist. I can look at a pile of scallops on a boat and tell you about what we are going to shuck out of it. We have very minimal bycatch. Out of 1,000 gallons of scallops, you might not have 2 wheel barrows full of shell and another time, you may have a hundred gallons of scallops and have a dump truck load of shells. It happens at different times of the year and I don't really know why.

Mr. Love asked if he was in favor of a management plan?

Mr. Brown said I would like to have more thought on that before I would commit myself one way or the other.

Mr. Love asked if he had any feelings on limited entry?

Mr. Brown said this past season, on limited entry, my plant employed 8 boats. One of the other plants had 10 and the other maybe 7. That's all there were other than Bill's boat. You want to run around the clock to reduce our cost of processing. We might have 25 boats per plant. You try to have more boats than you can actually run in 24 hours because you do have breakdowns and boats falling out of schedule all the time. Being a land processor, we have to keep our schedules tight

but as far as a limited entry, the scallops are going to die off in approximately 2 years of their life. If you put a limited entry on this year, what's to say that next year that the ocean isn't full of scallops and you've got a fishery out there you can't utilize because you've set yourself to a limited entry. I don't know how you would answer that question.

Ms. Shipman asked if he knows of any production going on to the east of the 80° line?

Mr. Brown said Bill's graph is pretty accurate. In speaking for his company, we would be in favor of giving up the bottom east of the 80° line. I've got no problem with that.

Dr. Kimmel said one of the options Bill mentioned was to have a 4-mile zone on either side of the 80° parallel.

Mr. Brown said we would not be in favor of a 4 miles to the west. The graph shows that we do have a large concentration of our scallops there. We're in the same shape as the shrimpers. We don't drag in the coral. Even though our webbing is a lot tougher than the shrimp boat's webbing, we still don't want to lose gear. If you lose gear, it means the boat is down which costs you money. One of our nets is typically about $1,800. You have to quit your trip and go back inshore, unload, rig up another net and then go back off and you might possibly miss one trip which is very expensive. As far as the coral, none of our fisheries try to get into the corals because it just costs us too much damage.

Mr. Roger Newton. I'm just like Bill Burkhardt; I want to be the only one in the business so that everyone can get out. There are some interesting things I would like to point out real quick. One thing, if you remember reading your sheet, you started in 1981 and 1982 and then came up with a program in 1986. One thing that kept you all out of it, and he's not being ugly but he goes back with some people on this council a long way, they had a biologist that did a lot of work and the biologists are still doing work, his assistant is still doing work. Before they go too far with these charts that are hypothetical, I would like to have a biologist come in and maybe save the landside plants; do a study on spat. Mr. Spitsbergen can tell you what that is. It's not that easy of a deal to have a spat bed. I can tell you what's wrong with his boat just like he told you what's wrong with our shore facilities. I thought this was a closure I came to. You called it management and we are talking about closing on the east side of the 80° line to the 28/30 which concerns me. Basically the only place I've found that we caught scallops was north of the Oculina Bank, right above it in the area you are closing. Bill said you didn't catch any in that area, but I have had fishermen that have caught scallops in that area. I am not a biologist and do not pretend to be one, but I would like to have an opportunity before we go too far with Mr. Burkhardt's program to bring a biologist in.

Ms. Shipman asked if he could show them in Graph 1 what area, in particular, he was referencing.

Mr. Newton showed them.

Ms. Shipman asked about how much of his production was coming out of there?

Mr. Newton said maybe 15% of the overall production. They were small scallops that I would consider on their last leg. Here again, I'm not saying that those scallops were 6 months or 18 months old. They counted between 180 and 300. They were dying and were full of barnacles. By the shell size they should have counted 150. I will relinquish to a biologist to give you the answers there because I don't have them. I can just tell you what I did.

Ms. Shipman asked if they have consistently fished in there or is it a one or two year occurrence?

Mr. Newton said Bill can answer it better than me as he has been doing it for 15 years. This winter we fished some there and I'm not going to dispute Bill because he's been doing it for 15 years. I will, however, on his biology.

Mr. Allen Scott, representing Lambert International Fisheries and also the Calico Conservation Association. To a certain degree, what I'll have to say to you tonight will be repetitive of what Mr. Brown and Mr. Newton have told you. I hope that having been representing, by and large, everyone in the industry probably except Bill Burkhardt for the last 18 years, I can give you a little perspective on what probably has been happening as well. It's true that this particular resource has had very drastic ups and downs. As you saw witnessed in 1984, with no explanation, with the same number of producers in the business and essentially the same boats available, from one year to the next you doubled or tripled your production; likewise in 1988. That's a situation we have an answer to. Mr. Burkhardt has a theory.

In the mid-80s the producers got together and formed an association called the Calico Scallop Conservation Association. It's non profit and we have contributed over the years to real science to deal with real production issues in the industry. In that regard we have funded, in many ways, the Sea Grant program at the University of Florida and also a program headed up by Norm Blake, his staff, and associates at the University of South Florida. Among other things, over the years, besides money, we've provided boats, infrastructure and equipment for these folks to go out and study our resource that we make a living on.

To get this all in perspective a little bit, to be fair to Bill, he may produce 10% of the calico scallops. I suspect that Lambert International, Mr. Newton and Mr. Brown's company, U.S. Fresh, and also David Bates who now is in the business, would constitute 90% of the production side of the industry. I would also suggest that the investment in the industry, on the shoreside, plant side, is a multi-million dollar investment with Lambert International. I would suspect it's very much the same with the other landside producers. Mr. Burkhardt does have a process ship. I wouldn't presume to say what he has invested in that, but it's probably miniscule by comparison from what the rest of the industry has invested shoreside. We have and try to keep employed, even in bad times, 75 employees and even through non production times, we keep a full staff aboard. We have no desire to either destroy or fish out a resource that supports this infrastructure we have put together.

The theory of the shell bed is Bill's theory with no science. What the scientists have told us, after many years of study, is in 1988 based on biopsies and actual mortality testing on scallops found dead in shell dragged up literally in a period of a day or two from good production to no production, the University of South Florida determined that there was an intestinal parasite of unknown origination. They theorized that it was possibly brought to Port Canaveral or around Port Canaveral in some type of shell fish attached to foreign vessels coming in. We now have to deal with the fact that we import in Port Canaveral, from all over the world, organisms that stick to the bottom of vessels and come in and potentially contaminate our resource off the coast. What happened in this case, no matter where it came from, our resource at the end of 1988 suffered a massive natural die-off due to an intestinal parasite. That was the official scientific conclusion of the University of South Florida staff. What has happened since that time is this resource has been slowly regenerating itself to the extent that we now have a good commercial viable fishery working its way back into a good resource situation.

Another thing that gravitates against Bill's theory is that we have, on the Gulf coast of Florida, periodic extremely good productions of calico scallops. We don't have shell bed issues over there. We never know when they are coming in. All of a sudden you will have a resource, which is

much spottier on the Gulf coast, of incredibly good production of calico scallops out of the Gulf of Mexico for which I think all of us have plants standing by there that go into mothballs to take advantage of that resource when it comes around. The scientists have also concluded that they could find no evidence that overfishing is the cause of any depletion of our resource of the calico scallops. What they have determined though is we try to zero in on what is going to keep us fed and keep our industry in good health. Most probably natural conditions that include water temperatures and the amount of nutrients that come up the Gulfstream from in and around the coast of South America have the biggest effect on whether we are going to have a good production or no production off the east coast of Florida. When a hurricane blows through, we have trepidity experiences and we are going to have very poor or no production. Where they go or whether they die, we're not sure.

One thing that is for sure, we have spent a lot of money and time on science trying to answer these questions. 90% of the industry came here tonight to discuss a closure issue and we find that we are having to prepare ourselves apparently to address weird science that we've not seen anywhere on the proposed options at this point. I would join in with Mr. Brown and Mr. Newton and suggest that if this council has a concern for the shell theory, we be given the opportunity to address that at a proper time and in a proper forum. As to the closure issue, I'm not going to repeat what I had to say in Cocoa Beach when we appeared there. Hopefully that will be part of your administrative record. We're not in favor of management nor any closure on the record. I would, however, like to say that Bill, based on our own in-house evaluation of our captains plotting information, has done an exceptionally good job with the left side of Chart 1 in plotting out where the best of our production seems to have historically been. To that extent, I did in the context of the rock shrimp fishery, give a written comment very much opposed to any closures on the westerly side of the 80° line which would have been catastrophic. However, even though I'm not speaking for Lambert International nor the Conservation Association that we're in favor of closures, we cannot see that insofar as our particular fishery is concerned, the west side of the 80° line closure would probably not be of significant effect.

On the suggestion that there should be size and catch limitations, Bill, of course, can sit out on a boat and processing through with a certain size of grid in his trummel, he can sort out what size he is going to keep and what size he's going to throw away. Obviously you aren't going to watch him, churning 300 count whole scallops back overboard after they've had a chance to die on the deck of his boat; however, the landside producers process the scallops that come in. You have to understand these scallops don't bed up in 100, 125, nor 150 count. Most of the time the captains consider it a real plus if they can go out and happen to hit a bed where they are going to get 300 count down to 125 count. At least in his experience this is considered to be optimum size for selling this particular product. You cannot take a boat and bring in 100 count. There is no such thing as a load where you can come in and have a catch count at 100. In that catch you're going to have 300 and 200 count scallops; you're going to have a mix. You might be able to police a shoreside plant and put them out of business by saying you can't bring in anything but 100 count scallop. Soon what you would do is drive everybody offshore so they would be in Mr. Burkhardt's territory. Because this machinery, if you want to set it so you only bring to shore 100 count, I guess you kill them on deck and churn the rest back in. I don't think that is the purpose of this council nor is it their intent. The shoreside companies have very significant investments. We want as much as or maybe more, than Mr. Burkhardt to find good long term solutions to the historical ups and downs in this particular resource. They are biological, we are convinced, the scientists are convinced. However, we haven't put a real finger on it as yet. If you want information, we will work with you on that. Right now, as far as 90% of the industry is concerned, if you are addressing the closure issue, I'll be glad to answer any questions you have.

Mr. Moffitt asked how long would a scallop live on the deck of a boat once it comes aboard?

Mr. Scott said remarkably long. We prefer to have the captains bring them in while they are still fresh and strong. The quality, we find, to be much better. I would say it depends on the time of the year. It's tougher in the hot summer months to keep them good and strong on the deck of the boat. Most of the time, you can run a 16-hour turn-around.

Mr. Moffitt asked given the fact that a scallop would live a remarkably long time on the deck of a boat, wouldn't it be possible to screen them out on deck before you brought them in?

Mr. Scott said that's exactly what he said and I suppose if Mr. Burkhardt wanted to do that, he could probably come up with the equipment that would do that. In fact, we could do that shoreside as well.

Mr. Moffitt asked if anyone else could do it on the water.

Mr. Scott said yes. If you are asking the question about the mechanics, I think what you would end up doing is wasting a lot of good sellable product for no real good reason. We just went through a run of between 150 count and most of it was up to 300 count scallops. These are mature 300 count scallops. What I mean by mature is you can have a full size shell with barnacles on it indicating it's an old scallop about to die and it's going to be a 300 count scallop. It's not unusual at all. If you are going to separate out mature 300 count scallop, all you are really doing is wasting that scallop because he's going to be done anyway.

Mr. Moffitt said the answer to his question would be that it would be possible to do that.

Mr. Scott said by shell size you could separate out smaller shell sizes than larger shell sizes.

Mr. Love asked if a good bit of these real small scallops go to landfill?

Mr. Scott said not very often anymore. Once in awhile you will have a captain that not withstanding the instructions, will bring in a load of small scallops. The landside producers in many cases will set a rule and tell captains you simply will not buy his load if he brings in a small scallop. Unusually if he comes in with that kind of a load, you may end up having to unload his load and take them to landfill. I've seen that happen. That's an exception and not the rule. The processor is not in the business to sell these little tiny scallops.

Dr. Kimmel asked if he said he represented approximately 90% of the calico scallop fishermen?

Mr. Scott said the industry, which is the producers. I would say the producers represent a lot more than 90% of the boats. There is only one boat represented by Mr. Burkhardt. The landside plants, of course, have to use a number of boats to serve a single landside plant. This last run, Lambert International got as high as servicing about 10 boats at one time.

Dr. Kimmel asked what percentage of the entire landings does that represent?

Mr. Scott said I haven't checked, but I would suspect Lambert produces maybe a little less than half with U.S. Fresh and Mr. Newton may be producing the other half; I'm speaking landside plants.

Dr. Kimmel asked of the options listed, which one or ones would he select as a preferred option?

Mr. Scott said without endorsing any closures, the preferred option is the one on Mr. Burkhardt's board, #1 the left side.

Dr. Kimmel asked what number that is on the potential options sheet?

Mr. Scott said it's not on here. This shows just a 4-mile strip. Our records indicate we do very little calico scallop trawling to the east of the 80° line as is reflected on Mr. Burkhardt's chart.

There being no more public comments, the public scoping meeting was adjourned.

TAPE OF PROCEEDINGS ON FILE (2 Tapes)

Transcribed By:
Cindy Glaser
August 2, 1995

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

PUBLIC SCOPING MEETING

POTENTIAL OPTIONS FOR CALICO SCALLOP MANAGEMENT
Palm Beach Gardens, Florida
June 19, 1995

Attendees

Council Members:
Fulton Love
David Cupka
Jack Dunnigan
John Floyd
Dr. Kimmel, Designee For Andrew Kemmerer
Bony Peace
Susan Shipman
Dennis Spitsbergen
John Brownlee
Bill Cole
Belinda Flanigan
Ben Hartig
Pete Moffitt
Dr. Russ Nelson
Jerry Schill
LTCDR Chris Sinnett

Staff Members:
Michael Jepson
Bob Mahood
Roger Pugliese
Sharon Coste
Cindy Glaser
Gregg Waugh
Dr. Theo Brainerd
Deb Buscher

Speakers:
Bill Burkhardt
Roger Newton
Thomas Brown
Allen Scott

Observers/Participants:
Dr. John Merriner
Ellen Peel
Dick Stone
Don Doyle
Jay Moon
Ken Hinman
Capt. Mike Merritt
E.V.E. Joy
Bill Arnold
Brian Lockwood

NEPA/MAGNUSON PUBLIC SCOPING MEETING
POTENTIAL OPTIONS FOR CALICO SCALLOP MANAGEMENT

Palm Beach Gardens Marriott
4000 RCA Boulevard, Palm Garden, Florida 33410
Telephone (407) 622-8888/ FAX (407) 622-0052

June 19, 1995

Prepared by:
Gregg T. Waugh
Deputy Executive Director
South Atlantic Fishery Management Council
1 Southpark Circle, Suite 306
Charleston, South Carolina 29414

A. BACKGROUND

The South Atlantic Council is considering management measures for the calico scallop fishery. The Council prepared a profile of the calico scallop fishery in August 1981, updated the profile in November 1982 and prepared a draft fishery management plan in November 1982. The Council considered implementing a shell size or meat count but deferred action based on industry input. The Council again considered regulation of the calico scallop fishery during 1986 at the request of the industry. At the October 1986 meeting, the Council voted to cease activities on emergency regulations for the calico scallop fishery and return to a monitoring phase.

Amendments to the Magnuson Act require that the Council evaluate the impact of each fishery on the habitat. In Amendment 1 to the shrimp fishery management plan, the Council is proposing establishing a restriction on rock shrimp trawling to protect the habitat. Habitat damage from calico scallop trawls and potential enforcement problems with the rock shrimp regulations need to be addressed.

B. SCOPING MEETING

The purpose of a scoping meeting is to give you the opportunity to comment before the Council develops a position on an issue. Scoping meetings are required by the National Environmental Policy Act (NEPA) and are also now a part of the pre-management plan and amendment process. Scoping meetings are different from public hearings in that the Council does not have a position on a particular issue prior to scoping meetings; public hearings occur after scoping meetings. This scoping meeting will allow you to comment on any measures you think may be appropriate for the calico scallop fishery. Your comments will be considered by the Council in discussing this issue.

C. POSSIBLE OPTIONS

Option 1. Proceed with development of a calico scallop fishery management plan.
Option 2. No action.
Option 3. Prohibit calico scallop trawling south of 28°30' N. latitude.
Option 4. Prohibit calico scallop trawling south of 28° N. latitude.
Option 5. Calico scallop trawling south of Cape Canaveral only with transponders.
Option 6. Prohibit calico scallop trawling west of the Oculina Bank.
Option 7. Prohibit calico scallop trawling south of Bethal Shoals.
Option 8. Prohibit calico scallop trawling in depths less than 120 feet.
Option 9. Calico scallop trawling only from Duval through St. Lucie Counties with transponders.
Option 10. Limit calico scallop trawling to Duval through St. Lucie Counties.
Option 11. Prohibit calico scallop trawling south of the vehicle assembly building.
Option 12. Others???

William H. Burkhardt
1445 Girard Blvd.
Merritt Island, Fl 32952
Phone 407 783 9409 Fax 407 454 3191

South Atlantic Fishery Management Council
One Southpark Circle, Suite 306
Charleston, S. C. 29407-4699

June 19, 1995

Dear Council Members:

I am owner operator of the scallop vessel LINDA LEE. Enclosed is a copy in outline of the scallop presentation I made to the South Atlantic Council at Palm Beach on June 19, 1995.

Sincerely,

William Burkhardt

CALICO SCALLOP PRESENTATION OUTLINE

POSTER 1

CHART A — GROUNDS - LOCATION OF PRODUCTION AREAS SHOWING HEAVY, MEDIUM & LIGHT PRODUCTION.
PROPOSED CLOSED TO SCALLOP TRAWLING AREA. PROPOSED TRANSPONER REQUIRED AREA.

CHART B — PRIMARY SPAWNING AREA / SPAT OBSERVATION - a SHELL BED b NUTRIENT UP-WELLING c SPAWNING STOCK d LARVAE e PREVAILING CURRENTS f SPAT ATTACHMENT g SHELLS OFFER PREDATOR PROTECTION h OFFSHORE MORE PRODUCTIVE.

POSTER 2 ---

SHELL DISTRIBUTION

CHART A — AREAS OF HEAVY SHELL BEFORE 1988.

CHART B — REMAINING AREAS OF HEAVY SHELL AFTER 1988.

POSTER 3

SHELL STOCK VESSEL & PROCESSING METHODS

PHOTO A — VESSEL - WITH SCALLOPS/ SHELL & BYCATCH. AVERAGE SHELL PRECENTAGE VARIES FROM 90/10 to 10/90. THE FISHERIES MANAGEMENT FOR FISHERMAN MANUAL CLEARLY DEFINES SAME SPECIES BYCATCH ON PAGE 16 (BYCATCH OF UNDER SIZE FISH).

DRAWING B — SEPARATOR - HOW IT WORKS, BYCATCH/SHELL TO LAND FILL.

DRAWING C — STEAMER & SHELL/MEAT SEPARATOR - HOW IT WORKS, SHELL TO LAND FILL.

DRAWING D — EVISCERATOR - HOW IT WORKS, EVISCERA & WASTE WATER TO DISPOSAL SITE. ABRASIVE ROLLERS, LG. SCALLOPS MORE YIELD PER BU. SMALLER SCALLOPS LESS YIELD PER BU. OF SHELL STOCK. AT 300/400 COUNT 10 OR 20 TIMES MORE SHELL STOCK IS NEEDED TO PRODUCE A GALLON OF SCALLOPS.

POSTER 4

PROCESSOR VESSEL (TYPICAL DESIGN)

DRAWING A — TOP VIEW SHOWING DECK, SEPARATOR, EQUIPMENT LAYOUT & DISCHARGE CHUTES TO OCEAN.

B — EXPLANATION OF SEPARATOR DESIGN & ADVANTAGES.

DRAWING C — SIDE VIEW OF SEPARATOR.

POSTER 5

LANDING/EFFORT/COUNT SIZE - GRAPHS

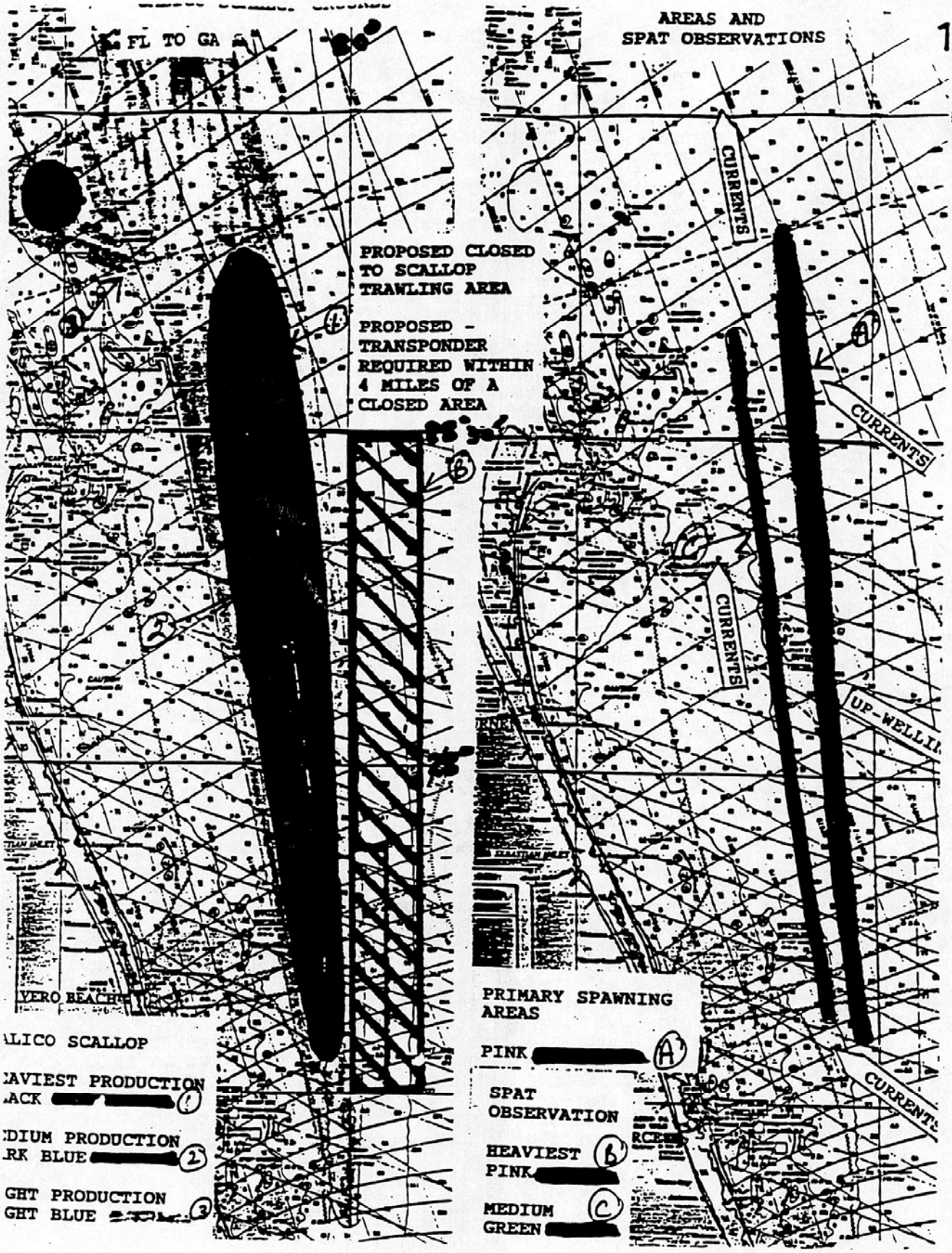
GRAPH A — FLORIDA LANDINGS - SHOWING INDUSTRY START/BUILDING/REDUCING. COUNT SIZE 100/150 AT START, TO 200/300 COUNT TODAY. HEALTHY SCALLOPS- SMALL SHELL/BIG MEAT. OCCASIONALLY - LARGE SHELL/SMALL MEAT. HIGH NATURAL MORTALITY USUALLY OCCURS BEFORE 6 MONTHS & ALMOST NEVER OCCURS AFTER 6 MONTHS. 1994 & 1995 SHOWN IN DETAIL BELOW UNDER HEADING ACTUAL.

GRAPH B — NORTH CAROLINA LANDINGS - SMALLER SCALE BUT OBVIOUSLY SIMILAR. LONGER HISTORY TO OBSERVE. DECLINE MAYBE DUE TO SHELL BED DEPLETION & NOT A SMALLER SIZE TAKEN PROBLEM BECAUSE N.C. HAS A 150 COUNT LANDING REGULATION IN PLACE.

GRAPH C — EFFORT CHART - SHOWING PROGRESSION OF REPORTED STOCKS INDUSTRY STARTS /BUILDS/REDUCES, EFFORT, REDUCED ESCAPEMENT & SHELL BED DEPLETION AS THE PROBABLE CAUSE OF MAJOR DECLINE.

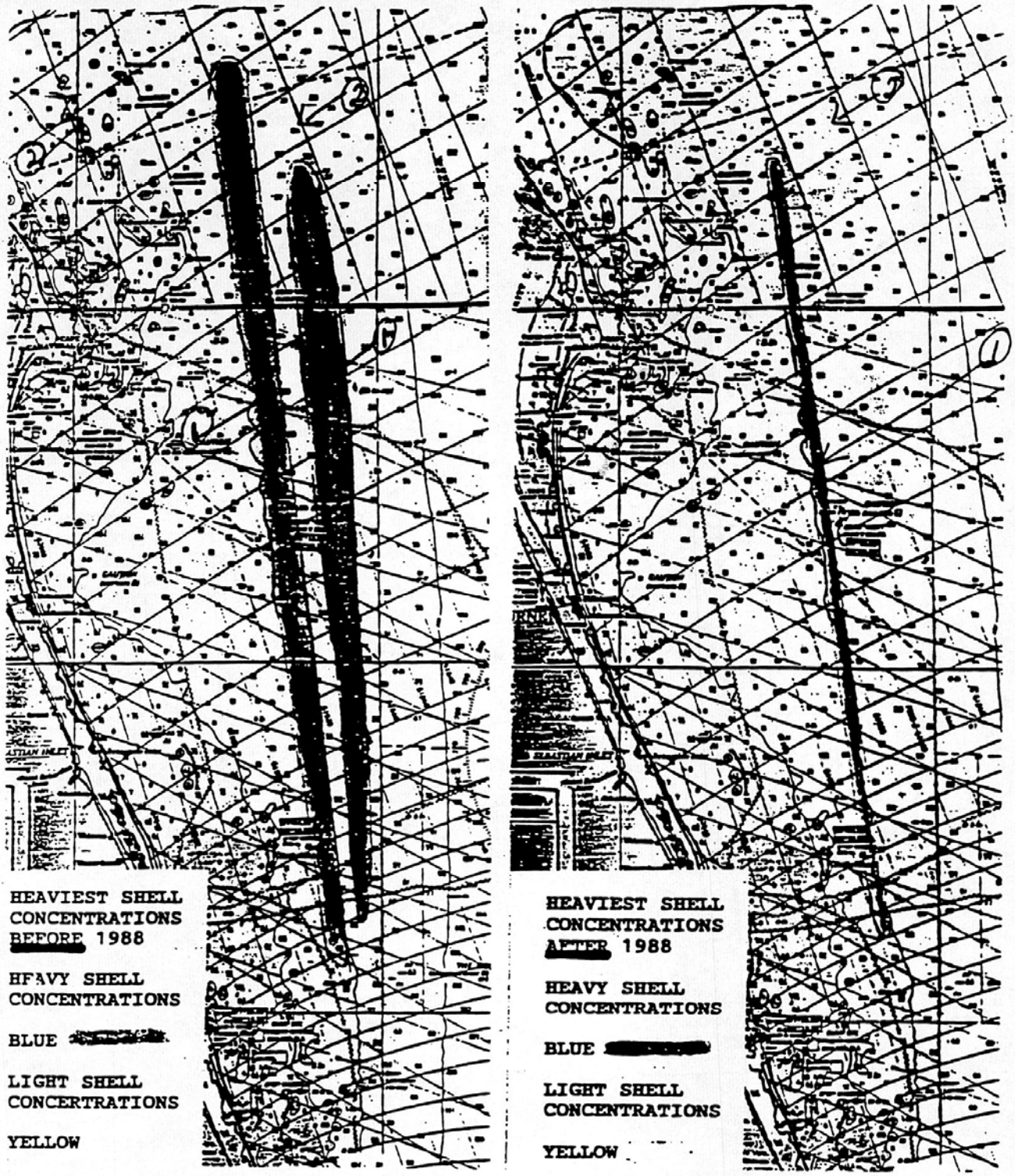
GRAPH D — ACTUAL - 1994/95 LANDING (FROM FLORIDA LANDING CHART ABOVE) ACTUAL --6 MILLION LBS. LANDED — PROPORTION OF ESTIMATED SIZES TAKEN. 1995 PRODUCTION LOW BECAUSE WE HARVESTED 200/300 COUNT IN 1994. NOT LIKELY TO HAVE MORE LANDINGS THIS YEAR

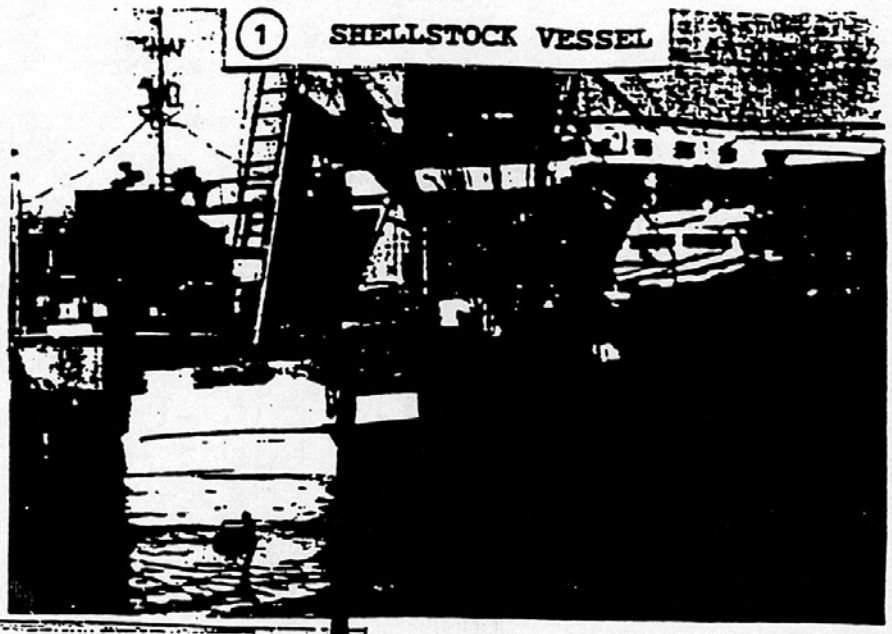
GRAPH E — POSSIBLE -- HAD WE WAITED UNTIL COUNT REACHED 100/150 COUNT WE PROBABLY COULD HAVE LANDED 5 MILLION LBS. IN THE LATER PART OF 1994 WITH HIGHER DOLLAR VALUE. IN 1995 WE POSSIBLY COULD HAVE LANDED 5 MILLION LBS. OF 100/150 COUNT ALSO WITH A HIGHER DOLLAR VALUE. IT IS MY OPINION THAT WAITING FOR A LARGER SIZE WOULD HAVE INCREASED COMBINED LANDINGS BY 1/3 AND DOUBLED THE DOLLAR VALUE.

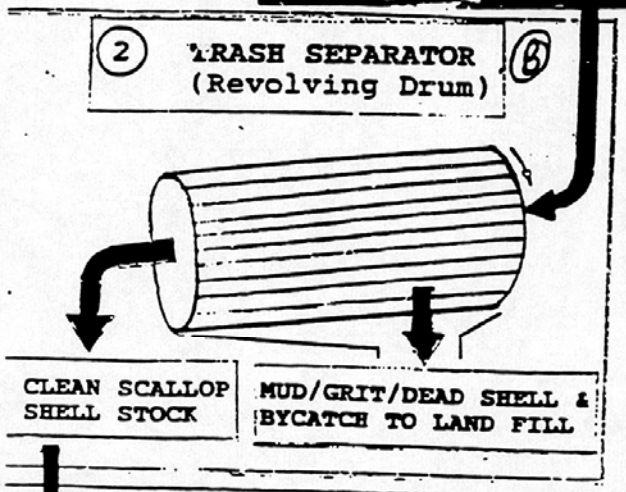

AREAS AND
SPAT OBSERVATIONS
FL TO GA
PROPOSED CLOSED
TO SCALLOP
TRAWLING AREA
PROPOSED -
TRANSPONDER
REQUIRED WITHIN
4 MILES OF A
CLOSED AREA
CURRENTS
CURRENTS
CURRENTS
CURRENTS
VERO BEACH
PRIMARY SPAWNING
AREAS
PINK
SPAT
OBSERVATION
HEAVIEST
PINK
MEDIUM
GREEN
ALICO SCALLOP
AVIEST PRODUCTION
ACK
DIUM PRODUCTION
RK BLUE
GHT PRODUCTION
GHT BLUE

BETWEEN THE YEARS OF 1978 & 1989 FLORIDA D.N.R. RECORDS INDICATE APPROXIMATELY 125 MILLION POUNDS OF SCALLOP MEATS WERE LANDED.

USING A CONSERVATIVE 1 TO 10 RATIO MORE THAN 1.25 BILLION POUNDS OF SHELLS WERE LANDED BETWEEN 1978 & 1989. THE ACTUAL NUMBER (FROM ALL OTHER SOURCES) COULD EXCEED 5 BILLION POUNDS.

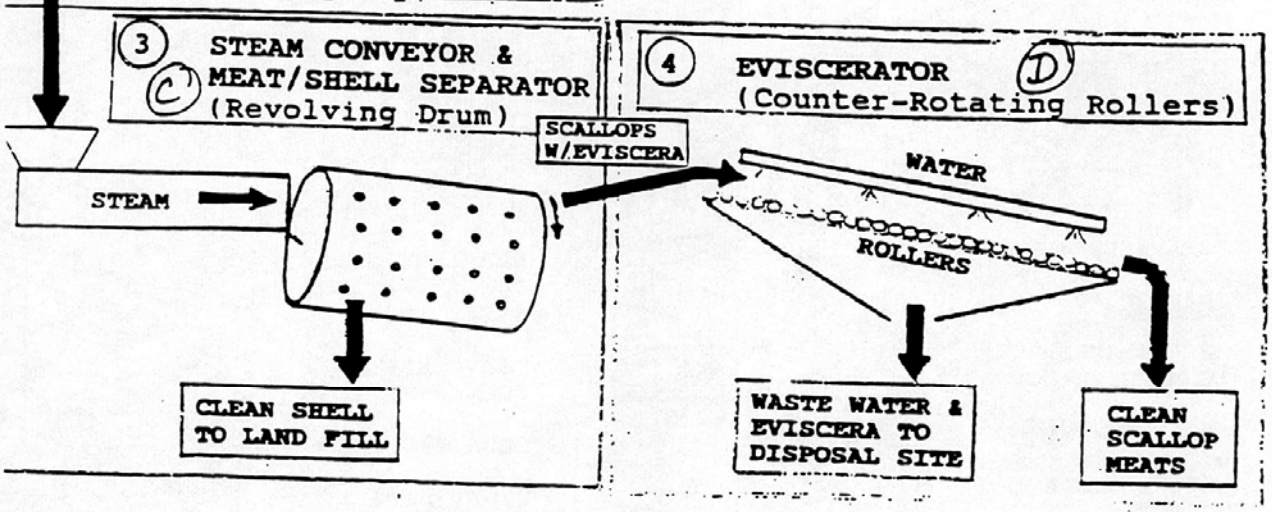




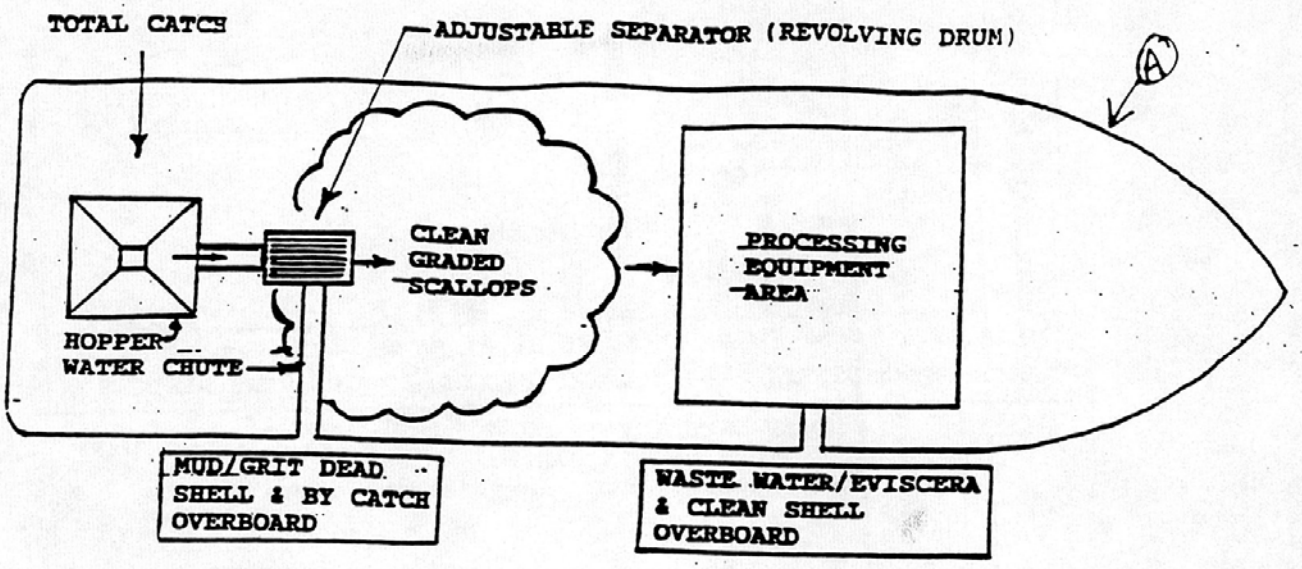


SHELL INFORMATION

WHEN SCALLOPS ARE HARVESTED FROM A TYPICAL BED, SHELL PERCENTAGES CAN VARY FROM APPROX. 90/10 TO 10/90. ON THE AVERAGE ONE HALF OF SHELL STOCK IS UNWANTED OLD DEAD SHELL THE OTHER HALF BECOMES CLEAN NEW SHELL ONCE THE MEATS ARE REMOVED IN STEAM PROCESS.



TOP VIEW



THE ADJUSTABLE SEPARATOR IS DESIGNED TO DO THE FOLLOWING:

A SELECT THE TARGETED SCALLOP SIZE. ADJUST TO VARYING SHELL SIZE/ MEAT SIZE WITH A SIMPLE MECHANICAL ADJUSTMENT.

B IMMEDIATELY RETURN TO THE SEA ALIVE, SMALL SCALLOPS UNDER THE TARGETED SIZE, ATTACHED SPAT & OTHER SPECIES BYCATCH. RESEARCH HAS SHOWN THAT MOST WILL LIVE IF QUICKLY RETURNED TO THE SEA.

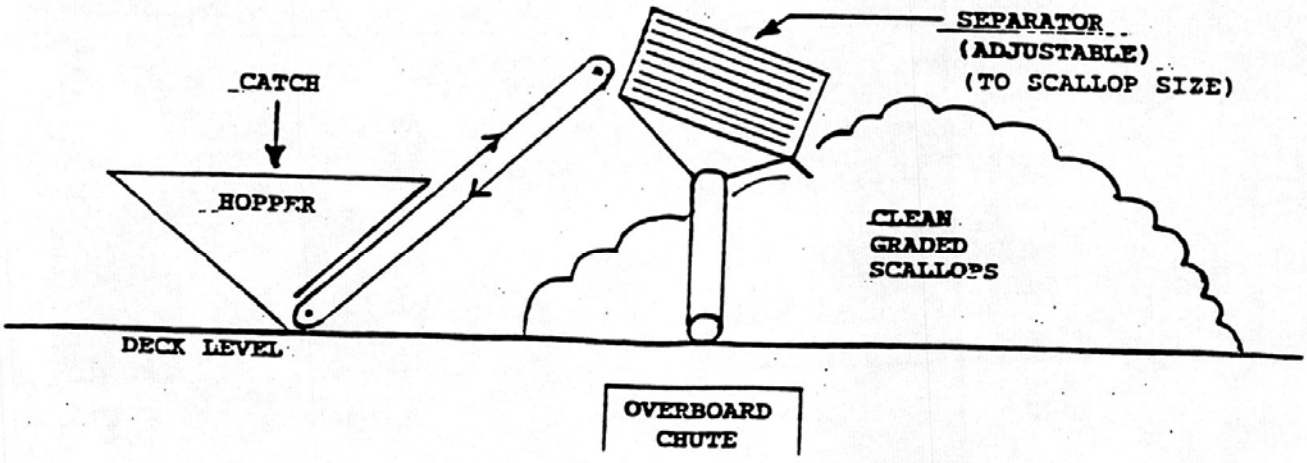
C SEPARATE THE CLEAN SCALLOPS AND IMMEDIATELY DISCHARGE OVERBOARD THE MUD, SHELL & BYCATCH.

ADVANTAGES:

1 REDUCES WEIGHT IMPROVING VESSEL SAFETY.
2 IMPROVES PRODUCT QUALITY BY REMOVING BACTERIA IN THE WASHING PROCESS.
3 REDUCES OR ELIMINATES SAME SPECIES & OTHER SPECIES BYCATCH.
4 RETURNS SHELL TO THE ORIGINAL BED.

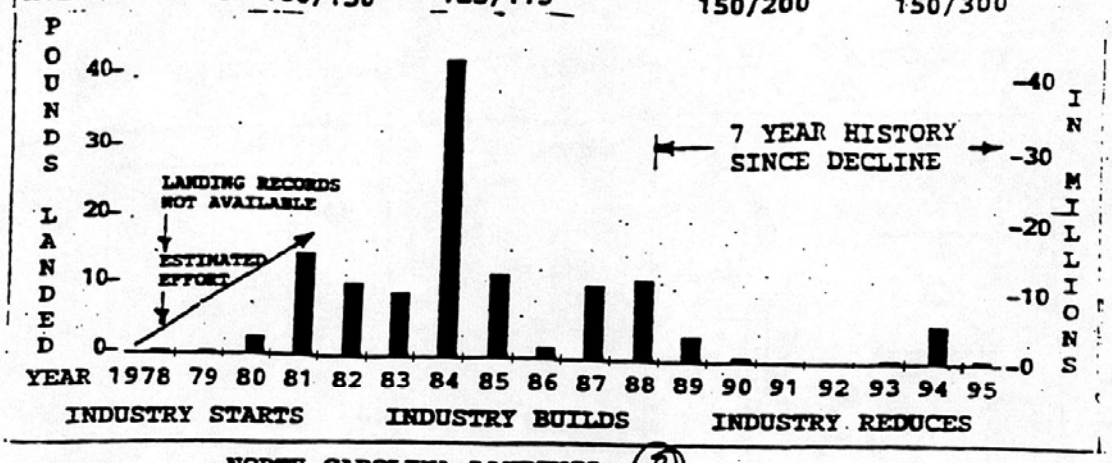
C SEPARATOR

SIDE VIEW



PROVIDED BY D.E.P.

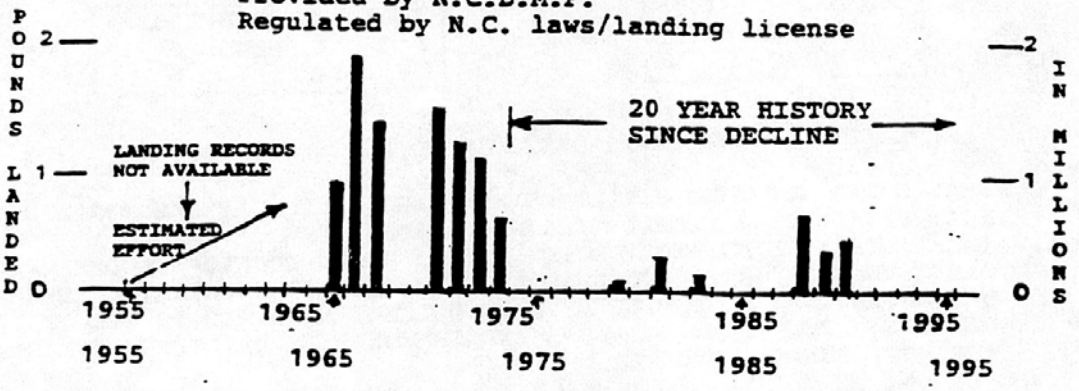
AVERAGE COUNT 100/150 125/175 150/200 150/300

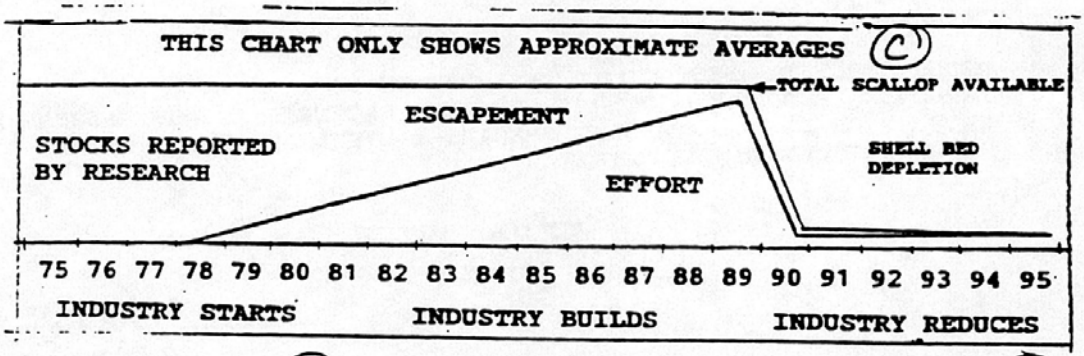


NORTH CAROLINA LANDINGS (B)

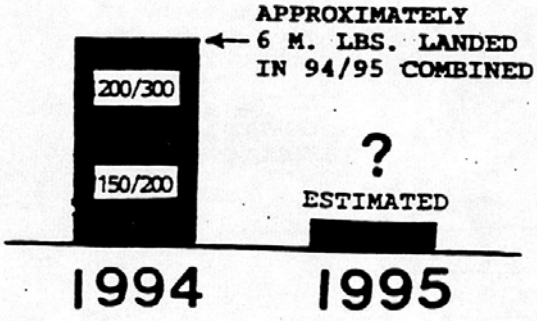
Provided by N.C.D.M.F.

Regulated by N.C. laws/landing license

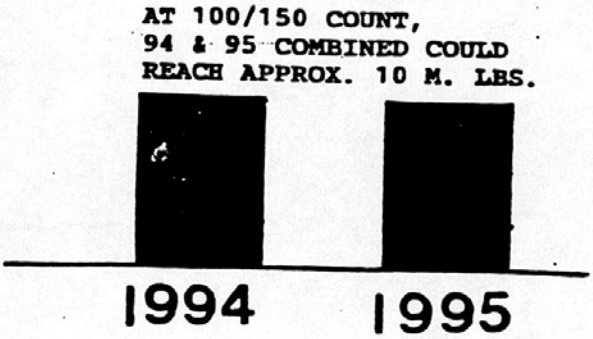




ACTUAL (D)



POSSIBLE (E)



Attachment 6

CALICO SCALLOP PRESENTATION OUTLINE

KEY PROBLEMS

1 SHELL BED DEPLETION - AFFECTS SPAWNING

2 BYCATCH - SAME SPECIES BYCATCH - SHELL W/SPAT & UNWANTED UNDER SIZE SCALLOPS ARE HARVESTED WITH TARGETED SIZE.

3 ESCAPEMENT - WE MAY NOT BE LEAVING ENOUGH SCALLOPS FOR SPAWNING AT PRE 1988 LEVELS.

4 GROWTH OVERFISHING - TARGETED COUNT SIZE IS TO SMALL. GROWTH TAKES OVER NATURAL MORALITY AFTER 6 MONTHS. SMALL SIZE LOWERS PRICE & DEPRESSES PRICE ON LARGER SIZE AT THE SAME TIME.

5 ECONOMIC OVERFISHING - HARVESTED TO FAST GLUTS THE MARKET & REDUCES MAXIMUM DOLLAR POTENTIAL.

GOALS & OBJECTIVES

TO ACHIEVE ANNUAL OPTIMUM YIELD I PROPOSE WE DO THE FOLLOWING:

A PROTECT THE SPAWNING & NURSERY HABITAT.

B REDUCE OR ELIMINATE SAME SPECIES BYCATCH.

C INCREASE ESCAPEMENT TO ASSURE MAXIMUM SPAWNING LEVELS.

D ADDRESS GROWTH OVERFISHING (COUNT SIZE) WITH A MECHANISM THAT ASSURES RESPONSIBLE FISHING (CO-MANAGEMENT).

E PREVENT ECONOMIC OVERFISHING FROM OCCURRING WITH A MECHANISM THAT ASSURES RESPONSIBLE FISHING (CO-MANAGEMENT).

HOW

MY RECOMMENDATIONS ON HOW TO ACHIEVE THESE GOALS & OBJECTIVES ARE AS FOLLOWS:

1 IN A F.M.P. REGULATE THE <u>RETURNING OF ALL SHELLS</u> TO THE ORIGINAL BED. THIS CAN BE DONE BY A TRANSFER OF THE SHELL/BYCATCH SEPARATOR TO THE SHELL STOCK VESSEL (USING EXISTING PROVEN TECHNOLOGY) & BY DECK LOADING THE CLEAN SHELLS ON THE RETURN TRIP TO THE GROUNDS (ADDRESSES GOALS & OBJECTIVES A & B).

2 IN A F.M.P. <u>ADOPT THE N.C. LANDING REGULATIONS</u> THAT HAVE BEEN USED SUCCESSFULLY FOR 20 YEARS. THE FOLLOWING IS A BRIEF OUTLINE OF THESE REGULATIONS:

a CLOSED UNTIL OPENED.
B CLOSED UNTIL SIZE REACHES 150 COUNT.
c CLOSED WHEN SIZE LANDED GOES ABOVE 160 COUNT.
d CLOSED WHEN PRODUCTION DROPS BELOW A CERTAIN GALLONS PER DAY LEVEL.
e OPENED WHEN RESEARCH DETERMINES SIZE & QUANTITY IS AVAILABLE.
(ADDRESSES GOALS & OBJECTIVES C, D, & E).

THROUGH CO-MANAGEMENT & COMMITTEES MAKE MANAGEMENT ADJUSTMENTS AS AS NEEDED. (ADDRESSES GOALS & OBJECTIVES D & E)

Appendix C. Presentations and Materials Provided by Mr. William Burkhardt at the Florida Marine Fisheries Commision, February 24, 1998 Meeting

APPROXIMATE SCALLOP YIELDS AT VARIOUS SHELL HEIGHT SIZES

AGE	APPROXIMATE SHELL HEIGHT	APPROXIAMTE COUNT	APPROXIMATE YIELD
6 MONTHS	= 1/2"	= 500	= 5%
8 MONTHS	= 3/4"	= 400	= 10%
10 MONTHS	= 1"	= 300	= 25%
12 MONTHS	= 1 1/4"'	= 200	= 50%
14 MONTHS	= 1 1/2"	= 100	= 75%
16 MONTHS	= 1 3/4"	= 75	= 90%

YIELD EXAMPLE: A 40,000 LB. TRUCK LOAD OF 300 OR 400 COUNT SCALLOPS MIGHT YIELD 500 OR 1,000 LBS. OF MEATS. THE SAME TRUCK LOAD OF SCALLOPS IF LEFT TO GROW WOULD TURN INTO SEVERAL TRUCK LOADS OF SCALLOPS THAT COULD EASILY YIELD 3,000 LBS. OR MORE PER TRUCK LOAD. BY WAITING, A GAIN OF MORE THAN 10 TIMES COULD BE EXPECTED. TO SAY THAT WE LOOSE 1/2 OF THE SCALLOP MEAT AVAILABLE TO US (BY HARVESTING TO SOON) WOULD BE A VERY CONSERVATIVE ESTIMATE.

SOME PEOPLE THINK WE SHOULD HARVEST SMALL SCALLOPS BECAUSE THEY MIGHT GET STUNTED AND NOT GROW ANY BIGGER. IN 20 YEARS I HAVE NEVER OBSERVED THIS CONDITION BUT WILL AGREE IT COULD BE POSSIBLE.

SOME PEOPLE THINK WE SHOULD HARVEST SMALL SCALLOPS BECAUSE THEY MIGHT DIE OR DISAPPEAR. WHEN EITHER OF THESE CONDITIONS OCCUR THE SCALLOPS ARE USUALLY LESS THAN 6 MONTHS OLD AND WERE NOT BIG ENOUGH TO HARVEST. ONCE A SCALLOP GET OLD ENOUGH TO HARVEST, DISAPPEARING OR DIEING IS A RARE OCCURRENCE BUT POSSIBLE.

IT IS MY OPINION THAT WE NEED TO ESTABLISH A MINIMUM SHELL HEIGHT SIZE THAT IS REGULATED BY THE STATE. THE GAIN THAT WE WOULD SEE ALL THE TIME WOULD FAR OUT WEIGH ANY LOSSES THAT COULD OCCUR FROM THE SCALLOP STUNTING, DISAPPEARING OR DIEING. THE STATE OF N.C. HAS SUCCESSFULLY USED A 1 1/4" SHELL HEIGHT AND 150 COUNT MEAT SIZE AS A GUIDE LINE WITH NO APPARENT OPPOSITION FROM EITHER THE PROCESSORS OR THE BOATS. I PROPOSE THAT A MINIMUM SHELL HEIGHT OF 1" BE ESTABLISHED AS A SIZE LIMIT IN THE STATE OF FLORIDA.

Appendix D. Calico Scallop Bycatch Information

Table 1. Calico scallop bycatch information. Source Florida Marine Fisheries Commision Draft Rule Package.
Survivorship over a 4 hr. Test period of individuals removed from scallop by-catch on Febuary 12-13, 1991. A=animal alive after time interval, D=animal dead after time interval. *= survivor with obvious scale damage.

Taxon Station	No.	Time: .3hr.	4hr.
Fishes			
Bothidae			
South	2	A	A
South	2	A	1A/1D
South	2	A	1A/1D
South	1	D	
South	2	1A/1D	1A*
South	2	1A/1D	1A*
South	1	A	A
South	2	1A/1D	2D
South	2	1A/1D	1A
South	2	A	A
Centropristis phildelphica			
South	1	A	A
Central	1	A	A
North	1	A	A
Diplectrum formosum			
North	2	A	D
North	1	A	D
North	1	A	D
North	2	A	1A/1D
North	1	D	
Gymnachirus melas			
Central	1	A	D
Gymnothorax nigromarginatus			
North	1	A	A
Lactophyrs quadricornis			
North	1	A	A
Monocanthus hispidus			
Central	1	D	
Central	1	A	D
North	1	D	
North	1	A	A
Ogocephalus radiatus			
South	3	A	A
South	2	A	A

Taxon Station	No.	Time: .3hr.	4hr.
Ophidon gravi			
Central	1	A	A
Ophidon holbrooki			
Central	1	D	
Prionotus roseus			
South	1	D	
South	1	D	
South	2	1A/1D	1A
South	2	1A/1D	1A
South	2	1A/1D	1A*SC*
Scorpaena brasiliensis			
South	3	A	A
Central	5	A	A
Spoeroides parvus			
Central	1	A	A
North	1	A	A
Syngnathus louisianae			
North	2	A	A
Synodus foetens			
South	1	A	D
North	1	D	
Crustaceans			
Calappa flammea			
Central	3	A	A
Central	3	A	A
Libinia emarginata			
Central	1	A	A
Central	1	A	A
Sicyonia brevirostris			
Central	9	7A/2D	7A
Portunidae			
South	3	A	A
South	3	A	A
South	3	2A/1D	2A
South	4	A	A
South	3	A	A

Suvivorship over a 4hr. Test period of individuals removed from scallop by-catch on June 5-6, 1991. A =animal alive after time interval, D=animals dead after time interval.

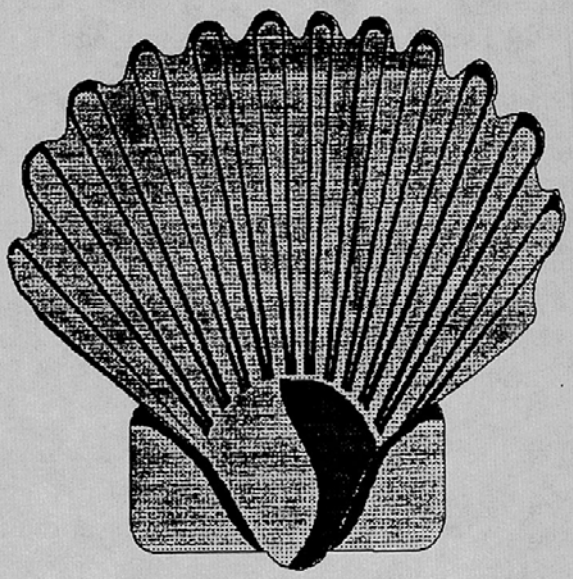
Taxon Station	No.	Time: .5hr.	1hr.	4hr.
Fishes				
Bothus robinsi				
Central	1	A	A	A
Gymnothorax nigromarginatus				
North	1	A	A	A
Hemipteronotus novacula				
North	1	A	A	A
Halieutichthys aculeatus				
Central	2	A	A	A
North	3	A	A	A
Ogocephalus raiatus				
North	2	A	A	A
Raja eglantaria				
North	1	A	A	A
Crustaceans				
Callappa flammea				
South	1	A	A	A
Callinectes sapidus				
Central	2	A	A	A
Hepatus epheliticus				
South	2	A	A	A
Libinia emarginata				
South	1	A	A	A

Suvivorship over a 4hr. Test period of individuals removed from scallop by-catch on September 19-20, 1991. A =animal alive after time interval, D=animals dead after time interval.

Taxon Station	No.	Time: .5hr.	1hr.	4hr.
Fishes				
Balistes capriscus				
Central	2	A	A	A
Halieutichtys aculeatus				
Central	1	A	A	A
North	2	A	A	A
Lactophrys quadricornis				
Central	1	A	A	A
Monocanthus hispidus				
Central	1	A	A	A
Ogcocephalus radiatus				
North	1	A	A	A
Crustaceans				
Portunidae				
Callinectes ornatus	3	A	A	A
Callinectes sapidus	1	A	A	A
Ovalipes stephensoni	1	A	A	A
Paguridea sp.				
Central	1	A	A	A
North	1	A	A	A
Sicyonia brevirostris				
Central	2	A	A	A
Mollusks				
Octopus burrvi				
Central	1	A	A	A

Appendix E. Response of the Scallopers to Proposed Management Measures in the Comprehensive Amendment for Essential Fish Habitat in the South Atlantic

Response of Scallopers to Proposed Management Measures in the Comprehensive Amendment for Essential Fish Habitats in the South Atlantic



William O. Antozzi
Fisheries Economics Office
National Marine Fisheries Service
9721 Executive Center Drive N.
St. Petersburg, FL 33702

May 18, 1999

SERO-ECON-99-12

Response of Scallopers to Proposed Management Measures in the Comprehensive Amendment for Essential Fish Habitats in the South Atlantic

The purpose of this exercise was to ascertain the opinions of calico scallop vessel owners and captains regarding the proposed prohibition of trawling for calico scallops in the expanded Habitat Area of Particular Concern area (HAPC). The expanded HAPC is part of the proposed Comprehensive Amendment for Essential Fish Habitat (EFH) in the S. Atlantic and also is being considered as part of a proposed Calico Scallop Fishery Management Plan (FMP). Only those owners/captains geographically removed from the Florida East Coast were selected for interviews. The premise was that these remote captains and owners were less likely to have been aware of the impending Amendment and it's implications. All members of the Calico Scallop Advisory Panel live or the Florida East Coast. The objective of this exercise was to afford scallopers with home ports outside the Florida East Coast an opportunity to provide their appraisal of the HAPC's impact on their scalloping activities.

The areas proposed for closure constitute an expanded version of an existing HAPC along with two adjacent small satellite areas. These areas consist of sea bottom where oculina corals and other live bottom were determined to be prevalent. The management measures are designed to protect this essential habitat from the destructive effects of bottom fishing. The proposed closed areas are located offshore between Cape Canaveral and Fort Pierce Florida, at a depth generally between 35 and 100 fathoms (exact longitudes and latitudes are provided in the proposed Calico Scallop FMP and in the proposed Comprehensive EFH amendment).

NMFS Fishery Statistics provided a list of 27 vessels known to have scalloped off the East Coast of Florida within the last three years. 14 of the 27 vessels are currently home ported on the Florida East Coast and 13 elsewhere. These 13 vessels were the subject of the exercise.

Nine owners and captains were contacted by telephone.[1] Collectively they own or operate 12 of the 13 non-Florida E.C. scallop vessels. The vessels are home ported in NC (7), AL (1), SC (1), Ga (1), and on the FL West Coast (2).

One contact out of nine was aware of the general plan to regulate calico scallop fishing, and none were aware of the proposed amendment's action items (including the expanded closure area) or their potential impacts. All contacts were provided with verbal and fax descriptions of the proposed closed area and were asked to provide an estimate of the impact on their future scallop production potential.
All owners/captains were asked: "do you expect that your production of calico scallops from the Florida East Coast will be reduced more or less than 5% if the proposed closed areas go into

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[1] Making more than nine contacts requires prior approval by OMB

effect as a result of a new Calico Scallop FMP?"[2] On a per vessel basis, 4 projected a negative impact of 5% or more, while 7 projected the impact at less than 5%. One of the contacts "passed" on his projection because the captain did not feel that he had enough recent experience in the subject area to provide an opinion.

All are very interested in being notified of any new developments or proposals to regulate the calico scallop industry.

References

SAFMC. 1998. Final Comprehensive Amendment Addressing Essential Fish Habitat in Fishery Management Plans of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Circle, Charleston, SC 29407-4699. 142 pp.

SAFMC. 1998. Final Fishery Management Plan for the Calico Scallop Fishery in the South Atlantic Region. Including A Final Environmental Impact Statement, Regulatory Impact Review, and Social Impact Assessment/Fishery Impact Statement. South Atlantic Fishery Management Council, 1 Southpark Circle, Charleston, SC 29407-4699. 124 pp.

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[2] The question could also have been asked relative to the Comprehensive EFH amendment because the action is being considered in both documents.

Appendix F. Summary Report on the Calico Scallop (*Argopecten gibbus*) Fishery of the Southeastern United Sates

SUMMARY REPORT ON THE CALICO SCALLOP

(Argopecten gibbus)

FISHERY OF THE SOUTHEASTERN UNITED STATES

William S. Arnold

Florida Department of Environmental Protection

Florida Marine Research Institue

100 8th Avenue S.E.

St. Petersburg, Florida 33701-5095

January 10, 1995

generations of scallops. Early growth is rapid, but varies with size, season, and environment (Allen and Costello, 1972). In the vicinity of Cape Canaveral, Florida, scallops reach 40-45 mm SH in 8 to 10 months (Blake and Moyer, 1991), but growth may be considerably slower off North Carolina (Wells et al., 1964). Terminal shell height averages 65 mm (Roe et al., 1971). Maximum life span for A. gibbus is 24 months, but the average life span is closer to 18 months (Roe et al., 1971).

Recruitment (sensu Keough and Downes, 1982) also occurs throughout the year; peak recruitment occurs during March through June, with a minimum during August through November (Allen, 1979). Timing and extent of recruitment may be extremely variable from year to year, and year class failure has been documented for the Cape Canaveral population (Moyer and Blake, 1986).

Factors influencing year-class success are not well understood, but physical oceanographic processes are certainly a contributing factor. Leming (1979) hypothesized that coastal upwelling near Cape Canaveral influences the distribution and abundance of A. gibbus in that region. Upwelling along the Florida east coast between Fernandina Beach and Canova Beach was described by Green (1944) and thoroughly characterized by Leming (1979). Upwelling in that region is a seasonal phenomenon that occurs primarily between April and August and that injects cold, nutrient rich water onto the shallow east Florida continental shelf. Potential effects of upwelling on calico scallops include

terms of both species composition and numbers, the by-catch is approximately equally distributed among fish, echinoderms, and crustaceans (Nelson et al., 1992); by-catch comprised a maximum of 1.5% of the total weight of the trawl (Nelson et al., 1992). Although some commercially important species were collected as by-catch (e.g. Callinectes sapidus, Sicyonia brevirostris), they constituted a minor portion of the total catch. Nelson et al. (1992) concluded that calico scallop by-catch "may have relatively low impacts on species of commercial or recreational importance". It should be noted, however, that by-catch mortality is 100% because the entire catch is brought to shore for processing. Finally, it has always been accepted that the A. gibbus fishery is a federal problem because fishing occurs well outside state waters (Figure 4). However, because most landings occur in Florida, federal managers have had little apparent interest in the fishery. As a result, the fishery has languished in obscurity. It should be noted that, although the Cape Canaveral fishery does occur exclusively in federal waters, it is probable that at least some of the Cape San Blas fishing effort occurs in state waters (Figure 5).

It would be difficult to develop an effective management plan for calico scallops based upon our present understanding of the animal and its environment. We know that the South Atlantic Bight (SAB), the biome within which two of the three fished populations of calico scallops live, is strongly influenced by seasonal upwelling (Atkinson et al., 1985). It is reasonable to

Moyer, M.A., N.J. Blake, W.S. Arnold. 1993. An ascetosporan disease causing mass mortality in the Atlantic calico scallop, Argopecten gibbus (Linnaeus, 1758). J. Shellfish Res. 12: 305-310.

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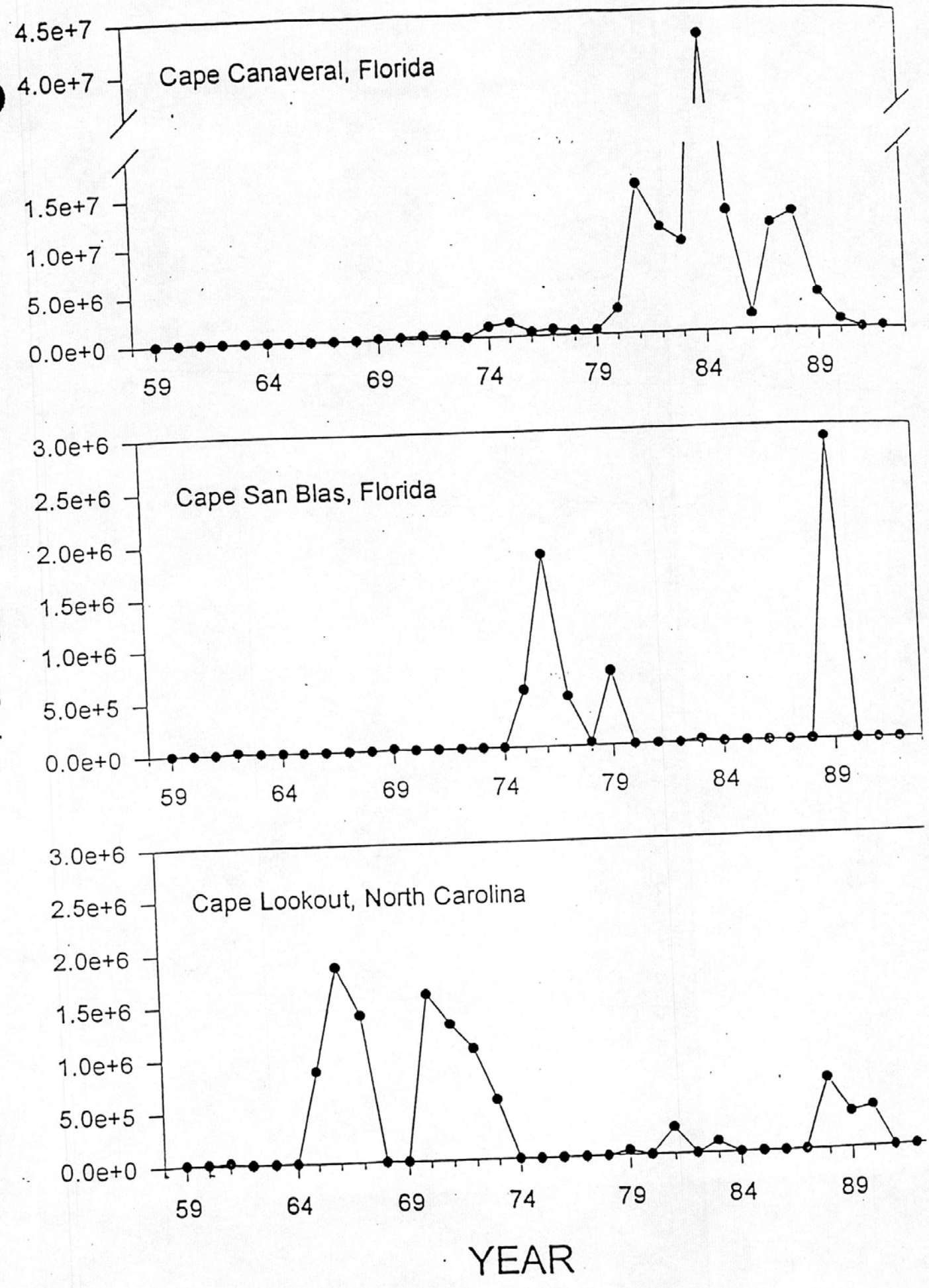
Cape Canaveral, Florida
4.5e+7
4.0e+7
1.5e+7
1.0e+7
5.0e+6
0.0e+0
59
64
69
74
79
84
89
POUNDS LANDED
Cape San Blas, Florida
3.0e+6
2.5e+6
2.0e+6
1.5e+6
1.0e+6
5.0e+5
0.0e+0
59
64
69
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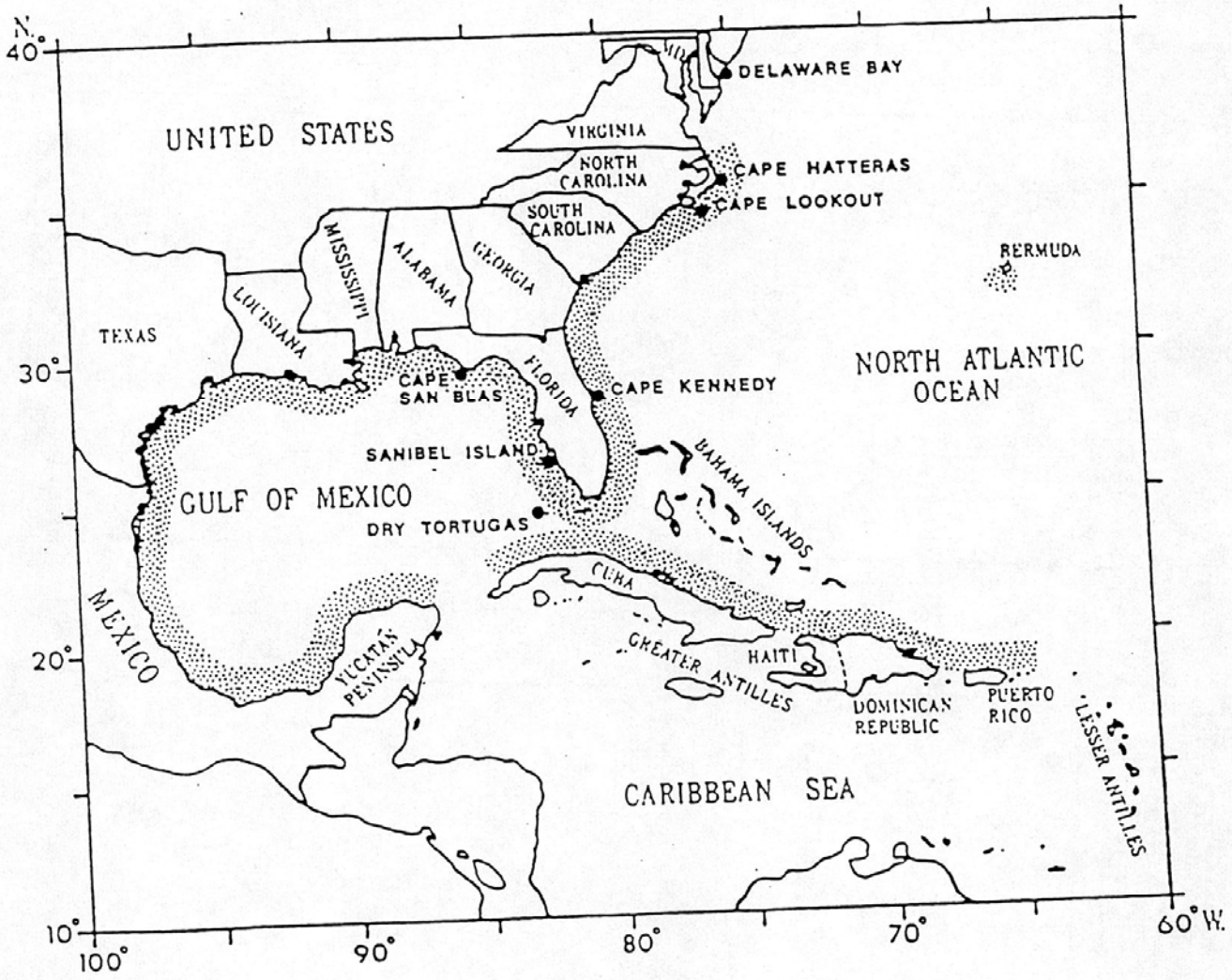
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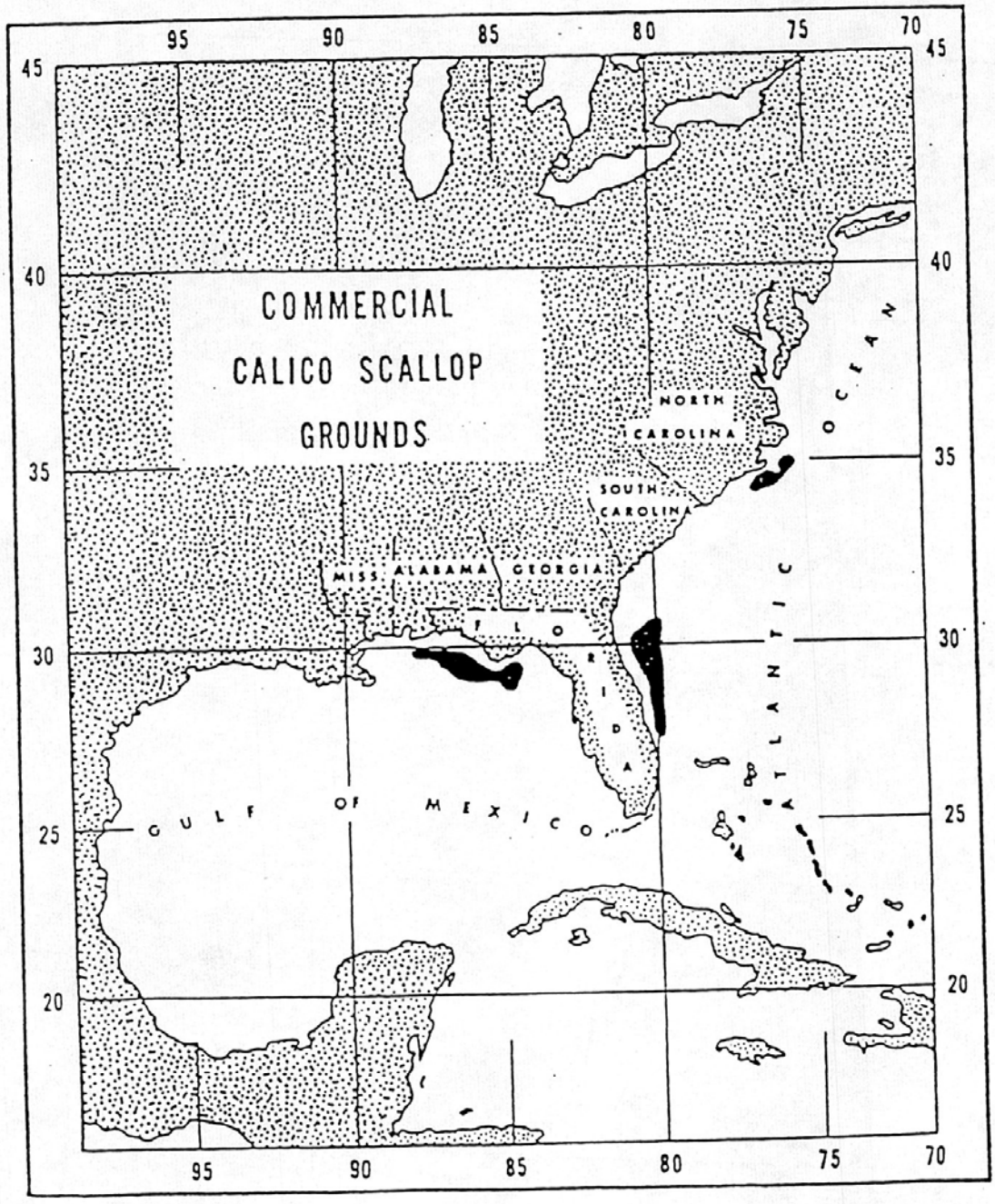
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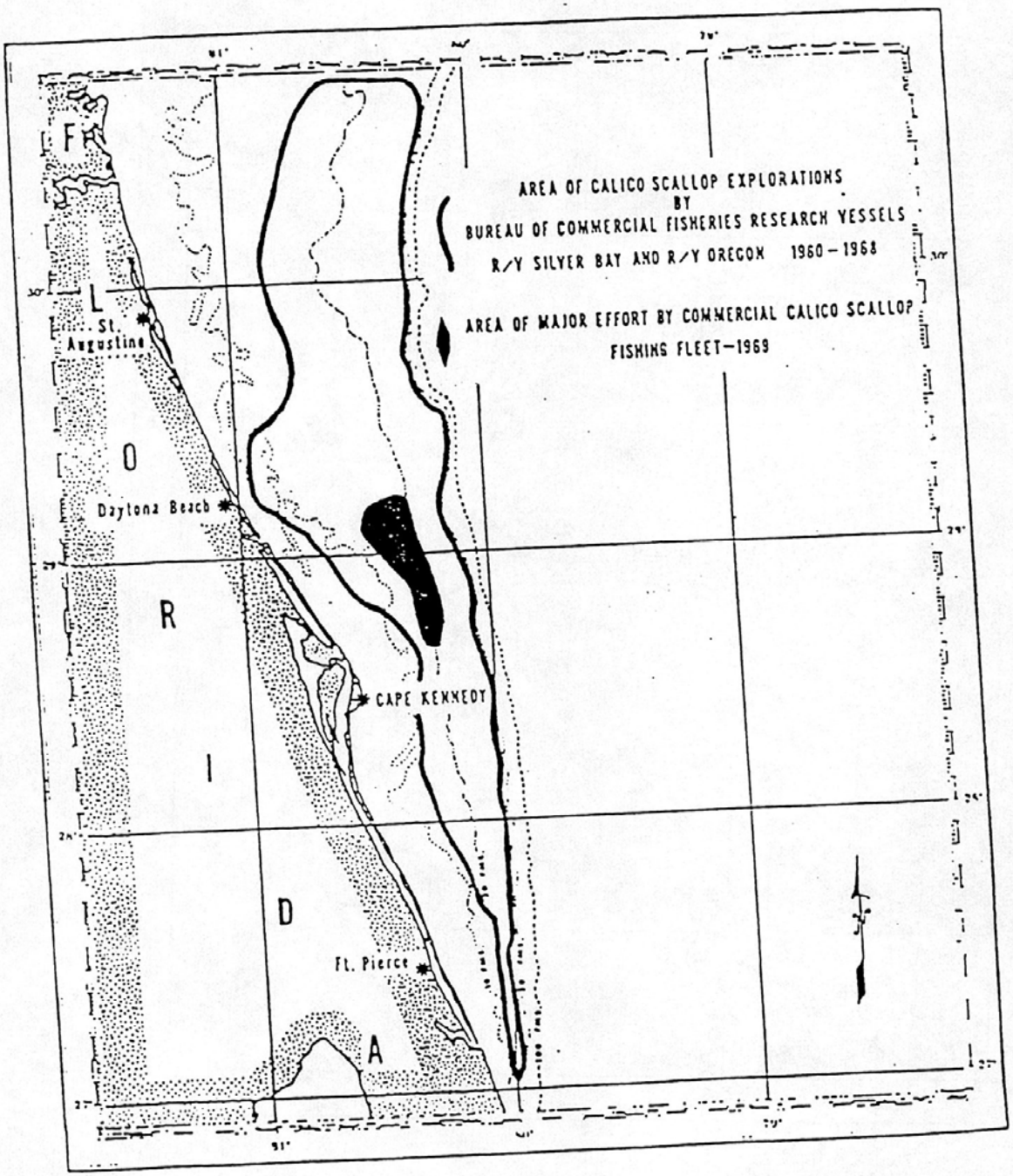
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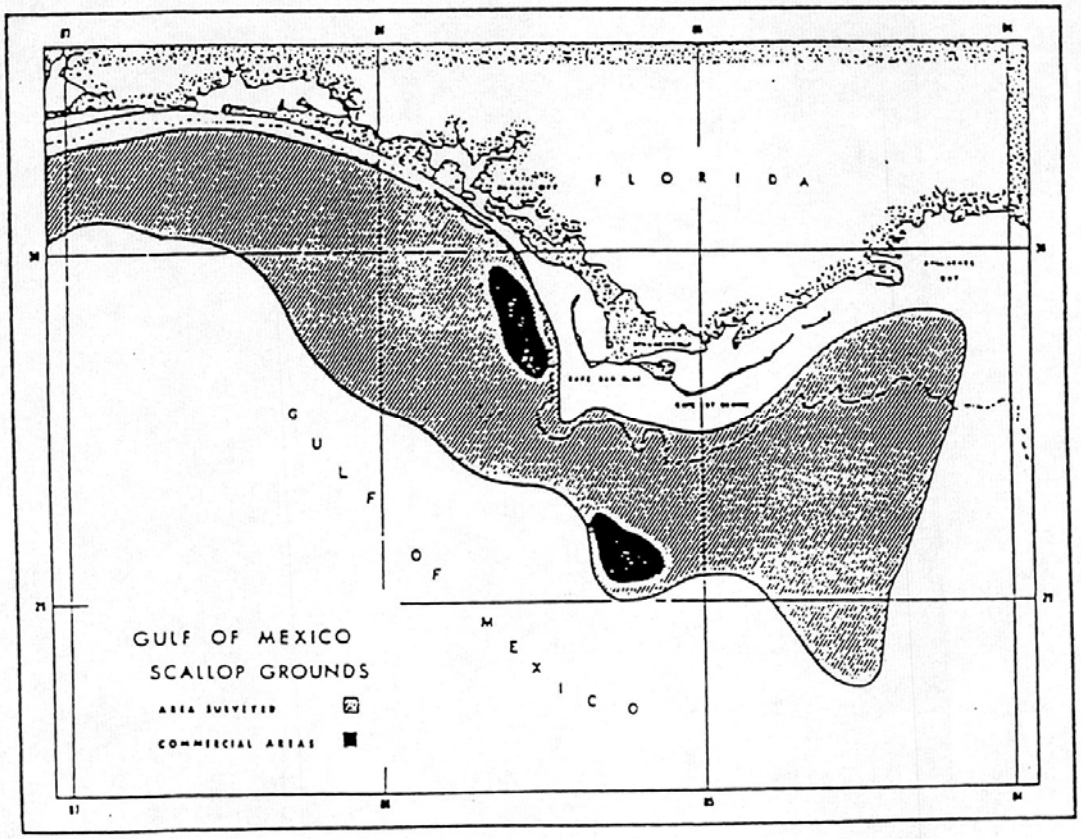
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Appendix G. The Calico Scallop, *Argopecten gibbus*, Fishery of Cape Canaveral, Florida

In: Developments in Aquaculture and Fisheries Science, Volume 21,
Scallops: Biology, Ecology and Aquaculture, S.E. Shumway (ed.)
Chapt. 14, 899-911. Elsevier Science Publishers, Amsterdam, 1991

THE CALICO SCALLOP, *ARGOPECTEN GIBBUS*, FISHERY OF CAPE CANAVERAL, FLORIDA

NORMAN J. BLAKE and MICHAEL A. MOYER

Department of Marine Science, University of South Florida, 140 Seventh Avenue South, St. Petersburg, Florida 33701 (U.S.A.)

INTRODUCTION

The calico scallop, *Argopecten gibbus*, represents a relatively new commercial species to the American market. Although large stocks of calico scallops were known as early as 1949 (Chestnut, 1951), the adductor muscle, the only scallop part commonly consumed by the American public, is small in comparison to other scallop meats. Due to the small meat size hand-shucking is not economically feasible for large scale production. This limited the extent to which the species was harvested prior to automation and thus the stocks remained largely underutilized until the late 1970's.

The first reported commercial fishery for the species began in 1959 (Cummins, 1971) near Cape Lookout, North Carolina and by the mid-sixties had extended to the Cape Canaveral area of Florida. Some commercial fishing for the species began off Cape Canaveral as early as 1967; however, it would be almost a dozen more years before a major calico scallop industry located in Port Canaveral, Florida would begin to realize its potential. Presently the calico scallop fishery of Port Canaveral is the largest scallop fishery in the United States with maximum yields of scallop muscles alone reaching almost 40 million pounds.

Distribution of commercial stocks

The calico scallop, *Argopecten gibbus*, is largely restricted to the sub-temperate and tropical waters of western North Atlantic with the major stocks distributed from Cape Hatteras, North Carolina to the Cape San Blas area of the northeastern Gulf of Mexico (Waller, 1969). Calico scallops have also been collected from the Greater Antilles, Bermuda, and the western portions of the Gulf of Mexico (Waller, 1969) but stocks of commercial importance have not been reported from these areas. At least one other species, *Argopecten circularis*, is commonly called a calico scallop and is harvested in the Republic of Panama.

Argopecten gibbus, inhabits the relatively shallow waters of the continental shelf and upper slope out to reported depths of 370 m (Waller, 1969). Major commercial stocks along the Atlantic and Gulf coasts are usually located in depths of 20-50 m on hard sand bottom.

Although the exact locations of commercial stocks vary from year to year, the Cape Lookout, Cape Canaveral, and Cape San Blas areas (Fig. 1) are particularly important to the fishery. The North Carolina fishery is small and extremely transient (Allen and Costello, 1972) but the scallop meats produced are often large for the species and are good quality. The Cape San Blas fishery of Florida is also highly variable and commercial fishing efforts may occur only every 2-3 years and only after other stocks have been depleted. The most significant and persistent commercial stock occurs in the vicinity of Cape Canaveral, Florida.

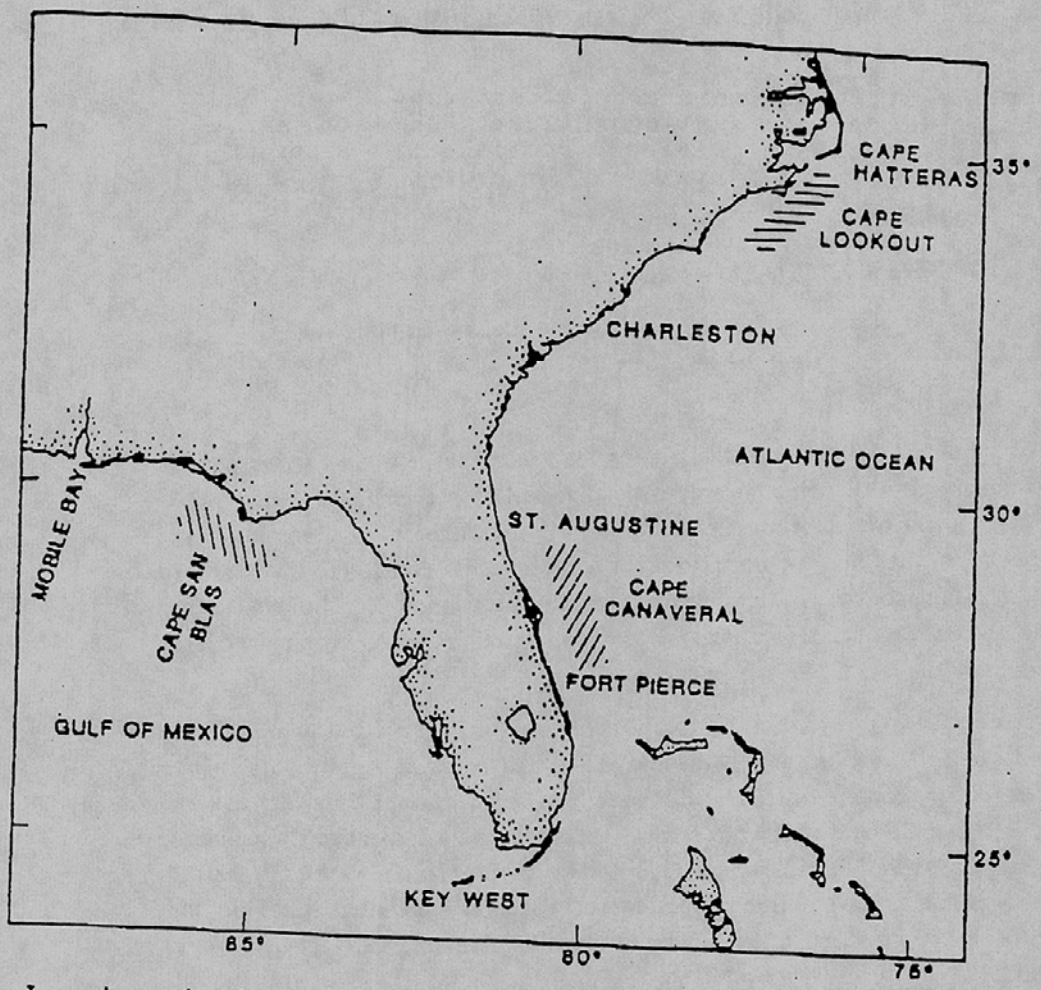

Figure 1. Locations of major commercial stocks of calico scallops in the southeastern United States.

Description of the Cape Canaveral Fishery

Commercial stocks of calico scallops were first observed off Cape Canaveral in 1960 (Bullis and Cummins, 1961). Investigations by the Bureau of Commercial Fisheries, now the National Marine Fisheries Service, from 1960 to 1968 showed that commercial concentrations varied greatly along the coast from the St. Johns River near the Florida/Georgia border to Fort Pierce, Florida in depths of 19 to 74 m (Bullis and Cummins, 1961; Drummond, 1969; Roe, *et al.*, 1971; Cummins, 1971). More recently the most productive beds have been found to be located in 30 to 50 m of water extending from about St. Augustine, Florida to Fort Pierce, Florida, making a harvestable area of about 2,000 square miles (Fig. 1).

Although the current commercial fishery began in 1967, significant landings did not begin until 1980 (Fig. 2). This was due to an increase in stocks and to the refinement of automated steam processing equipment. The equipment allowed shellstock representing up to 800 gallons of shucked meats to be processed and packaged within an hour.

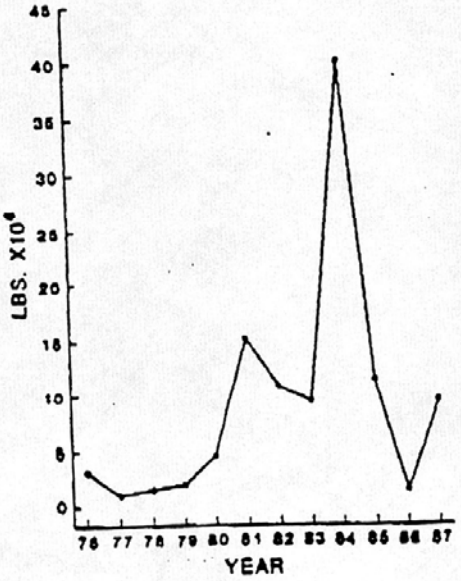

Figure 2. Commercial landings of calico scallops from the southeastern United States during the period 1976–1987.

Processing begins as the shellstock is removed from the boat deck by a 'knuckle boom'. The scallops are then placed in a 'batching hopper' which relays the unsorted load to an automated shaker. The shaker removes the broken and dead shell, sand, and unwanted species. Steam is then used to 'shock' the scallop meats and to separate the meat and other tissue from the shell. A series of rollers then eviscerates the scallops separating the visceral mass from the adductor muscle. The visceral mass, commonly eaten in other countries, is discarded while the adductor muscle is rapidly cooled in a series of water baths and chill tanks. Quality control includes 'hand culling' of any shell fragments or other imperfections before entry into the final series of chill tanks prior to packaging. With the exception of the 'hand culling' the entire process can occur without the meats touching human hands and since the product is shipped immediately to a wholesaler or retailer, it can reach the consumer within 24 to 48 hours without being frozen.

There are presently five calico scallop processing plants in Port Canaveral. Each plant can support upwards of 20 boats although at any one time the number of boats per plant may vary from 5 to 15. Most of the boats used by the calico scallop fishery are modified 'Gulf style' shrimp boats 20 to 25 m in length. Each boat commonly fishes two modified shrimp trawls, one from each side. The trawls are fished from 20 to 30 minutes after which the unsorted catch is placed on the deck (Fig. 3). Total fishing time may take 8 to 10 hours before returning to the shore-based processing plant. A normal trip for a calico scallop fishing boat is 16 to 20 hours 'dock to dock' with each boat doing 5 to 7 trips per week.

Figure 3. A 'Gulf style' shrimp trawler modified for calico scallop fishing.

Status of the resource

Fluctuations in yearly stocks

It was estimated in 1971 that as much as 20 million pounds of scallop meats could be produced annually from the Cape Canaveral calico scallop beds using 40 vessels (Allen and Costello, 1972). In 1984 one of the major calico scallop processors located in Port Canaveral processed 14.5 million pounds using only 20 boats. The processing plant operated 24 hours per day for 7 days a week. Total weekly catches were only limited by the number of boats that could be handled by the processing plants and not by the size of the stocks. Total catch for 1984 was 39.5 million pounds but this does not represent a maximum sustained yield and the concept of maximum sustained yield does not lend itself to this fishery.

By early 1985 the number of scallops located throughout the Cape Canaveral scallop grounds dropped dramatically as reflected in the landings (Fig 2). Fishing continued at minimal levels until late November of 1985 at which time fishing was suspended until the end of the year. In 1986 there was again a minimal level of fishing from January until May and poor yields forced the industry to completely shut down from late May until the end of November.

Since 1986 stocks have slowly returned to normal levels (Fig. 2). Yearly totals exceeding 30 million pounds should not be expected to occur with any frequency. With the present fishing pressure, yearly totals should average 10–15 million pounds.

Catch per unit effort

It has generally been thought that yields off the east cost of Florida are highest in the fall. This is then followed by a decrease in the winter and another increase in the spring (Roe *et al.*, 1971). Minimal catches of scallops occur during mid–summer.

The rougher seas of the winter months and hurricanes during the summer months force a temporary reduction in the number of trips made per boat. Because the boats are frequently loaded to the point of instability, fishing operations cease in seas of 6 to 8 feet. The efficiency of the fishing gear also diminishes under these conditions.

Thus, total seasonal yields may not be an accurate measure of scallop abundance. A more accurate measure is provided by looking at the average number of gallons of scallop meat per trip for each week. Weekly average production per trip or catch per unit effort (CUE) for 1984–85 is shown in Fig. 4. Catch rates through October 1984 varied from 400–600 gallons per trip with the average being about 500 gallons. After October 1984 catches declined steadily throughout 1985 and fishing efforts were terminated in early summer of 1986. Fishing did not resume until November of 1986.

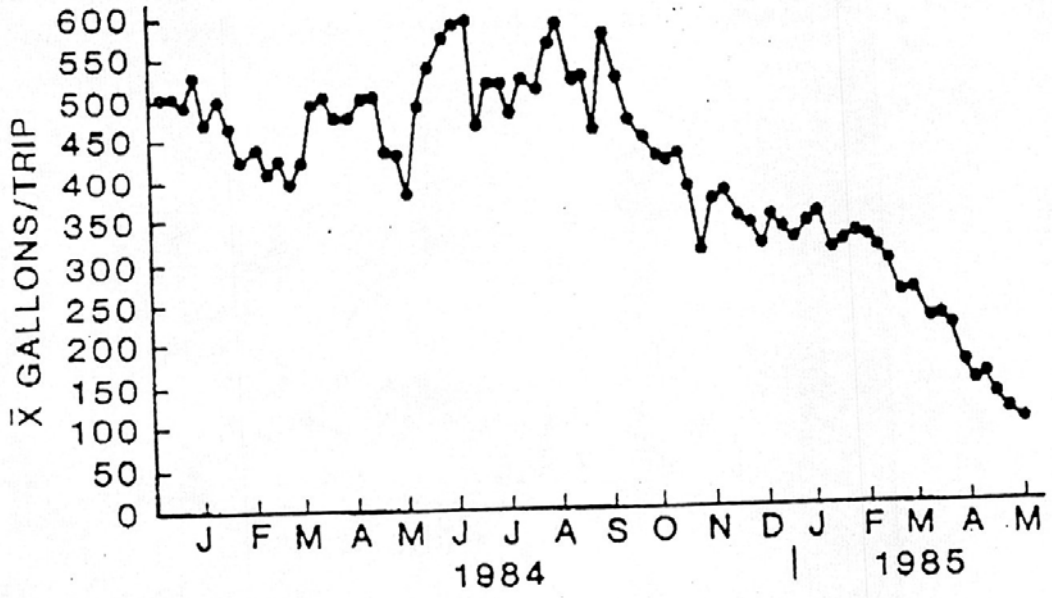

Figure. 4. Weekly average production per trip for 1984 and 1985.

However, these were not normal fishing years. In the years for which data are available the very high catches were followed by a steady decline and population levels remained low throughout 1985. Table I shows a more normal average catch per unit effort based on season.

TABLE 1
Representative averages of gallons of scallop meats per trip by season

Season	Mean Gallons/Trip
Fall (Oct. – Dec.)	200–300
Winter (Jan. – Feb.)	200–250
Spring (Mar. – May)	225–350
Summer (June – Sept.)	90–150

Meat counts

In comparison to other commercial species of scallops, meat counts (number of muscles per pound) are high and scallops representing a 100–300 count have commonly been processed. Although scallops of up to 400 per pound can be processed by the automatic shucker, the scallops are most profitably harvested when counts drop below 200 per pound.

Figure 5 shows the relationship of scallop shell height to meat count. Meat counts of less than 300 per pound are obtained when the shell height exceeds 38 mm. This minimum acceptable size occurs in most years beginning in November. By June many of the scallops are 45–50 mm in shell height and reach an average minimal count of about 100 per pound, but these large calico scallops are approaching the end of their life span and meats are lower in quality.

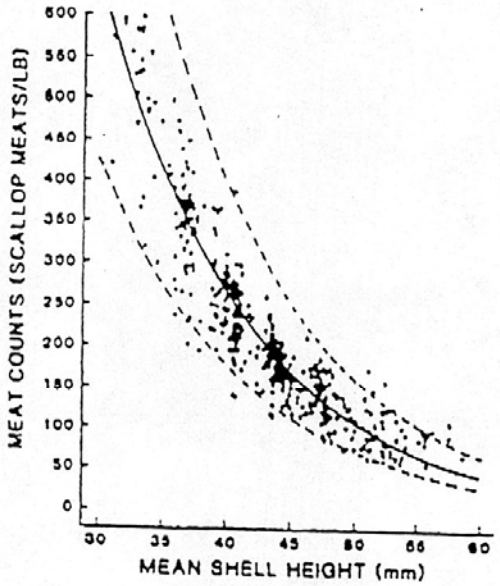

Figure 5. The relationship of shell height to meat counts. The dotted line shows the prediction limits (75%) for the simple exponential regression.

Regulation

The landings by the calico scallop industry of Florida is not presently regulated by state or federal fishery management programs since stocks are annual and over-fishing is not considered a problem during most years. Instead the industry has formed a self-regulating association. Members of the association have agreed to limit fishing efforts until at least 75% of the stock at a particular location reaches a shell height of at least 38 mm. In some respects this represents a conservation measure as well as an economic measure since by 38 mm much of the population will have undergone their first spawning event.

BIOLOGY

Reproduction

The calico scallop, like the bay scallop, is a functional hermaphrodite. The calico scallop exhibits two spawning periods during each calendar year when optimal environmental conditions occur (Moyer and Blake, 1986). The first and predominant spawn of the calendar year occurs in late spring from April to June (Fig. 6). This follows the accumulation of gonadal reserves during the winter months. When spawning does occur it is rapid and often complete. A large percentage of any sub-population normally spawns over a 1-3 week period.

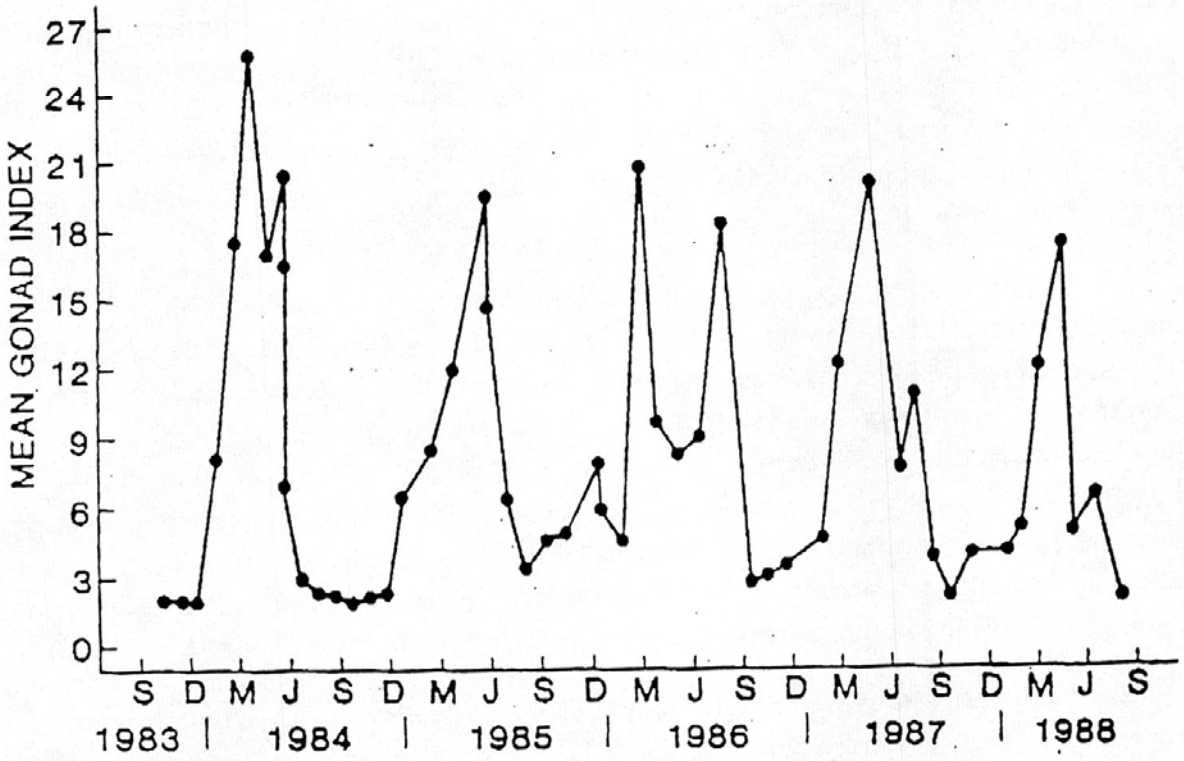

Figure 6. Reproductive cycle of calico scallops represented by changes in gonadal indices from 1983-1988.

The second reproductive cycle of the calendar year begins with an accumulation of gonadal reserves in July and August with spawning occurring in late summer to early fall. The 'fall

spawn' apparently occurs only when environmental conditions are optimal and does not occur every year (Fig 6). Only a portion of the total population is involved in this minor spawn; however, the 'fall spawn' appears to be important to the maintenance of the commercial stocks into the spring and summer months.

The individual scallop normally reproduces for the first time at an approximate age of either 6 or 12 months depending upon season of birth and the presence or absence of a fall spawn. Age, however, appears to be of less importance than environmental conditions since scallops as young as 3 months due occasionally spawn. Whether or not there are any differences in the viability of larvae produced by scallops of different ages has not been examined. A scallop will normally spawn either 2 or 3 times during its 18–24 month life span, although the number of scallops reaching a third spawn in usually very low.

Attempts have been made to characterize the reproductive cycle of the calico scallop through the use of ovarian color changes (Roe *et al.*, 1971; Miller, 1979) but this qualitative technique can be misleading. The gonadal color of scallops in the late stages of development and early stages of spawning exhibits only minimal changes. This may be one reason why previous investigations did not recognize the two distinct spawning periods.

Utilization of gonad index rather than ovarian color change makes determination of reproductive state less subjective by employing a quantitative rather than a qualitative technique. Over the years a wide variety of techniques have been referred to by the term gonad index. The method commonly used in calico scallop research follows Giese (1959). The scallop tissue is divided into its component parts and dried to constant weight. The gonad index is then calculated by determining the percentage by weight of the total scallop (shell excluded) consisting of gonadal tissue.

The environmental controls for reproduction are not well understood but probably include food, temperature, and age as with *Argopecten irradians* (Sastry, 1968; Blake and Sastry, 1979; Barber and Blake, 1985). The current dynamics in the region of Cape Canaveral may also be important to the maintenance of the population and these variables have received considerable study (Lee and Brooks, 1979; Leming, 1979; Blanton *et al.*, 1981; Lee and Atkinson, 1983). During the summer months coastal upwelling brings deep Gulf Stream water onto the shelf resulting in lowered bottom temperatures. This nutrient rich, colder water may be important in allowing the scallops to accumulate nutrients rapidly. The importance of bottom water temperatures to spawning in the species have previously been recognized (Miller *et al.*, 1981).

In both July–August, 1987 and April–May 1988 spawning occurred when bottom temperatures reached 19–20°C. At temperatures above 22°C maturation apparently stops and spawning does not occur. Thus a fall and spring spawn both require a bottom temperature of 19–20°C. This may be brought about by winter atmospheric temperatures or by the intrusion onto the shelf of colder deep water which occurs during the summer months. Intrusion of the colder deep water is variable both spatially and temporally from year to year. In addition, the

degree to which water temperature decreases is also variable. This variability is probably the major factor determining the presence or absence of a 'fall spawn'.

Miller *et al.* (1981) have suggested that the cold water intrusions may have both favorable and unfavorable results. On the favorable side, the intrusion may initiate spawning, provide food through phytoplankton blooms resulting from nutrient-rich water, and provide an optimal temperature range of 15–27°C for survival. The intrusions may be unfavorable if bottom temperatures are lowered below 15°C where mortality may occur.

Growth

Figure 7 shows the growth rate (shell height) of calico scallops from seven locations off Cape Canaveral from August 1987 to February 1988. Growth rates are not constant but vary as environmental conditions change. Growth rates were initially quite high averaging greater than 1.5 mm per week. The growth rate dropped throughout August reaching 0.8 mm per week in September as bottom water temperatures began to increase. During October when bottom water temperature increased beyond 23°C, growth rates declined to about 0.3 mm per week. By January as bottom temperature again declined, growth rates increased.

Costello *et al.* (1973) estimated that calico scallops are planktonic for 16 days under laboratory conditions and set at about 0.25 mm shell height. Therefore Allen (1979) estimated that 10 mm scallops would be about 51 days old and 28 mm in about 3 months. This agrees well with our measurements in 1987–1988 (Fig. 8) when a May–June spawn resulted in 28 mm scallops in September.

An overall average growth rate from August 1987 when the scallops were 23 mm to about 40 mm in February 1988 was 0.65 mm per week. Considering a 2 month interval from spawning to 23 mm, a total of 8 months was required for the scallops to reach 38–40 mm, the commercial size desired by the industry. This period could of course be increased or decreased depending upon environmental conditions, particularly bottom water temperatures.

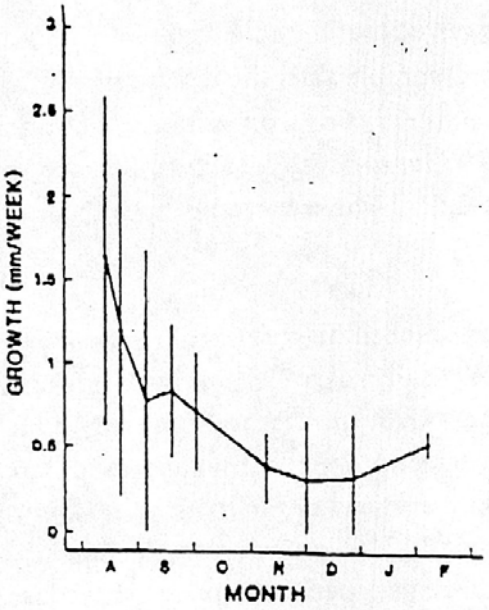

Figure 7. Mean growth rates of calico scallops from 7 locations off Cape Canaveral from August, 1987 to February, 1988. Vertical bars show ± 1 standard deviation.

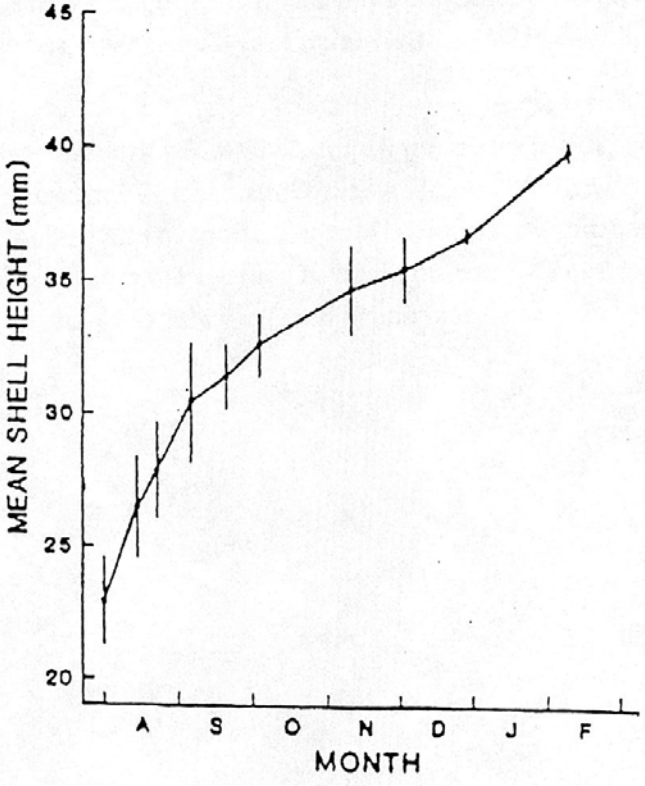

Figure 8. Mean increase in shell height of calico scallops from 7 locations off Cape Canaveral from August, 1987 to February 1988. Vertical bars show ± 1 standard deviation.

Mortality

Roe *et al.* (1971) estimated monthly mortality rates ranging from 1% to 31% depending upon the age composition of the population. High mortalities may also occur, even in the young of the population, if bottom water temperatures decrease below 15°C (Miller *et al.*, 1981).

The calico scallop lives a maximum of two years (Roe *et al.*, 1971). However, since post-spawning mortality may be high, only a small percentage of a year class may survive after 18 to 20 months.

Problems of the Industry

Waste disposal

Since only the adductor muscle is commonly consumed in the United States, as much as 55–70% of the viscera remains. This viscera as well as unwanted species are presently transported to a sanitary landfill and discarded. This is costly to the industry and places a burden on landfill operations. Some attempts have been made to utilize this viscera, particularly as hog feed, but to date no large-scale commercial utilization has been developed.

Parasites

As with many seafood products, calico scallops serve as the host to several parasitic organisms. Free-swimming third-stage larvae of the nematode, *Sulcascaris sulcata*, use molluscs including the calico scallop, (Blake *et al.*, 1983; Barber *et al.*, 1987) as an intermediate host. The third-stage larvae molt to fourth-stage larvae within the molluscan host. The marine turtles *Caretta caretta* and *Chelonia mydas* ingest the larvae as they feed upon the molluscs and the fourth-stage larvae then molt into adult nematodes within the gastrointestinal tract of the turtle (Berry and Cannon, 1981). The nematode presents only an aesthetic problem because they are not harmful to human health (Blake *et al.*, 1985) since they are quickly destroyed by human gastric juices and cannot survive human body temperatures.

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Appendix H. Price Analysis for Florida and North Carolina Bay Scallops and Southeast Calico Scallops

PRICE ANALYSES FOR FLORIDA AND NORTH CAROLINA BAY SCALLOPS AND SOUTHEAST CALICO SCALLOPS

J. E. EASLEY, JR. AND FRED J. PROCHASKA
MARINE ECONOMISTS

AUGUST, 1985

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

Technical Report Number 2

SAFMC Contribution Number 7

Under the authority and funding of the Magnuson Fishery Conservation and Management Act of 1976, Public Law 94-265 as amended.

Price Analyses for Florida and North Carolina Bay Scallops and Southeast Calico Scallops

J.E. Easley, Jr.
and
Fred. J. Prochaska
Marine Economists

August, 1985

Acknowledgements

We wish to express appreciation to several individuals who have contributed to this study. In particular several individuals within NMFS provided data upon short notice: Jim Price, Ernie Snell, Ken Harris, Joan Palmer, H. Foster and George Darcy. Bob Kellogg (formerly at NCSU) assisted during the initial stages of setting up the data set. And Ann McDermed (NCSU) performed her usual magic with organizing the data and setting up the program for use in the regression analysis. Finally, but not least, we appreciate the patience and support of the South Atlantic Fishery Management Council and staff (especially Gregg Waugh) in the lengthy gestation of this study.

Price Analyses for Florida and North Carolina Bay Scallops and Southeast Calico Scallops

Introduction

Substantial growth in calico scallop landings during the 1980s has caused many management questions to surface. The main question of importance in this analysis is the effect of calico scallop landings on seasonal bay scallop prices received by Florida and North Carolina fishermen.

The study as originally invisioned in 1982 changed slightly and has been expanded. Up to date monthly data on prices and quantities for each state and type of scallop fishery in the U.S., imports and inventories were necessary to accomplish the project. Data delays were experienced because of confidentiality problems and backlogs of data requests for current data which were not available in published sources. To protect the confidentiality of the data individual monthly observations are not reproduced in this report. The overall delay in the analysis, however, was fortunate because of substantial changes that subsequently occurred in the calico scallop landings. The additional two years of data allowed bay scallop price analyses to be expanded into two major market periods and provided sufficient data for analysis of calico scallop prices. The latter analysis was not envisioned in the original research proposal.

The report is divided into five sections. Background annual data trends are initially reviewed. The monthly data used in the price analyses are then discussed. The third section presents the economic and statistical methodology where the theory and assumptions for the estimated price models are discussed. The following section reports

the empirical results. The last section contains the summary and conclusions.

Scallop Volume and Price Trends

Annual movements in bay scallop landings in North Carolina have varied widely with a slight upward trend over the 1974-84 period (Figure 1). Peak annual landings occurred in 1980 with over 325,000 pounds. Landings then declined to a low of approximately 130,000 pounds in 1982. By 1984 landings again rose to nearly 300,000 pounds. North Carolina landings usually occur within a 6 to 7 month period each year with the majority of landings reported between December and March.

Florida annual landings of bay scallops have generally trended downward from levels attained during the latter 1970s (Figure 1). Florida landings have been at low levels since 1980 with a recent range from approximately 10,000 pounds in 1984 to nearly 25,000 pounds in 1983. Florida typically produced commercial landings 7 and 8 months a year over the 11 year period with peak production occurring during June through November. Annual changes in Florida and North Carolina landings moved in opposite directions in 5 of the 11 years analyzed.

Overall both Florida and North Carolina bay scallop prices have increased over the 1974-84 period (Figure 2). However, North Carolina prices peaked at nearly $3.50 per pound in 1981 and have since declined. Florida prices show a more consistent upward trend with a peak at approximately $3.40 per pound in 1983. The wider price variations for North Carolina appear to be consistent with the wide variation in landings. However, relatively high North Carolina prices in 1980

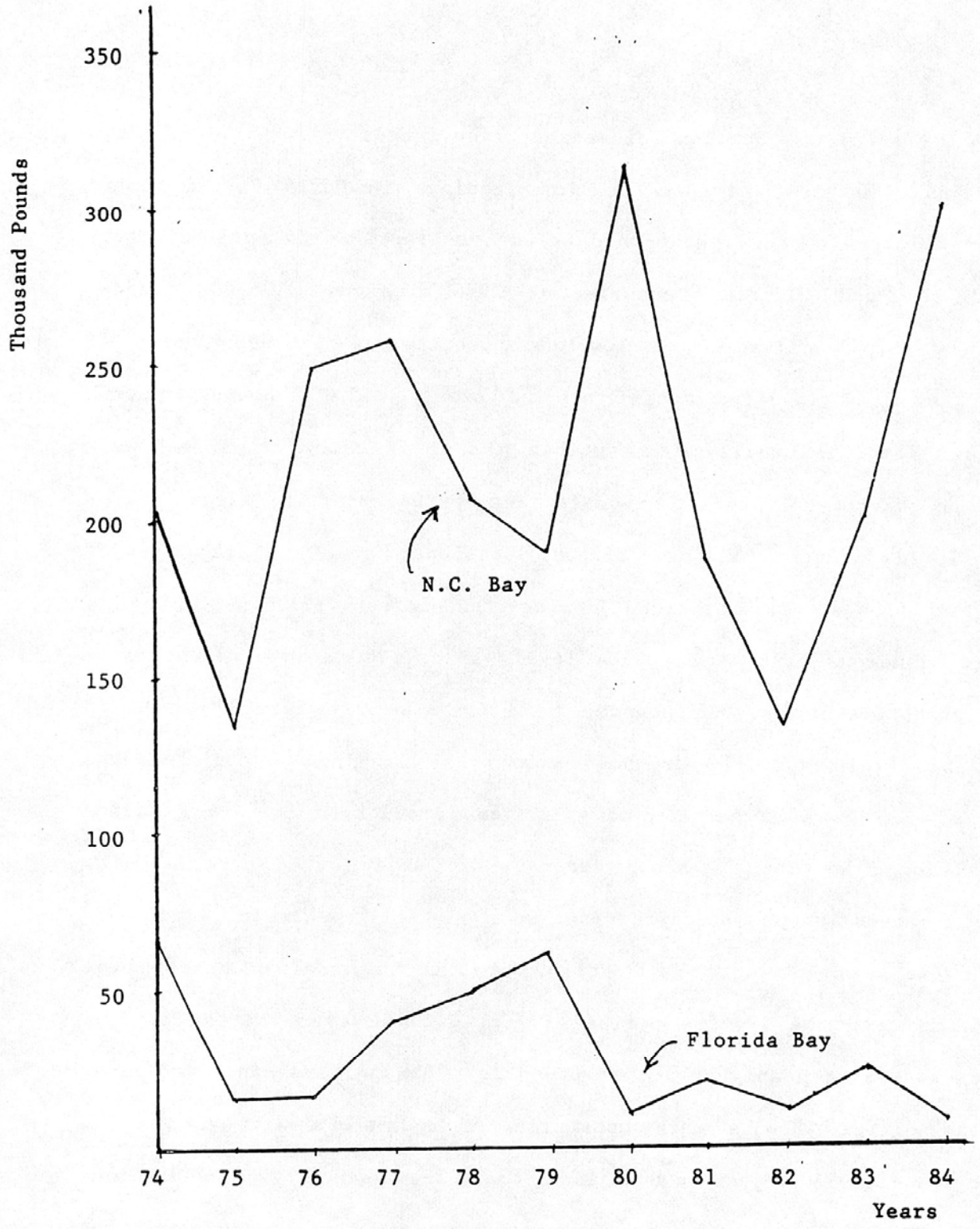

Figure 1. Florida and North Carolina Bay Scallop Annual Landings, 1974-84.

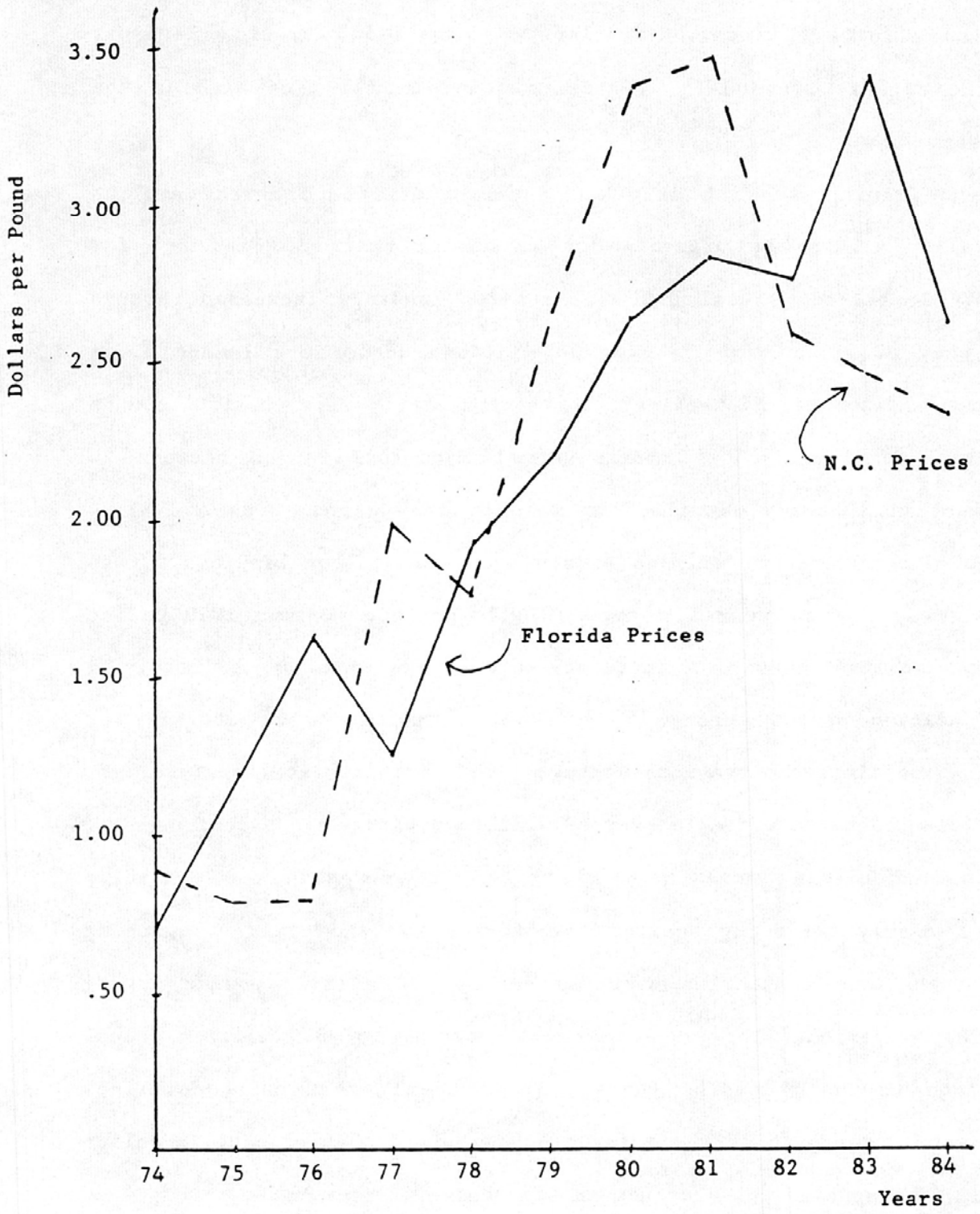

Figure 2. Florida and North Carolina Annual Exvessel Bay Scallop Prices, 1974-84.

(Figure 2) and peak production in 1980 (Figure 1) suggest other factors are also affecting prices. Similarly, though 1983 Florida landings were the highest since 1979. Prices reached an all time high in the same year.

Other variables which help to explain Florida and North Carolina bay scallop prices are presented on an annual basis in Figure 3 for the 1974-84 period. Total U.S. sea scallop landings increased through 1978, when a recent high of over 34 million pounds were landed. Sea scallop landings then declined to approximately 19 million pounds annually during 1982-84. Imports of all scallops ranged between 20 and 30 million pounds annually for most of the period, with a 1983-84 average high of over 31 million pounds. Calico scallop landings varied little from year to year for the 1974-79 period. During 1980 calico scallop landings began to increase reaching between approximately 9 to 15 million pounds during 1981-83. This represents an increase of four to nine times the previous average level of calico scallop landings. In 1984 landings increased to over 40 million pounds.

Total beginning inventories in Figure 3 represent the summation of the monthly beginning scallop inventories for each year. Beginning monthly scallop inventories averaged nearly 4.7 million pounds during the 1981-84 period. This compares to an average of 3.5 million pounds per month in the preceding years. It is likely that calico scallops made up a larger part of these inventories, given the increase in calico scallop landings and the decrease in sea scallop landings.

Although monthly data are not reproduced in this report for confidential reasons, the means and ranges for some of the principal

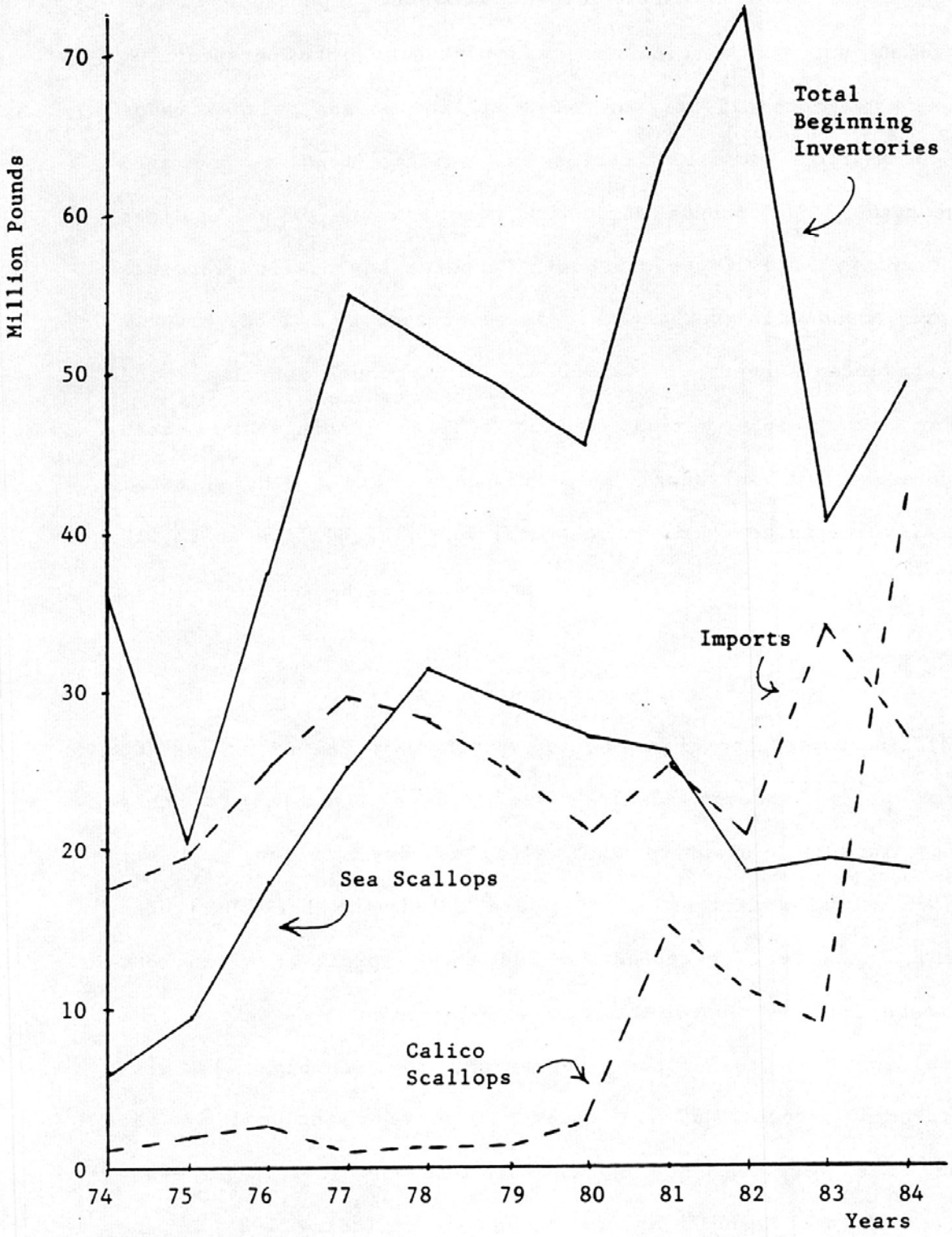

Figure 3. Total Annual Beginning Monthly Inventories, Imports, and Calico and Sea Scallop Landings, 1974-84.

variables are given for a clearer insight into the importance of the variables and to put the conclusions and inferences into perspective. Monthly imports averaged slightly over 2.0 million pounds, with a range of .6 to 4.9 million pounds. Florida bay scallop landings averaged landings averaged 4,049 pounds per month with a range of no landings to a high of nearly 57,000 pounds. North Carolina bay scallop landings averaged 31,525 pounds per month, with a range of zero to 142,681 pounds. Calico scallop landings averaged 144,000 pounds per month for the period 1974-80. For the 1981-84 period, calico scallop landings more than doubled with a monthly average of 321,000 pounds. Total U.S. personal income gradually increased over the period from $1,107 billion to $3,113 billion.

Data Description

In addition to aggregate domestic variables expected to affect demand and/or prices through supply effects, data assembled for this study include landings (quantity and value) of bay, calico, and sea scallops. Since the different species are likely to be substitutes in consumption, data were collected for all three species, and in most cases, by state for the South Atlantic and Northeastern regions. As the research and data collection progressed, the monthly data were assembled through December 1983. However, as was mentioned in the introduction, the very large 1984 calico landings in Florida (and consultation with the Council staff) warranted including 1984 in the analyses. Table 1 lists the variables used in the study, variable definitions and sources of the data.

Table 1. Variables Used and Data Sources for Monthly Observations, January, 1974 - December, 1984

Variable Name	Description	Source
BEGINS	Beginning stocks (total scallop inventory at beginning of month)	NMFS, Shellfish Market Review (June 1982) Updated after April 1982 through persona communication with Industry Analysis Bra
SEAQ	U.S. Landings (quantity) of sea scallops	Same as above, except 1984 total from Fisherie of the United States, 1984, is allocated month based on 1983 monthly landings
IMPORTS	U.S. scallop imports	Same as BEGINS
ENDS	Ending stocks (total scallop inventory at end of month)	Same as BEGINS
CPI	Consumer Price Index	1974-83 from Economic Indicators, 1984 from Su Current Business
INCOME	Total U.S. personal income	Same as C.P.I.
SHRIMP	Exvessel shrimp price index	Fisheries of the United States, various issue
NEBAYQ	Landings (quantity) indicator for North-eastern bay scallops. Constructed by summing N.Y., Mass., and R.I. landings.	NMFS Northeast Fisheries Center, Woods Hole
NCBAYQ	N.C. bay scallop landings (quantity)	NMFS and North Carolina Department of Marine Fisheries, Relevant state landing bullet various issues. 1984 updated from NMFS Southeast Fisheries Center, Miami.
NCBAYP	N.C. bay scallop price (N.C. bay scallop value divided by quantity)	Same as NCBAYQ
NCCALQ NCALP	N.C. calico landings (quantity) and price (computed V/Q)	Same as NCBAYQ
SCCALQ SCCALP	S.C. calico landings (quantity) and price (computed V/Q)	"

Table 1. (cont.) Variables Used and Data Sources for Monthly Observations, January, 1974 - December, 1984

Variable Name	Description	Source
GACALQ GACALP	Ga. calico landings (quantity) and price (computed V/Q)	Same as NCBAYQ
FLBAYQ FLBAYP	FL. bay landings (quantity) and price (computed V/Q)	"
FLCALQ FLCALP	FL. calico landings (quantity) and price (computed V/Q)	"
SEBAYQ	Southeastern bay landings (quantity) constructed by summing N.C. and FL. bay landings	"
SECALQ	Southeastern calico landings (quantity) constructed by summing N.C., S.C., GA. and FL. calico landings.	" "

The variables listed in Table 1 are those actually used in the analysis. In addition, various annual and monthly zero-one variables were created to perform specific tests (e.g. seasonal demand shifts, etc.). Price variables were created from value (V) and quantity (Q) data. Thus, landings values are not listed in Table 1, but are in the data set. Similarly, quantities and values for Massachusetts, Rhode Island, and New York (which were used to generate the Northeastern bay quantity variable) are in the data set but not listed in Table 1 since they were not used individually in the analysis.

For several of the years in the data set, only annual landings were available for Massachusetts and Rhode Island. To allocate these annual landings by month, the proportion of the annual total landed each month in New York was used. Similarly, 1984 total U.S. scallop landings were allocated by month in 1984 by the 1983 proportion of total landed each month. For 1984, only annual totals were available for New York, hence the total was allocated by month based on 1983 monthly New York landings.

Finally, months with missing data were excluded from the analysis of any given equation. Missing data appear as no entry (with surrounding months showing landings), as opposed to a zero entry. Legitimate zeros, for example, are entered for off-season bay scallop landings. Those are retained in the analysis. Fortunately, these exclusions of observations did not affect the analyses significantly. No observations were lost in the calico scallop models or in the Florida bay scallop models. Only four observations (½%) were lost in the North Carolina models.

Methodology

The models estimated in this study have price as the dependent variable. This formulation was chosen for two reasons: 1) The major questions to be examined in the study deal with bay scallop price effects of calico scallop landings, and 2) There may be occasions in the future when the Council might want to predict prices or analyze price effects of alternative management strategies. On both counts, price-dependent equations are logical formulations. Furthermore, given that Florida and North Carolina's bay scallop fisheries are relatively small, they are price takers at the exvessel market levels. In addition, they exist with (or part of) much larger scallop markets which requires careful attention be given to effects of substitutes in consumption, particularly with other sources and species of scallops. These considerations also suggest price-dependent equations of the nature estimated in this study. Prices are estimated as a function of (1) the quantity landed for the specific product for which price is analyzed, (2) substitute products in the market, (3) income, and (4) structural shifts in the market.

The degree of substitution between products and the range of substitution available makes selecting substitutes and/or measuring volumes of substitute products a difficult decision. After theoretical consideration and data analysis it was decided to estimate Florida and North Carolina bay scallop prices separately and as a function of the following substitute products: Northeast bay scallop landings, sea and calico scallop landings, beginning monthly inventories and imports of all scallops, and shrimp prices. Florida (North Carolina) prices were not estimated as a function of North Carolina (Florida)

bay scallop landings since these generally occur in different months. For the shrimp variable an exvessel shrimp price index was used as an aggregate variable representing an average of the many sizes and types of shrimp available in the market. The theoretically expected sign of the substitute relationships are negative for the quantity measures.

As a result of these expectations one-tail statistical t tests were used and only negative values of t of specified sizes were declared to be significantly different from zero. For the shrimp price index measure of a substitute seafood product, only significant positive values were declared significant. The economic logic for these tests is that an increase in quantity of one product will lower that product's price which will increase the quantity demanded of that product. This in turn will result in a decrease in the demand price of the substitute product. Therefore the expected sign of the relationship between the price of one product and the quantity of a substitute product is negative. If the substitute product is represented by its price, such as the case of the shrimp price index, the positive sign between prices is expected by similar economic logic. Accepting as significant estimated effects with sign relationships opposite than those discussed here would imply the products were compliments in consumption. This is possibly true for some part of the market such as for combination seafood platters. It was assumed in this analysis that such complimentarity was too small a part of the total market to dominate the relationships in the total market.

Income was included in the models because income is at least one of the ultimate constraints (demand shifter) guiding consumer purchases.

Based on economic theory a positive relationship between prices and income indicates a "normal" or superior product while a negative relationship would indicate an inferior good. In these analyses it was assumed that bay scallops were not inferior products in the eyes of the consumer and therefore only significant positive t tests were accepted as significant.

Two demand structural shifts were included in the bay scallop analyses. The first was consumption seasonality. Months of the peak season were analyzed with a zero-one variable. A positive sign would indicate an increase in demand. One hypothesized reason for such a seasonal shift might be a preference for fresh product over frozen products out of season. The second structural shift considered in the bay scallop price analyses was concerned with the sudden growth which occurred after June 1980 in the calico scallop industry. To handle this hypothesized structural shift, separate demand functions were estimated for each period (before and after July 1, 1980).

Monthly data were used in the multiple regression analyses for the following reasons. Monthly data allow for the testing of seasonality and provide sufficient degrees of freedom for estimating the regression coefficients. In addition, knowledge of price changes on a month-to-month basis allows for consideration of seasonal restrictions on specific fisheries.

The regression coefficients estimated to show price effects in the tables in the following sections are "partial" effects. This means, for example, the estimated price effect from increased imports is what will happen to price if imports change and no other variable changes.

Other variables obviously change through time but fortunately the regression technique used separates the individual effects so that each estimated coefficient is a partial effect. Therefore, to predict total price effects when several variables are changed, the summation of these effects is necessary. In the following analyses partial effects are discussed unless otherwise specified.

The estimated price effects (coefficients) are in terms of price per pound measured in dollars. The data for the substitute products were entered into the regression models in pounds when quantity was the measure. Since a one pound change in volume has a very small effect on market prices, the estimated effects are preceded by a decimal with many zeros. For ease of data presentation the estimated effects were scaled as if the change was in terms of larger quantity units, such as 1.0 million pounds. Scaled quantity units are presented in table headings. In the case where scaled units were larger than actually exist in the industry, adjustments are made in the discussion of the results.

The same basic economic logic was used to formulate the calico scallop price equations and to draw statistical and economic conclusions. The seasonal demand shift was not included since calico scallops are landed in most months.

Scallop Price Analyses

Florida Bay Scallops

The price analysis for the total 1974-84 period explained 68 percent of the monthly variation in Florida bay scallop prices (Table 2). Florida had landings in 84 months of this period. Bay scallop landings

Table 2. Florida bay scallop exvessel price effects (dol./lb) per unit of change in specified variables for three time perio

			Scallops						
Time Period[b]	R^2	Constant	Florida Bay (10,000 lbs.)	Calico (mil. lbs.)	N.E. Bay (mil. lbs.)	Beginning Inventories (mil. lbs.)	Imports (mil. lbs.)	Sea (mil. lbs.)	Income (100 bil.)
1974-84	.68	.097 (.22)	-.149 (-2.19)	-.217 (-2.63)	.379 (1.19)	-.057 (-1.55)	-.102 (-1.48)	.114 (1.72)	.131 (5.67)
1974-June 1980	.66	-.719 (-.72)	-1.47 (-2.19)	-1.720 (-1.34)	.481 (.35)	-.109 (-1.26)	-.107 (-.88)	-.114 (-.78)	.171 (2.24)
July 1980-84	.30	.438 (.31)	.180 (.55)	-.237 (-2.05)	.406 (1.15)	-.043 (-.82)	-.005 (-.05)	.172 (1.11)	.137 (2.42)

[a]Statistical t values are given in parenthesis. One tail t values in excess of .845, 1.296 and 2.390 are significant at the 90% and 99% confidence levels for the 1974-84 model. For the other two models comparable t values are .845, 1.310 and 2.457 For expected negative impacts the specified t values are preceded by a minus sign.

[b]Time period are months starting with January and running through December of year specified unless month is otherwise specif

[c]Season includes the months June through November.

had a statistically significant negative effect on exvessel bay scallop prices. For the total period a 10,000 pound increase (decrease) in landings resulted in a nearly 15 cent per pound price decrease (increase). The price effect was essentially identical at -.147 dollars per pound for the earlier period 1974 through June 1980. However, the price equation estimated for the July 1980 through 1984 period showed no significant bay scallop landings effect on bay scallop prices. For this latter period Florida landings were on an average between one third to one fourth of the landings in the preceding years. This smaller level of market activity may explain at least part of the absence of a significant price relationship. The overall explanatory power of the model for the latter period was 30 percent compared to 68 and 66 percent for the 1974-84 and 1974-June 1980 models, respectively.

The landings of calico scallops in the Southeast had a statistically significant negative effect on Florida bay scallop prices in all models estimated (Table 2). For the total 1974-84 period the effect was statistically significant at the 99 percent confidence level. During this total period a 1.0 million pound increase (decrease) in monthly landings resulted in a decrease (increase) in monthly prices of 22 cents per pound in Florida bay scallop prices. During the early period, 1974-June 1980, a one million pound increase (decrease) in monthly calico scallop landings resulted in a $1.72 decrease (increase) in Florida bay scallop prices. This rather large price change, however, has to be put in perspective. During the 1974-June 1980 period annual calico scallop landings only ranged from approximately 1.0 to 2.2 million pounds. Therefore a monthly change of 1.0 million pounds would be

quite large. More realistically, a 100,000 pound monthly change should be considered. In this case prices would have changed in the opposite direction by 17.2 cents per pound. After June 1980, monthly calico scallop landings had a significant negative effect on Florida bay scallop prices of nearly 24 cents per pound.

Northeast bay scallop landings had no significant effect on Florida bay scallop prices in any period analyzed. Beginning scallop inventories however, had a statistically significant negative effect on Florida bay scallop prices at the 90 percent confidence level for the total period and the 1974-June 1980 period. The negative effect of beginning monthly inventories was 10.9 cents per pound during the earlier period per 1.0 million pound change compared to 5.7 cents per pound impact for the total period. After June 1980 beginning inventories were still negatively related to Florida bay scallop prices, however, with a statistical significance level of only approximately 80 percent.

Scallop imports had a statistically significant negative effect on Florida bay scallop prices at the 90 percent confidence level for the model estimated for the total 1974-84 period. A 1.0 million pound increase in monthly scallop imports decreased Florida bay scallop prices by a little over 10 cents per pound. The estimated relationship was also negative for the two subperiods but with less statistical significance, especially after June 1980.

The only meaningful economic relationship between Florida bay scallop prices and sea scallop landings occurred during the 1974-June 1980 period. During this period a one million pound monthly increase in sea scallop landings resulted in a price decrease of 11.4 cents

per pound. This relationship, however, was only significant at approximately the 75 percent statistical confidence level.

Income in all analyses showed a very positive statistically significant relationship with Florida bay scallop prices. A monthly change in income of 100 billion dollars resulted in price increases between 13 and 17 cents per pound. However, for the 1974-84 period such an income change ($100 billion) would take approximately 7 months to occur on average.

The shrimp price index variable as an indicator of a substitute seafood product variable does not give consistent results for the total period. For all periods estimates are not economically and/or statistically significant with respect to Florida bay scallop prices.

The positive signs for the seasonal variable suggest an increased demand for Florida bay scallops during the height of the production season. However, this effect was only statistically significant during the earlier period and at only the 85 percent confidence level.

North Carolina Bay Scallops

Overall the same three models were estimated for North Carolina as were estimated for Florida bay scallop prices. North Carolina models had higher R^2s and therefore implied higher explanatory power (Table 3). However, the results in many cases are quite different than those estimated for Florida, which implies a different market.

The effect of North Carolina bay scallop landings on prices during the earlier period was neither economically nor statistically different

Table 3. North Carolina bay scallop exvessel price effects (dol./lb.) per unit of change in specified variables for three tim

			Scallops						
Time Period[b]	R^2	Constant	N.C. Bay (100,000)	Calico (mil. lbs.)	N.E. Bay (mil. lbs.)	Beginning Inventories (mil. lbs.)	Sea (mil. lbs.)	Imports (mil. lbs.)	Income (100 bil.)
1974-84	.68	-.680 (-1.86)	.321 (1.07)	-.391 (-2.60)	-.633 (-.64)	-.028 (-.43)	.254 (2.03)	-.275 (-1.97)	.135 (4.13)
1974-June 1980	.82	-1.782 (-3.08)	.058 (.20)	-.637 (-.90)	-1.129 (-.57)	.175 (1.91)	-.166 (-1.09)	-.072 (-.43)	.202 (3.78)
July 1980-84	.77	10.144 (6.70)	-.929 (-2.08)	.225 (1.78)	1.280 (1.63)	-.262 (-4.85)	-.306 (-1.39)	-.166 (-.80)	-.216 (-3.70)

[a]Statistical t values are given in parenthesis. One tail t values in excess of .845, 1.296 and 2.390 are significant at the 80 90% and 99% confidence levels for the 1974-84 model. For the other two models comparable t values are .845, 1.310 and 2.457. For expected negative impacts the specified t values are preceded by a minus sign.

[b]Time period are months starting with January and running through December of year specified unless month is otherwise specifie

[c]Season includes the months December through March.

from zero. However, after June 1980 North Carolina bay scallop landings were highly related to prices received by fishermen. From July 1980 through December 1984, a 100,000 pound increase (decrease) in North Carolina bay scallop landings resulted in a decrease (increase) of nearly 93 cents per pound. This change in the price/quantity relationship from the earlier period to the latter period may reflect the development of localized markets in North Carolina. This tentative conclusion is futher supported in the discussion of impacts of calico scallop landings and other variables in the following paragraphs.

Calico scallop landings had a statistically significant negative effect of 39 cents per pound on North Carolina bay scallop prices per million pound increase in monthly landings in the analysis of the total 1974-84 period. There was also a negative effect on prices when only the 1974-June 1980 period was considered, however, the statistical confidence level was only approximately 80 percent for this model. After June 1980 month-to-month changes in calico scallop landings did not have a significant effect on North Carolina bay scallop prices. This change in price-landings relationship may possibly be explained in two ways. First, the highly significant negative relationship between North Carolina bay scallop landings and prices after June 1980 suggests a more independent specialized market for bay scallops has developed which should make bay scallop prices less dependent on monthly variations in calico landings. Second, since calico scallop landings have reached such large levels during the 1980s their effect is likely to be seen in built up levels of inventories. Beginning inventories were at higher average levels during this period and it was only during this period

that beginning inventories had a highly significant effect on North Carolina bay scallop prices. A 1.0 million pound increase in beginning inventories reduced North Carolina bay scallop prices by 26 cents per pound (Table 3).

Other substitute scallops in the market were Northeast bay scallops, sea scallops and total imports. Northeast bay scallop landings had no significant statistical and/or economic effect on North Carolina prices in any of the periods analyzed. Landings of sea scallops had a significant negative effect on North Carolina bay scallop prices in both of the subperiods analyzed. The effect was nearly twice as large after June 1980 than in the 1974-June 1980 period. Imports negatively affected North Carolina bay scallop prices in all periods studied, however, the effect was only statistically significant for the total period model covering the 1974-84 period.

Consumer income had a highly significant effect on North Carolina bay scallop prices in the analysis covering the total 11 year period. A $100 billion monthly increase in income resulted in a price increase of nearly 14 cents per pound. During the earlier period, 1974-June 1980, the effect was slightly larger at 20 cents per pound. However, after June 1980 the estimated effect was negative which has to be declared insignificant unless one wants to conclude the product became an inferior good. There is no reason to believe such a change has occurred.

The estimated positive sign for the coefficient of the shrimp price index suggests buyers of North Carolina bay scallops regard shrimp as a substitute product. For the total 1974-84 period and the period

prior to July 1980, a 1 percent increase in monthly shrimp prices resulted in a North Carolina bay scallop price increase of between 18 and 20 cents per pound. This estimated effect was significant at the 90 percent statistical confidence level. The estimated relationship is still positive but at an insignificant level for the after June 1980 model.

The seasonal demand variable representing the months December through March resulted in a consistantly negative estimated relationship with North Carolina bay scallop prices. During the 1974-June 1980 period, the estimated coefficient was negative and statistically significant at the 90 percent confidence level and resulted in a nearly 50 cents per pound decline in prices during the peak season after variation in all other variables were accounted for. During this period variations in monthly North Carolina bay scallop landings did not effect prices. These two items of information suggest that during the peak season during the 1974-June 1980 period the demand curve was flat or horizontal (no relationship to quantity landed) and it shifted downward during the peak season. This probably reflects a wholesale buyer attitude about abundant supplies and therefore lower prices regardless of volume landed from month to month rather than a seasonal decline in consumer preferences. After June 1980, however, the market appeared to reflect a more "normal" situation. This is based on the conclusions that the relationship between prices and quantities landed became significantly negative and the seasonal downward demand shifter was no longer significantly different from zero.

Calico Scallops

The overall explanatory power of the three models estimated for calico scallop prices are generally higher than the models estimated for Florida bay scallop prices but equal to or less than those estimated for North Carolina as is suggested by R^2 values (Table 4). However, most of the explanation of calico scallop prices is limited to a few variables. The principal variables are calico scallop landings and income.

A 1.0 million pound change in monthly calico scallop landings resulted in a price change in the opposite direction of 49 cents per pound when all eleven years were included in the analysis. There were calico scallop landings in 127 months of the total 132 months considered. The landings effect was highly statistically significant in all time periods analyzed. During the early period, 1974-June 1980, a 1.0 million pound increase in calico scallop landings would have resulted in a price reduction of $1.12 per pound. Since during this period annual landings only ranged between 1.0 to 2.4 million pounds, a monthly landings increase (decrease) of 10,000 or 100,000 pounds would be a more realistic consideration; such a consideration would show price decreases (increases) of 1.12 cents or 11.2 cents per pound, respectively. After June 1980 a 1.0 million pound change in landings resulted in a price change in the opposite direction of approximately 50 cents per pound.

Southeast bay scallop landings (N.C. plus Florida) were only statistically and economically significant during the July 1980-84

Table 4. Southeast calico scallop price analyses in dollars per pound effect per unit of change in specified variables for t

Time Period[b]	R^2	Constant	Scallops						(1
			Calico	Southeast Bay	Sea	Northeast Bay	Import	Beginning Inventories	
			Million Pounds						
1974-84	.65	-.191 (-1.40)	-.490 (-10.59)	-.265 (-.24)	.135 (3.39)	-.141 (-.71)	-.038 (-.95)	-.014 (-.71)	
1974-June 1980	.83	-.689 (-3.51)	-1.12 (-3.68)	.559 (.49)	.010 (.21)	-.120 (-.25)	-.011 (-.26)	.031 (1.03)	
July 1980-84	.70	-.498 (-.58)	-.497 (-7.35)	-3.580 (-1.79)	.120 (1.23)	-.127 (-.53)	-.041 (-.61)	-.062 (-2.03)	

[a]Statistical t values are given in parenthesis. One tail t values in excess of (in absolute terms) .848, 1.296 and 2.390 are significant at the 80%, 90% and 99% confidence levels, respectively, for the 1974-84 and 1974-June 1980 models. For the Jul comparable t values are .851, 1.303 and 2.423.

[b]Time period are months starting with January and running through December of year specified unless month is otherwise specif

period. Again, the absolute size of the price coefficient in Table 4 is largely due to a consideration of a 1.0 million pound monthly change in landings. A 100,000 or a 10,000 monthly increase (decrease) in southeast bay scallop landings resulted in a 35.8 cent or a 3.58 cent decrease (increase) in prices, respectively.

Sea scallop and Northeast bay scallop landings were in no period economically and/or statistically significant in explaining calico scallop prices. Northeast bay scallop landings did however, show the expected negative relationship to calico scallop prices. Imports were negatively related to calico scallop prices in all periods analyzed, however, the estimate was only statistically significant at the 80 percent confidence level for the 1974-84 period. Beginning inventories had a statistically significant effect on reducing calico scallop prices after June 1980. A 1.0 million pound increase in monthly beginning inventories resulted in a 6.2 cent per pound decrease in calico scallop prices.

Income changes have a highly significant effect on calico scallop prices. Depending on the period considered, a $100 billion increase in monthly income increased calico scallop prices between 8.3 and 11.9 cents per pound.

Changes in the shrimp price index did not show a statistically significant positive effect on calico scallop prices in any period analyzed. Shrimp and calico scallops cannot be considered as market substitutes in contrast to the substitute relationship between shrimp and North Carolina bay scallops found in some periods analyzed.

Summary and Conclusions

The bay scallop markets in Florida and North Carolina appear to be different. Many of the same variables effect each market differently. Consequently, effects of management alternatives have to be analyzed separately for each of these two fisheries.

During the earlier years Florida bay scallop prices were highly sensitive to monthly bay scallop landings but were not significantly related in the later months after June 1980. North Carolina bay scallop price and landings showed the opposite patterns between the two time periods. However, prior to July 1980 there was a downward shift in seasonal demand for North Carolina bay scallops which may, in effect, result in a similar type of price-quantity relationship found in Florida during the earlier period.

Calico scallop landings exerted significant downward pressure on Florida bay scallop prices in all periods analyzed. The same effect was estimated for North Carolina except for the later period (after June 1980) when the relationship was no longer statistically significant. However, in this later period accumulated calico scallop landings may have affected North Carolina bay scallop prices through beginning monthly inventories. This period was the only one in which inventories were significantly negatively related to North Carolina bay scallop prices. The opposite situation occurred for Florida bay scallop prices; inventories significantly reduced prices downward during the earlier period, but not in the latter periods.

Changes in Northeast bay scallop landings do not significantly affect Florida or North Carolina prices. Sea scallop landings impact North Carolina prices more consistently than Florida bay scallop prices.

The volume of imports was negatively related to both Florida and North Carolina bay scallop prices in all periods analyzed. However, the variable significantly reduced bay scallop prices in only the model for the overall period. In explaining variations in calico prices, the variable was significant at only the 80 percent level for the entire period. Hence, imports do not appear to affect prices of southeastern scallop landings as much as several other variables tested. However, current increased imports and a good potential for greater imports from South and Central America make this a variable which may be of concern in the future.

Inceases in income overall can be expected to push bay scallop prices upward in both markets. Shrimp prices had no significant effect on Florida prices in any period and were no longer significant in North Carolina bay scallop markets after June 1980. The increased demand for and total volume of scallops in the market imply that scallops are developing into their own market, with shrimp viewed as less of a substitute than they once were.

The calico scallop price structure is most significantly affected by monthly calico scallop landings and consumer incomes. Beginning monthly inventories of all scallops and imports effect calico scallop prices in some periods. The relationship between calico scallop prices and these later variables were usually negative but not always statistically significant.

The results suggest that the North Carolina market for bay scallops may have developed a more independent status in recent years while the Florida market may have moved in the opposite direction. However,

the diminished size of Florida landings in recent years may have accounted for some of the change in estimates. Restrictions on calico scallop landings during the peak Florida bay scallop season would likely increase bay scallop prices. However, if that restriction "bunched up" calico landings in other months, then calico prices would likely be reduced. What the resulting net effect would be on total revenue to the two fisheries is unclear, but given the overwhelming size of the calico scallop fishery, one might expect such a policy to cost calico fishermen (through lower prices) more than it would benefit bay scallop fishermen (through higher prices). If the fisheries were of comparable size, then this might not be the case. If bunching up of calico landings did not occur (as a result of, for example, fishermen pursuing alternative fisheries) then total annual calico landings could fall. Calico landings would have to decline by only a small fraction from current levels to swamp the positive effect of higher bay scallop prices.

Our analysis suggests, especially based on the latter period estimates, that restrictions on the timing of calico harvests may be unwise. This is somewhat surprising vis a vis the conventional wisdom surrounding the effects of calico landings on bay scallop prices, especially North Carolina bay scallop prices. However, as noted earlier, North Carolina bay scallop prices may be affected indirectly through seasonal restrictions which affect levels of inventories. What is not clear is what effect seasonal alterations in calico landings would have on levels of inventory. If monthly calico landings became more variable as a result of seasonal restrictions, that may or may not

result in more variability in inventories. Gains in bay scallop prices from reduced inventories in some months might be offset by increased inventories in other months. Such inventory effects might result in transferring gains in price in one state's bay scallop fishery to reduced prices in the other.

Appendix I. Florida Rule Package

FILED
99FEB-9 PM 2:55
SECRETARY OF STATE
TALLAHASSEE, FLORIDA

CHAPTER 46-53

CALICO SCALLOPS

46-53.001 Definitions.-- As used in this chapter:

(1) "Calico scallop" means any scallop of the species *Argopecten gibbus*, or any part of the meat or viscera thereof.

(2) "Harvest for commercial purposes" means the taking or harvesting of any calico scallop for purposes of sale or with intent to sell or by means of any trawl.

(3) "Harvest" means the catching or taking of a marine species by any means whatsoever, followed by a reduction of such marine species to possession. Calico scallops that are temporarily possessed for the purpose of determining compliance with the size limit imposed by this chapter shall not be considered harvested if those that are undersize are returned to the water immediately after sorting.

(4) The term "land", when used in conjunction with the harvest of calico scallops, means the physical act of bringing the harvested calico scallop ashore.

(5) "Trawl" means a net in the form of an elongated bag with the mouth kept open by various means and fished by being towed or dragged on the bottom. "Otter trawl" means a trawl with its mouth kept open by means of boards or "doors" on each side.

Specific Authority 370.027(2), F.S. Law Implemented 370.025, 370.027, F.S. History - New 3-1-99.

46-53.002 Size Limit.-- Each harvester and processor of calico scallops shall possess calico scallops that are of legal size. Calico scallops shall be considered of legal size if a one pound sample of calico scallop meats, taken from any single container possessed by the harvester or processor, contains no more than 250 individual meats. If containers are possessed, the capacity of which is less than one pound, a sample taken to determine compliance with this rule may be made up of the contents of more than one container. Each sample containing more than 250 calico scallop meats shall constitute a separate violation of this size limit.

Specific Authority 370.027(2), F.S. Law Implemented 370.025, 370.027, F.S. History - New 3-1-99.

46-53.003 Harvest Requirements; Harvest for Commercial Purposes; Gear Specifications; Closed Areas.--

(1) No person shall harvest calico scallops within or without the waters of the state or land any calico scallop unless such person possesses a valid saltwater products license.

(2) No person shall harvest calico scallops for commercial purposes within or without the waters of the state using any gear other than an otter trawl meeting the following specifications:

(a) No such trawl shall be towed for more than 25 minutes, beginning when the trawl is placed in the water and ending when the trawl is completely removed from the water.

(b) In the areas where the use of such trawls is allowed by

subsection (3), no more than two unconnected otter trawls, each with a headrope no longer than 40 feet, a perimeter around the leading edge of the net not greater than 120 feet, and a mesh area not greater than 500 square feet, shall be deployed from any vessel.

(c) No such trawl shall be deployed or fished that has a mesh size anywhere in the trawl body or bag less than 3 inches stretched mesh or that has a twine size smaller than #84.

(d) No such trawl shall be used for the directed harvest of any species other than calico scallops. Any bycatch of other species shall be immediately returned to the water where caught.

(e) Such trawls, to the extent that they meet each provision of this rule, shall be exempt from the Turtle Excluder Device (TED) requirement of Rule 46-31.004 and the applicable regional Bycatch Reduction Device (BRD) requirement of Rule Chapter 46-31.

(3) No otter trawl shall be used in the directed harvest of calico scallops within the following areas:

(a) All state waters of Jefferson, Taylor, Dixie, Levy, Citrus, Hernando, Pasco, Pinellas, and Hillsborough Counties, and all state waters of Wakulla County east of the following described line:

Beginning at the St. Marks Lighthouse, proceed southerly on a straight line to flashing channel marker #1; thence, southerly in a straight line to a point on the state waters boundary where a straight line from flashing channel marker #1 to flashing bell buoy #24 intersects

with said boundary.

(b) All state waters shoreward of a line one mile seaward of the Colregs Demarcation Line, except that in Wakulla, Franklin, and Gulf Counties, all state waters shoreward of a line three miles seaward of the Colregs Demarcation Line.

(c) All waters closed to the use of otter trawls for the harvest of shrimp, during the time periods indicated, pursuant to the following Marine Fisheries Commission rules:

1. Rule 46-31.0156.

2. Rule 46-31.016.

3. Rule 46-38.001.

4. Rule 46-38.002.

Specific Authority 370.027(2), F.S. Law Implemented 370.025, 370.027, F.S. History - New 3-1-99.

CALICO SCALLOPS
MARINE FISHERIES COMMISSION
SEPTEMBER 1998
STAFF

INTRODUCTION

The calico scallop fishery has been developing in the southeast over the past 30 years. In Florida, the fishery initially developed around the Cape Canaveral area, and is still prominent there. Subsequently, calico scallop beds have been discovered and exploited in the Gulf of Mexico, mainly off of the Carrabelle area, but more recently in the southwestern Gulf.

The majority of the fishery uses shrimp boats that reconfigure their nets when calico scallops are located in abundance. This activity has normally occurred in the federal waters of the South Atlantic and the Gulf of Mexico; however, in the last year at least one individual, using a processing vessel, has been exploring and harvesting in state waters in southwest Florida. Because of gear restriction, this individual has operated under a Special Activities License issued by the Department of Environmental Protection.

At the Hollywood MFC meeting in December 1997, the calico scallop fishery was briefly outlined, and staff was directed to begin developing options for a fishery management plan for the species. Workshops were conducted in Cocoa Beach, 3 February 1998; and Apalachicola, 23 February 1998. Options were presented to the Commission in February 1998, and a draft rule was prepared. The Commission held a Final Public Hearing in Destin during June 1998. The rule as approved specified gear configurations, designated allowable harvesting areas, exempted calico scallop trawls from TEDs requirements, and set a minimum size limit of 1 1/4" shell height with 5% tolerance. Concerns raised by the industry regarding the minimum size requirements prompted the Chairman to agenda a reconsideration to reopen the FPH at the Ft. Myers meeting; however, the rule has since been withdrawn at the insistence of the Joint Administrative Procedures Committee (Attachment 1).

This paper contains the biology and description of the fishery from a previous staff paper. It is included here as a review.

BIOLOGY

Scallops of the genus *Argopecten* are bivalve mollusks of the Order Ostreoida, and Family Pectinidae. There are two species of *Argopecten* harvested in Florida, *A. irradians* (Lamarck, 1819), the bay scallop; and *A. gibbus* (Linnaeus, 1758), the calico scallop.

Calico scallops spawn year-round with peaks in the late fall and in the spring. The fall spawn may be critical to the continuance of the following years' stock. Calico scallops are functional hermaphrodites releasing sperm and eggs sequentially. Fertilization is external, occurring in the water column.

The pelagic larval stage of calico scallops is estimated to last 14-16 days. Spat settle onto hard substrate (e.g. disarticulated shells) at about 250um shell height (SH). In the Cape Canaveral area, scallops reach 40-45 mm (=1.5-1.8 inches) SH within 8-10 months. Terminal shell height is reported to average 65 mm (=2.5 inches). The average life span for calico scallops is 18 months, but may extend to a maximum of 24 months.

Recruitment occurs on a year-round basis with peaks occurring from March through June. Recruitment may vary from year to year for various reasons such as parasitic infestations, upwellings and currents, availability of suitable substrate for settlement, and water temperature.

Calico scallops range from Delaware Bay south into the Carribean Sea; the exact southern limit of distribution is unknown. Calico scallops are generally found in water depths of 10-400 m (=33-1,312 feet). Commercially harvestable stocks are located near Cape San Blas, Florida; Cape Canaveral, Florida, Cape Hatteras, North Carolina; and recently Sarasota, Florida.

FISHERY

Calico scallops were first reported landed off North Carolina in 1959. During the 1960's and 1970's harvestable beds were located off of the Cape Canaveral area. Landings from Canaveral increased to a level of 42 million pounds (meats) in 1984.

The fishery in Florida is concentrated in the Cape Canaveral area. There are three major processors located on Merritt Island, which is also the home port of the majority of the fleet. Two of these are shore-based facilities, and one is a processing vessel. In the Gulf of Mexico there are about five processing plants in existence or planned. The majority of the fishery operates by landing whole scallops to the processing plants for shucking and packing. However, processing can be accomplished aboard properly equipped vessels, where the entire procedure from harvest to packaging can be carried out at sea.

Calico scallops are harvested by means of otter trawls. Trawls designed for the directed harvest of scallops typically have headrope lengths of 30-55'. Nets are, constructed with 3" stretch webbing, generally made with #84 nylon thread. These nets need to be more rugged than shrimp nets because of the abrasive qualities of the animals being harvested. The net configuration is dictated by the weight of the scallops and is generally shorter in length than a shrimp trawl. This shorter length and resultant sharp taper to the body of the net preclude the installation of any presently certified TED. Door size ranges fro 8' X 40" to 11' X 40". Two unconnected nets are fished simultaneously. Tow speeds are between 2.5 and 3 knots with tow times ranging between 5 and 30 minutes (averaging 15 minutes).

Historically, the majority of the harvest of calico scallops has come from the EEZ in the South Atlantic and the Gulf of Mexico. It is believed that the waters off of the Canaveral area are home to the largest continual stocks of calico scallops.

THE RULE AS PASSED

The purpose of this proposed rule chapter is to facilitate the careful development of this commercial calico scallop fishery in an environmentally safe fashion. To that end, the proposed rules:

1. Prohibit the harvest of calico scallops between the Hillsborough/Manatee counties line, and the Big Bend/Northwest regions line;
2. Prohibit the use of scallop trawls in all state waters closed to otter trawls, and within one mile from the COLREGS Line, except in Franklin, Gulf, Wakulla counties - within three miles from the COLREGS Line;
3. Specify that calico scallop trawls used in state waters have a maximum headrope length of 40 feet (120 foot perimeter), a maximum surface area of 500 square feet, a minimum mesh size of three inches (stretch) and a minimum net twine size of #84;
4. Allow the use of a try net;
5. Establish a maximum tow time of 25 minutes, and allow TEDs exemptions for specified calico scallop trawls;
6. Allow the use of specified calico scallop trawls for the directed harvest of calico scallops only; and,
7. Prohibit the harvest , possession, or landing of calico scallops less the 1 1/4 inch in shell height, with a 5% tolerance for the harvest of undersized scallops.

ISSUES

The only contention with this proposed rule concerns the size limit requirement. The majority of the industry is opposed to the minimum shell width provision, and would prefer either no size limit or a meat count substitution. Staff conducted an informal meeting on 3 August 1998, in order to discuss possible alternatives to the minimum shell height language (Attachment 2). The group was in favor of resubmitting the sections of the rule that dealt with allowable harvesting areas and gear deployed in state waters. However, industry is still uncomfortable with the minimum size requirement.

Harvesters and processors on the east coast are working exclusively in federal waters and do not see a rationale for state regulation of the fishery. It is felt that a minimum size requirement on Florida harvesters would allow out-of-state fishers to harvest calico scallops off the Florida coast and land them in other states to avoid the minimum size law. This would potentially allow non-Florida harvesters to devastate calico scallop stocks while restricting Florida harvesters to a size limit. This faction of the industry is not necessarily opposed to a minimum size limit, but would rather see such a limit become part of a federal management plan, and thus effective from North Carolina to Florida.

The South Atlantic Fishery Management Council has stated an intend to develop a fishery management plan for calico scallops. Scallop management is presently incorporated into an overall habitat management plan. However, minimum size has not been addressed. The Gulf of Mexico Fishery Management Council does not have any plans to develop an FMP for calico scallops.

The use of a minimum size based on shell width could be problematic for harvesters and enforcement. Calico scallops are normally dumped on the stern of the harvesting vessels and returned to port for processing. Scallops are not sorted as to size until they are unloaded from the vessel at the processing plants. Without onboard sorting devices, it is difficult to maintain a constant control over the size of the animals harvested while at sea. Although processing vessels are equipped with graters, most vessels have no such capability, and the requirement for such devices would be cost prohibitive.

There are alternatives to the use of shell height or width to determine minimum size. A meat count is one alternative that has been extensively discussed. A further alternative would be to control the size of the scallops harvested by mesh size within the trawl. Little to no data exists to verify the effectiveness of this option; however, industry has indicated a willingness to fund and test nets with larger mesh sizes.

OPTIONS

1. Repropose calico scallop rule as passed at the Final Public Hearing.

2. Repropose the rule as passed with regards to gear and harvesting areas, but remove the minimum size requirement.

3. Repropose the rule as passed with regards to gear and harvesting areas, and require a minimum size limit on the west coast fishery.

4. Repropose the rule as passed with regards to gear and harvesting areas, and declare intention to add minimum size language that would coordinate with federal councils.

5. Begin development of a new fishery management plan for calico scallops.

STATEMENT OF ESTIMATED REGULATORY COSTS
SMALL BUSINESS AND SMALL COUNTY AND CITY IMPACT STATEMENT
FOR THE PROPOSED NEW RULE: RULE 46-53, F.A.C.
CALICO SCALLOPS, *Argopecten gibbus*
revised

PROBLEM STATEMENT

The major producers of calico scallops have approached both the federal councils and the Marine Fisheries Commission to adopt a management plan for calico scallops. One vessel operator currently fishing in state waters, was told that special activity licenses (SAL) were going to be withdrawn due to new interpretations of administrative authority, but that issue was resolved by the 1998 Legislature. However two regulatory issues must be resolved through this rule-making. Current regulations designate trawls as gear for the directed catch of shrimp in state waters. Additionally, federal regulations do not require scallop trawls to use turtle excluder devices (TEDS) in federal waters, but the Commission's regulation requires the use of TEDs in all trawls in state waters. The Legislature also enacted statutory language requiring the Commission to describe all allowable net gear used in state waters in rule by July 1998. The commissioners directed staff to promulgate a rule, then held a final public hearing during the June 1998 meeting. However the scallop rule was not approved due to unresolved issues related to a minimum size limit. During the interim, prior to this meeting, a workshop with industry representatives resulted in a new standard for the minimum size limit.

DESCRIPTION OF THE FISHERY AND AFFECTED INDIVIDUALS

The Fishery

The fishery has been characterized through the years in terms of fleet characteristics (SAFMC, August 1981), production and marketing economics (SAFMC; Rockwood, 1988 and Waugh 1995) and biology (Arnold, 1991 and 1995 and Blake, 1991).

Calico scallops have been taken intermittently in shrimp trawls since 1949, however no directed fishery developed. Calico scallop beds were discovered during exploratory fishing offshore, between Carrabelle, Florida and Mobile, Alabama (1957), off Daytona Beach (1960) and Cape Lookout, North Carolina (1959). Other beds have since been discovered off Southwest Florida and the Dry Tortugas. Commercial exploitation began in both the Cape San Blas and Cape Lookout areas in the late 1950's, however catches were sporadic. The development of the Cape Canaveral beds, due to the large size, have supported a directed fishery since the late 1960's. The early surveys determined the depth of the beds to range from 40 to 150 feet in the Gulf near Cape San Blas and from 60 to 250 feet off Cape Canaveral.

The development of fishing gear included the use of sea scallop dredges, modified clam dredges, modified shrimp trawls and the scallop trawl. Since 1973 scallop trawls are reported to be the only gear employed in the fishery. Despite higher maintenance costs then dredges, the trawls were found to be the more efficient gear type. The type of trawl used is unique to the fishery and necessary because shrimp trawl gear would sustain damage if employed to catch scallops. The top and bottom of the trawl is symmetrical, that is the head line and lead line are the same diameter; mesh size is at least three inches; and, net material is substantially thicker, # 84 rather than #15-20. The bag of the net is relatively short. When scallops are abundant, trawling time lasts only 10 - 15 minutes but during the end of season, or in areas of low abundance tow times may last one or two hours.

When reviewing their recent history of landings, different authors have erroneously concluded that a particular magnitude of landings was the norm. In fact the landings are highly variable and the explanation of the variation is complex and indeterminate. Arnold (1995) states, ".. the commercial fishery is highly variable and unpredictable." Increasing production was predicted after 1967, 1972 and 1985 only to be followed by declines. Early estimates of an MSY were never obtained, while MSY is now considered to be irrelevant to management. A peak of 40 million pounds of scallops were caught in 1984 in the Southeast with the majority from the Cape Canaveral beds, while the seventies saw average annual landing in the three million pound range, the eighties in the ten million pound range and the nineties have been less than one million pounds, with the exception of 1994, which was a six million pound season. This trend is not thought to indicate any conclusion other than the variability of the resource. Landings are generally reported in pounds of meats, whereas the industry refers to both count and gallons. The conversion used is that there are eight pounds per gallon. Rockwood concluded that there are 228 pounds of whole weight to the gallon. In other words there are 28.5 pounds whole weight to each pound of

meats. This latter equivalent is variable due to the lack of consistent relation between meat size and shell size.

The price and demand for calico scallops are related to the substitute prices of bay and sea scallops, the size of the calico and the price of imports. Historically the calico scallop has been the least cost alternative, with substantial price variation due to the size as measured by count. The sea scallop fishery has substantially declined with the World Count decision about the Canada-US fishing line, the ground fish closure area off New England and the intensification of effort in the remaining areas. However, participants attribute most of the price effects to imports. Beginning around 1995 scallops from Peru and Panama are said to have begun to complete: the import was of a similar size and appearance. During the nineties, imports from China are said to have taken over the market for smaller sizes. Import records from the NMFS aggregate all species but differentiate by produce form: live, fresh/frozen, dried/salted/brine and prepared/preserved. If other fresh and frozen species serve as substitutes to the calico, then there is substantial downward price pressure. During the seventies imports ranged from 9.5 to 22 million kilos, averaging 15 million. Since 1989, when fresh/live was first distinguished from frozen, imports have averaged 20 million kilos with roughly a third of the total in the fresh/live category.

Participants

The annual fluctuations in abundance have resulted in much of the catch comes from either off season shifting or poor shrimp season shifting by shrimp trawl vessels. For example between 1995 and 1997, statewide landings were reported as roughly 950,000 pounds, 0 pounds and 1.6 million pounds. The Canaveral fishery has been characterized as the largest in the world and much of the development of the Florida fishery resulted from vessels from adjacent home ports fishing throughout the Southeast.

During the record season off Cape Canaveral eight processors and roughly 200 vessels participated. During the mid-eighties, seventy boats participated, while in 1988, 30 to 40 boats moved to the panhandle after a parasite decimated the beds and stopped fishing off the Cape. Around 1987/88, the rock shrimp market grew and stabilized with the development of new technology and marketing; one result was that more trawling vessels could locate to the area.

Currently there are three processors in Canaveral and six processors in the panhandle; there is also one processor vessel in operation. Other processor vessels that participated in the fishery in the past are thought to have relocated to South America. Land-based processors can employ 25 to 30 vessels when operating at maximum capacity, 24 hours a day. During the 1995 season of roughly 1,000,000 pounds, twenty vessels were active in the fishery. With the exception of the processor vessel, off shore shrimp vessels in the 50 to 90 LOA range constitute the fishery. While offshore shrimp vessels are the norm in the fishery, fishing behavior is substantially different. Trip duration is less than twenty-four hours. A successful trip results in the vessel being dangerously overloaded so that fishing cannot occur during large seas or bad weather. The fishery is very seasonal and cannot sustain a vessel and crew throughout the year. On the east coast the major shifting is between the rock shrimp and calico scallop fishery and includes moving to other scallop areas, when landings decline.

Using annual landings summaries from the 1990s, summaries, average statewide catch per trip was reported to range from 600 to 2,000 pounds. Industry testimony states that 5,000 gallon/week is necessary for plant operation coming from vessel trips where 300 gallon trips are considered to be good and 1,000 gallon trips are not unusual during periods of abundance. So a 2,000 pound trip translates into 250 gallons and a 600 pound trip translates into 75 gallons. Remember, the real weight of a 2,000 pound trip totals roughly 57,000 pounds.

ESTIMATE OF TRANSACTIONAL COSTS

Management Measures

The evaluation of costs depends in part upon the magnitude in relation to the income statement of the firm. The only sources of income statements which represent industry averages are from the Rockwood survey of Brevard County firms. The Ward analysis of shrimp vessels operating in the Gulf of Mexico provides another source of information about similar vessels operating in the penaeid shrimp fishery. That information has been included as an Attachment. Since there is no federal management plan for this fishery, the proposed measures will apply in both state and federal waters.

The first proposal is a size limit. An organization of processors, the Calico Scallop Conservation Association, has imposed a 38mm size limit of their captains. This so-called gentleman's agreement is no longer promoted but

some processors refuse to accept catches when the average size is very small. One opponent of a shell size limit stated that the cost of equipment: a hopper, a conveyor, and the separator would cost in the range of $30 - 50 thousand if the shrimp vessel already had the necessary power and hydraulics. This would effectively close the shery in state waters. This was the controversial measure of the June rule. During that meeting and during subsequent discussions a maximum meat count of 250 per pound was incorporated into this proposal. Industry practice is that landside processing stops when the meat size costs begin to exceed the wholesale sales price. There is, on the one hand, a desire to land scallops which are thought to be near their maximum age in spite of size, whereas there is concern that immature scallops are also being landed because of the pressure of the number of vessels that participate in the fishery. Presently culling of catch occurs at dock side with the exception of the vessel processor. However, try nets are used in this fishery to sample meat size from beds before extensive landings are begun. The lack of size distribution information prevents calculation of the direct cost of revenue losses to the trawler captain and crew or the processor, but the proposed count is close to the minimum economic size. Therefore the cost of this measure will be in increased use of try nets resulting in increased steaming time.

The second, associated measure places a zero tolerance on the retention of bycatch. One study of bycatch indicated a 1.5 percent bycatch off Cape Canaveral while testimony indicates that it includes crabs, rock shrimp, ornamental shells, other shellfish, sawfish and other bottom dwelling species. This measure would require on-board culling of the catch and that is only being done on the processor vessel.

The third measure is the tow-time requirement. The duration is in line with industry comments about tow times during abundant area catches, however it is below the times given during poor fishing periods. This will tend to increase variable costs of fishing (fuel). The time requirement has been used to help ensure that potential turtle mortality is minimized.

The fourth measure includes all the design standards for the net including mesh size, twine size, and overall net dimensions. The overall size is larger than the industry recommendation in order to make it consistent with standard trawl measures in nearshore state waters. The other design standards are consistent with industry recommendations. The cost of such a net is roughly $1,800 (Waugh, 1995). Persons who participate in the fishery must use such nets since the need to dig into the bottom is greater, and consequent chaffing and draw is substantially greater. The nets are constructed so after they wear, top and bottom panels may be reversed.

The fifth measure prohibits the use of scallop trawls in areas and during seasons which are closed to shrimping or are closed to the use of shrimp otter trawl gear. The closure also includes fishing within a mile of the beach. Given the ecology of the animal none of the areas would affect scallop catches.

The sixth measure exempts the gear from the requirement that all trawls incorporate a TED into the design. Information about turtle interactions with the gear is limited. The gear uses a bag of substantially shorter length than shrimp trawls require, and the tow time requirement further mitigates the exemption. Comments from the federal agency and the state agency primarily responsible for endangered species protection have not yet commented on the draft rule.

The seventh measure does not provide for the recreational catch of calico scallops and precludes the catch of scallops with any but the designated trawl gear. The Commission has not considered restricted species designation however the barriers to entry are substantial to someone who does not own a diesel powered vessel that is capable of deploying the gear. The literature does not indicate any current recreational fishery. The information in Bell (1995), is incorrect. Reported recreational catch obtained from the Bell survey is thought to be bay scallops. The latter is an exclusively nearshore recreational fishery.

AGENCY IMPLEMENTATION COSTS

Enforcement costs may also be incurred by local, state and federal agencies including the Florida Game and Freshwater Fish Commission, U.S. Coast Guard, U.S. Department of Commerce NOAA Enforcement and local law enforcement agencies. None of these entities have programmed additional monies for such enforcement however the state and federal entities have MOUs with the FDEP/DLE. In an effort to assess the cost of implementation and enforcement on local governments a survey was conducted by the Advisory Council on Intergovernmental Relations. The Council is a legislative entity which collects information from local governments which is used by

the legislature to prepare economic impact analysis for bills which may affect local governments. The responses suggest that local government enforcement of MFC rules does not create significant costs.

The proposed rule will not have a significant effect on the revenues of local governments, small cities or small counties. The effects on state revenues will be insignificant. Testimony suggests that a very few vessels are able to land current levels of catch.. The actual amount of revenues resulting from increases in steaming times would depend on the occurrence of local option gas taxes and revenue sharing formulas in place.

SMALL BUSINESS IMPACT STATEMENT

Amendments to Chapter 120, F.S. which were enacted in 1985 charge each agency, prior to adoption of any rule, to consider the impact on small businesses. The definition of small business includes any independently owned and operated business concern which employs 25 or fewer permanent full-time employees and which has a net worth of not more than one million dollars. An analysis of the benefits and costs to directly affected persons has identified the business entities impacted by the proposed measures. Statutes now include small cities and small counties in the analysis where the implementation of a proposed rule would have a disproportionate impact on the area. Available data does not allow conclusive analysis, but the majority of affected businesses meet the definition of small business. The rule would also affect small counties and small cities to the extent that the direct costs of the rule would limit fishing to fewer itinerants vessels Therefore, the proposed rule making process should consider a rule to:

(1) establish less stringent compliance or reporting requirements;
(2) establish less stringent schedules or deadlines;
(3) consolidate or simplify compliance or reporting;
(4) establish performance standards to replace design standards; and,
(5) exempt small businesses from the rule.

We will also use this section of the statement to consider the economic and employment impacts which will result from this rule. All such businesses; whether directly or indirectly affected are considered to be small businesses. The rule will affect the following small business operations: Scallop processor vessel, vessels that seasonally target scallops; processors who are below the threshold; testimony during the SAFMC Scoping hearings indicate that the Brevard County processors each employ 75 people.

The total direct and indirect economic impact of the proposed amendments can be estimated within the state with the following information: 1. the change in dockside value or producer surplus resulting from the proposed regulation and, 2. the change in production costs (cost of operating the craft) in the case of the commercial fishery. These values can then be used to determine the direct and indirect value of output and employment resulting from the rule. Because of the change in the rule from a shell size to a meat count, the effects of the rule on small cities and counties are considered to be insignificant. The cost to small businesses will be from enforcement actions when sampling is insufficient to prevent undersized meats exceeding the count.

Employment changes are estimated per one million dollars, so a one million dollar decline in revenues to fishers would result in the loss of 25.9 jobs; likewise the gain of one million dollars would result in the gain of 25.9 jobs. The effect of production level jobs on indirect employment within the region is .4223, or for each increase/decrease in a support service-related job, there will be a .4223 increase/decrease in indirect support jobs. The table below can be used to calculate economic impacts associated with costs and benefits, which are provided by the affected individuals.

	OUTPUT MULTIPLIER	EMPLOYMENT MULTIPLIER
COMMERCIAL FISHING	1.7080	25.9
MARGIN MULTIPLIER	1.8056	29.0

REFERENCES

Preparation of this Statement was derived from a wide variety of sources. Standard economic methodology and comments received from the public and individuals in FDEP and other agencies have been incorporated into this Statement.

Data sources of particular significance include the NMFS's Trip Interview, General Canvass Landings and Marine Recreational Fishery Statistics Survey programs; the FDEP's Fishery Statistics Section's fishery dependent and independent monitoring programs; FDEP's Division of Law Enforcement license and permit and vessel registration application files and, import and export data from FAO and NMFS.

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SERC/CS1298.WPD
Robert M. Palmer
November 1998

Brevard County Calico Scallop Fishery
Direct Expenditures, 1984-87
(in thousands of dollars)

Item	1984	1985	1986	1987
Vessel Expenses				
Labor[a]	2,092	5,156	1,201	3,062
Fuel & Oil	1,586	1,260	685	794
Fishing Gear	833	753	691	831
Maintenance & Repair	1,032	1,291	728	991
Other Vessel Expense	2,396	2,213	2,061	2,397
Sub-Total	7,939	10,673	5,366	8,075
Plant & Shipping Expenses				
Fuel	719	609	75	312
Wages and Salaries	6,656	5,390	2,146	3,397
Packaging	2,576	2,153	200	807
Freight	2,626	2,387	426	1,321
Maintenance	1,742	1,995	601	850
Shell Disposal	369	510	163	222
Equipment Rental	273	239	56	114
Utilities	617	517	237	436
Other Plant Expense	1,331	2,812	484	2,015
Sub-Total	16,909	16,151	4,388	9,474
Office & Overhead Expense				
Wages and Salaries	711	1,090	785	923
Insurance	228	396	394	229
Office Supplies	41	40	23	30
Taxes	715	1,243	112	213
Harbor Lease	287	678	450	440
Utilities	139	130	110	79
Other Office Expense	1,098	1,354	722	1,315
Sub-Total	3,219	4,931	2,596	3,229
TOTAL EXPENSES	28,067	31,755	12,350	20,778

[a]Estimated on the basis of just one firm's experience.

Source: Questionnaire survey of Cape Seafood, Southern Seafood, Canaveral Seafood and Lambert Seafood.

REPRODUCED FROM ROCKWOOD.

Table R-4. Average cost and returns in the Gulf of Mexico shrimp fishery, 1969-92.

Cost/Revenue Categories	Average Real Dollars	Plus One Standard Deviation	Minus One Standard Deviation
Shrimp revenue	42,864.83	220,210.44	8,343.81
Other revenue	1,933.73	10,765.37	347.35
Total revenue	43,001.86	220,412.33	8,389.55
Fuel cost	8,106.57	43,188.36	1,521.62
Supplies	3,811.64	23,353.95	622.10
Maintenance	7,860.61	53,523.07	1,154.44
Overhead	1,498.82	8,036.47	279.53
Interest	5,007.91	19,802.05	1,266.49
Depreciation	2,024.83	12,337.96	332.30
Insurance	7,110.18	15,072.51	3,354.10
Total overhead	3,297.91	26,427.23	411.55
Crew shares	3,536.57	199,094.60	62.82
Total cost	36,437.71	216,231.16	6,140.22
Net revenue	6,564.15	41,881.18	2,249.33

Note: Figures have been converted to 1977 dollars.

Source: Ward et al. (1995).

Appendix J. Biological Effects of Scallop Trawling: Estimation of By-Catch Composition, Mortality and Effects on Bottom Communities.

BIOLOGICAL EFFECTS OF SCALLOP TRAWLING: ESTIMATION OF BY-CATCH COMPOSITION, MORTALITY AND EFFECTS ON BOTTOM COMMUNITIES.

Walter G. Nelson

John C. Sainsbury

Martha A. Sager

Department of Oceanography, Ocean Engineering

and Environmental Science

Florida Institute of Technology

Melbourne Florida 32901

Final Report to:

Florida Department of Natural Resources

Florida Marine Research Institute

Division of Marine Resources

100 Eighth Avenue S.E.

St. Petersburg, Florida 33701

March 1992

SUMMARY

The composition, quantity and mortality levels of trawl by-catch from the calico scallop fishery was determined at 3 stations located offshore from Cape Canaveral, Florida during 3 research cruises between February and September, 1991. A total of 30 species of fishes and 25 invertebrate species were collected. Dominant fishes of the by-catch were small flounders and soles (Bothus robinsi, Bothus ocellatus, Syacium papillosum, Gymnachirus melas, Cyclopsetta fimbriata), batfishes (Halieutichthys aculeatus, Ogcocephalus radiatus, Ogcocephalus sp. A., Bradbury), searobins (Prionotus roseus, Prionotus tribulus), planehead filefish (Monacanthus hispidus), and barbfish (Scorpaena brasiliensis). Invertebrates included portunid crabs (Callinectes sapidus, Callinectes ornatus, Portunus gibbesii, Portunus spinicarpus), the calappid crab, Calappa flammea, the rock shrimp, Sicyonia brevirostris, and a variety of starfish, brittle stars, and sea urchins. By-catch composition was relatively similar among the three stations and among the three sample dates, particularly for the invertebrate component.

The ability of organisms to survive the stresses associated with trawling varied strongly with taxon. The dominant bothid flatfish showed low survival compared to other groups, both in terms of survival during the trawling phase and in terms of post-trawl survival. Overall survival of flatfish was estimated to be only 4%. Species with stouter bodies, e.g. batfishes, or other protective elements, e.g. decapod crustaceans, showed better post-

trawl survivorship if immediately placed in seawater, but still suffered mortality in the trawling phase.

The half scale scallop trawl was dragged along the bottom in an area adjacent to a marker buoy in order to examine the effects of trawling on sediment characteristics and faunal content. Following scallop trawling, there was a shift to larger particle sizes in the sediments. There was no evidence for a decrease in either abundance or species richness immediately following scallop trawling.

Scallop trawling by-catch would not appear to cause major impacts to species of commercial or recreational fisheries importance. A proportion of many, but not all, of the species collected may survive the trawling if promptly returned to the water. Maximum negative impact falls on the small bothid flatfish with low resistance to trawl damage. Any reduction in mortality of the by-catch from scallop trawling would require immediate sorting of catch on board the vessels, which is a procedure not presently followed for most of the vessels in the fishery.

INTRODUCTION

The calico scallop industry of Florida, one of the major such industries in the U.S., is a primary Florida fishery with annual landings valued at as much as $70 million per year (Otwell et al., 1984). The calico scallop (Argopecten gibbus) is an epifaunal bivalve which is distributed from the northern side of the Greater Antilles, throughout the Gulf of Mexico, and northward to just above Cape Hatteras (Allen and Costello, 1972). Aspects of the biology of the calico scallop were discussed by Sastry (1962) while general reviews of the biology of this species were provided by Allen and Costello (1972) and by Broom (1976).

Commercially important concentrations of calico scallops tend to be associated with prominent capes. Within Florida, in addition to the important bed at Cape Canaveral, calico scallops occur at Cape San Blas (Allen and Costello, 1972). The calico scallop is found at depths ranging from 2 - 370 m, although most reports of calico scallops show collections from approximately 20 - 80 m.

Most scallop fisheries worldwide utilize heavily built dredges for harvesting. The dredge, or rake, is constructed with a heavy steel mouth frame to which the towing arms and brackets are attached. The bottom bar of the mouth is formed into a knife, or scythe, which scrapes the sea bed, lifting the shellfish which then pass back into the bag. The underside of the bag is usually constructed of steel rings crimped together so that it can withstand rough treatment from the bottom and the abrasive action of the shells. The top of the bag may be made of steel rings at

the rear end where the shells gather, but further forward, sash cord webbing is commonly used (Sainsbury, 1986).

Offshore fisheries (e.g. Georges Bank, Alaska) are usually worked by larger purpose built vessels of 80 - 120 ft in length, which may also be rigged to undertake bottom otter trawling as an alternate method. Such vessels are characterized by their heavy construction and special protection to the hull which absorbs the abrasion and loads imposed by the dredges in the harsh fishing conditions often encountered.

Sheltered water and inshore scallop fisheries (e.g. New England bay scallops, queen scallop fishery in West Scotland) are usually worked by smaller vessels of 30 - 55 ft utilizing one or more smaller rakes some 3 - 4 ft in width, constructed similarly to the 16 ft models used by larger vessels. Similar dredges are used in oyster fisheries worldwide (Sainsbury, pers. obs.).

A description of the development of the Cape Canaveral calico scallop fishery and a comparison to the earlier fishery off North Carolina is given by Allen and Costello (1972). In the early years of the Cape Canaveral fishery, vessel types included shrimp trawlers, New England scallopers, Chesapeake Bay dredgers and factory type scallopers. Gear types included both dredges and trawls. In recent years, the vessels working the Cape Canaveral area have been modified shrimp trawlers which tow bottom otter trawls from outrigger booms on each side of the vessel. These vessels are modified by reducing the length of their outrigger booms to about 20 ft (McGuffey, 1984) and utilize heavily built

bottom otter trawls of up to about 36 ft headrope/footrope length. The nets are rigged without floats and with several tickler chains so that they "tend bottom" heavily in order to scrape up the scallops which then pass back into the regular cod-end.

On most vessels, no sorting of the catch or processing is carried out on board. The catch is piled on the after deck of the vessel, and weights of 20 - 31 tons are common (McGuffey, 1984). Upon return to port, the catch is unloaded using a mechanical clamshell shovel which drops it into a bin which is the starting point for a processing line. The first process is to sort out useful scallops and discard the loose shell and debris. It is at this point that most of the by-catch is discarded.

Several vessels of some 120 - 150 ft working out of Port Canaveral were outfitted as factory vessels with the catch being sorted on board. Loose shell, by-catch and debris were discarded overboard and the scallops were opened, cleaned and packed on board.

Whereas examination of fisheries is often conducted with the goals of optimizing harvests and managing the fisheries resource, evaluation of the ecological impacts associated with the fishing process is rarely done (Peterson et al., 1987).

A variety of potentially serious ecological impacts may result from the use of any fishing gear. One impact of concern would be significant mortality of non-target species, with juveniles of other commercial species being of particular concern. Research on the Canadian scallop fishery has suggested other potential problems

(Caddy, 1973). Use of scallop dredges and trawls has been found 1) to leave persistent tracks and depressions in the bottom, 2) to cause suspension of fine sediments into the water column, 3) to cause appreciable sediment disturbance to larger sediment grain sizes, and 4) to produce up to 17% mortality of the target species left on the bottom.

A typical example of the problems with by-catch mortality in a region supporting multi-species fisheries is described by Brander (1988). In the Irish Sea, trawling for demersal species involves cod, whiting, sole, plaice and Norway lobster. The use of trawls for lobster, which used a smaller mesh size, resulted in a considerable by-catch of small demersal fish, which were discarded. The discards resulted in a large additional mortality source for these species. Similarly, the fishing mortality on plaice was largely a function of by-catch of other fisheries (Brander, 1988).

The composition of the by-catch from the Florida scallop fishery is largely undescribed, while the impact of scallop fishing on bottom communities of Florida coastal waters is virtually unknown. Knowledge of the impacts associated with scallop fishing are essential for development of integrated management plans for Florida's fishery resources. The primary objective of the present research was to determine the composition, quantity and mortality levels of trawl by-catch from the calico scallop fishery located off shore from Cape Canaveral and to determine the variation of these parameters with season. A secondary objective was to determine the impact of the scallop fishing gear on bottom dwelling animal communities.

MATERIALS AND METHODS

Study Area

The study area consisted of the scallop beds located off Cape Canaveral, Florida. These beds were primarily mapped and described during the 1960's (Bullis and Ingle, 1959; Bullis and Cummins, 1961; Anonymous, 1967; Drummond, 1969; Anonymous, 1970; Cummins, 1971; Roe et al., 1971). The scallop beds are located between 20 - 80 m depth on the continental shelf between Fort Pierce and the St. Johns River. Commercial concentrations of scallops are centered on Cape Canaveral (Bullis and Cummins, 1961) with the area between Cape Canaveral and Fort Pierce consistently being the most productive (Drummond, 1969).

Three sampling stations were selected from a set of existing stations currently being used in a University of South Florida study of the scallop population (W.S. Arnold, pers. comm.). Station locations were designated South (28° 06' N, 80° 09'W), Central (28° 30'N, 80° 10'W), and North (29° 00'N, 80° 17'W) (Figure 1). These stations correspond to University of South Florida station numbers 909-15B (North), 909-9B (Central), and 811-1 (South).

Depth was approximately 36 m at the South station, 38 m at the Central station, and 40 m at the North station. Temperature data collected via XBT (unpub. data courtesy of W.S. Arnold) on the cruise of February 12-13, 1991 showed a uniform temperature profile at the South station of approximately 22.5° C. The Central station showed a thermocline present between 15-25 m, with a

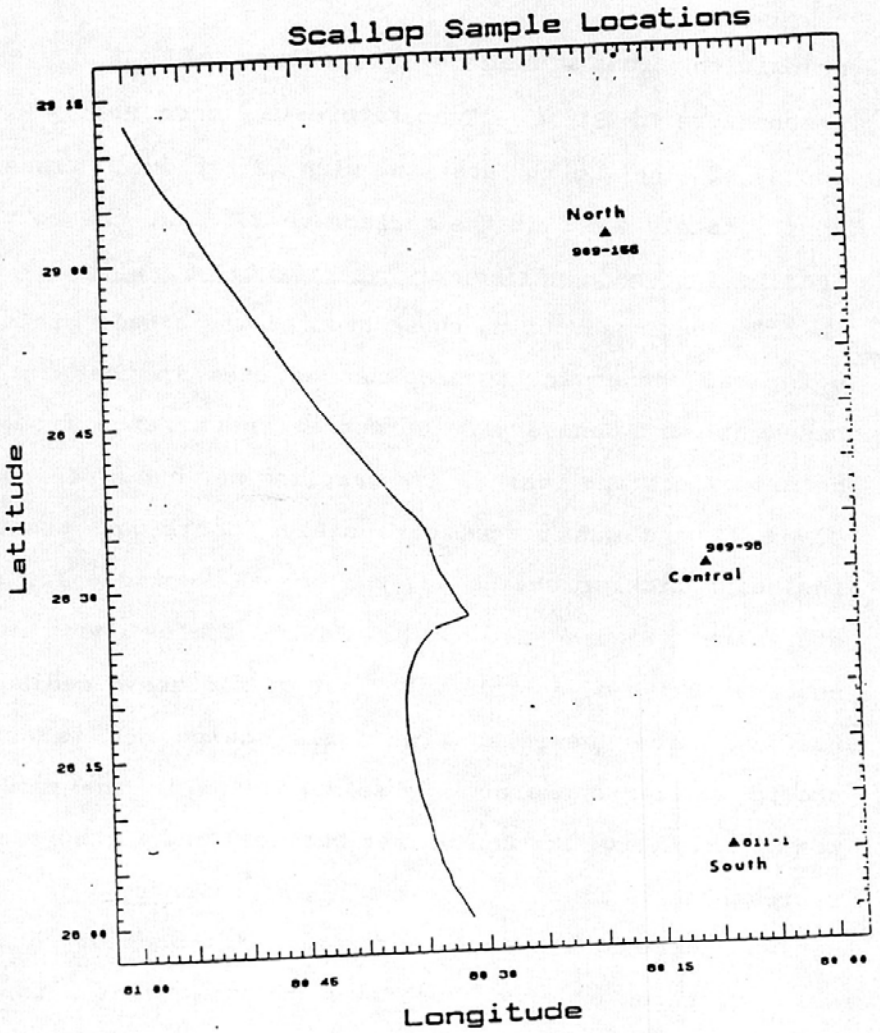


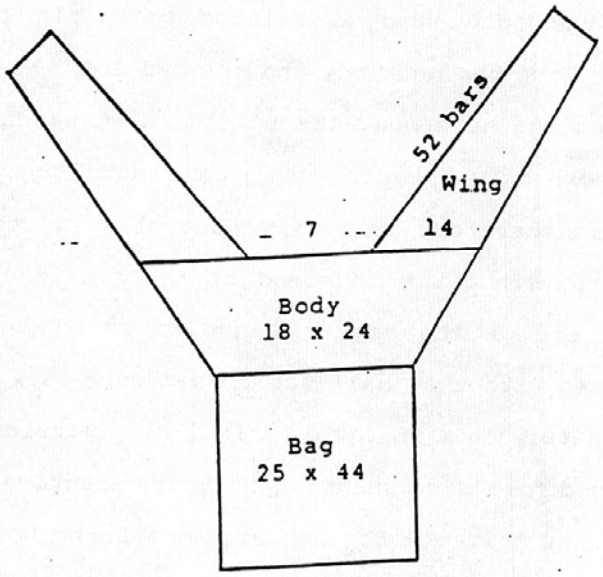
Figure 1. Location of the three sampling stations used in the scallop by-catch study offshore of Cape Canaveral. Numeric designations are University of South Florida station numbers. (Modified from map provided by W.S. Arnold).

transition from a surface temperature of 24° C to a bottom temperature of 21° C. Temperature was more nearly uniform with depth at the North station with a gradual transition from approximately 23° C at the surface to 22° C at the bottom.

Gear Design and Handling for Experimental Trawling

The net used during these studies was a half scale version of a typical commercial scallop net as used in the scallop fishery based at Port Canaveral. Commercial nets range from 30 - 40 ft headrope/footrope length. The sampling net had a headrope/footrope of 18 ft and was rigged with scaled doors and associated gear including tickler chains and the normal V-bridle for single warp operation (Figure 2). The "half scale" net is therefore representative of a "full size" net of the above median dimensions used on larger vessels. The "half scale" net is actually used aboard smaller commercial vessels working in the industry (pers. comm., Mr. George McCormick, net builder) and is therefore directly representative of the lower end of the industry. The "half scale" net was built by the George McCormick Net Shop of Port Canaveral, which supplies a large proportion of commercial nets used in the scallop fishery.

According to the net builder, experience with the half scale version indicated a catch rate of approximately half that of the full size version on the same fishing grounds. Such results are generally valid since the catch rates for scallops can be expected to be dependent upon the total area fished during a tow, and hence



NET PLAN

Shows one half of net, top and bottom identical

All webbing 3 inch.
Tickler chains: 2 x 3/8 inch.
Doors: 18 inch. x 36 inch.
Bridles: 29ft. x 3/8 inch.

Figure 2. Net plan and specifications for the net used in experimental scallop trawling.

the mouth opening width. The scallop net is designed and built to scrape the bottom and requires only a sufficient headline height to ensure the catch and associated materials pass back over the footrope into the net body and the cod end. No floats are normally fitted to the headrope, the height being maintained by tension in the headrope and hydrodynamic pressure opening up the twine. Height is therefore primarily controlled by the by the height of the doors, since the door end of the net is shackled directly to the aft end of the door. Based on standard industry practice, doors used with the "half scale" net were 18 x 36 in compared with approximately 48 x 96 in for a full size version. The sampling net was rigged following standard industry practice with tickler chains and bridles suitable for its size. Webbing was maintained at 3 in mesh, that which is used throughout the fleet. Within the commercial fleet, the manner in which a net is rigged and fished varies from boat to boat depending on the ideas and wishes of a skipper.

Preliminary trials were undertaken aboard the R/V Osprey to assess the effectiveness of existing equipment in handling and fishing the net and associated gear. Results from this experience showed that the existing winch and crane were marginal in the existing configuration, and that in order to set and retrieve the doors and net body satisfactorily, modifications were needed to the vessel.

Modifications to the vessel were undertaken, including the installation of a 1-ton capacity A-frame/davit system at the stern,

together with necessary underdeck stiffening. This facility, operated by hydraulic ram, was designed to pivot at the base through an arc sufficient to handle equipment between the after deck and a position clear of the vessel's stern.

When setting the gear, the warp and bridles were run from the main winch over a towing block hung from the A-frame. The operation started with the A-frame extended over the stern, doors at the block with the net hanging below, and the vessel moving forward at 4-5 knots. The net was then lowered and the shafts taken out of gear in order to prevent the net being sucked into the propellers. Once the net was clear of the stern, the shafts were put back in gear and the bridles and towing warp run out to the required scope.

When hauling back, with the A-frame extended, the warp and bridles were brought in until the doors were at the towing block; the A-frame was then pivoted inboard while the doors were held at the block. A HIAB crane situated on the vessel's afterdeck was then used to lift the body of the net aboard and elevate the cod end to dump its contents. To receive the contents, two 4 x 4 ft temporary checkers constructed from 2 x 10 in lumber were placed on the afterdeck.

A series of tows were made to determine the required scope for apparent optimum net performance on the sea bed. Judgement regarding efficiency of operation was based on the wear (shining) of the door shoes (uniform along length of shoe), shining of tickler chains (throughout length) and effective ground contact of

footrope chain (shining and amount of mud/bottom materials in net). A scope of approximately 5 times the water depth was found to be most effective in reproducing the performance of commercially operated gear in terms of shell, organisms, mud and bottom debris.

Based upon a total catch of 32 tons in a 16 hr period for commercial gear, and an average tow duration of 30 min (McGuffey and Sainsbury, 1985), the catch rate would be 2 tons/hr or 1 ton per average tow.

Dimensional analysis indicates that a half scale net will demonstrate the following characteristics as compared with full size gear:

Catch rate:	50%
Volume:	12.5%
Bottom area:	25%
Fishing time:	25% (to obtain equivalent volume)
Area fished:	12.5%

Since the operation and net rigging is designed to avoid non-bottom (higher swimming) species, the by-catch will be dependent upon the sea bed covered rather than the volume of water filtered. These factors allow results to be scaled up to be representative of the full size gear.

During the sampling, the average tow length was maintained at 15 min (equivalent to 1 hr full scale), resulting in a very full net. On occasions where the tow length was somewhat longer, the sampling net was found to be completely filled with shell, mud, and bottom debris to the extent that the contents escaped through the mouth during the retrieval operation. The estimated weight on these occasions was in excess of one ton while the estimated weight

for a regular tow of 15 min was approximately 0.5 ton. Therefore, the mass of the contents and treatment of by-catch simulated situations observed aboard the commercial fleet.

Composition and Quantity of the By-catch

The species composition and the amount of by-catch collected with a scallop trawl was determined on three cruises to evaluate seasonal variation in these parameters. Cruise dates were February 12-13, June 5-6, and September 19-20, 1991. Trawls were taken at all three station locations on the February and June cruises, but only at the North and Central stations on the September cruise. Number of trawls per station varied and were determined by the number of living scallops collected for ancillary studies of scallop biology.

When a scallop trawl was brought on board, the catch was immediately dumped on deck and the material was sorted by hand as quickly as possible. Living specimens of fishes were removed as soon as discovered and transported to seawater tanks for evaluation of survivorship. Thus, survivorship of these specimens represents an optimum condition and was not reflective of standard industrial handling practices. Non-living fishes and invertebrate by-catch were sorted and a wet weight of each category was determined using a dial type hanging scale. Wet weights of specimens placed in the holding tanks were directly measured in most cases. In a few instances wet weight values were estimated from average wet weight values of the non-living specimens. On the final cruise, the scale was damaged and could not be used. Specimens were therefore

returned to the laboratory and weighed on an electronic balance.

Mortality of the By-catch

Two components of by-catch mortality were examined in this study. One component was the quantity of non-living specimens in the scallop catch. The second component was the survival of specimens which were alive when the trawl was deposited on board. No analysis of mortality of specimens possibly occurring during the trawling phase but not captured by the trawl was attempted during this study.

Shipboard survival experiments were carried out on each sampling cruise generally following the methods of Wassenburg and Hill (1989). Specimens with signs of life were removed from the material collected by the scallop trawl and immediately transferred to glass aquaria ranging in size from 20 to 80 l, depending on the size of a species. In some cases, multiple individuals were placed in single large tanks. All tanks were continuously aerated with aquarium pumps and air stones, and water was not exchanged during the holding-period. Survivorship of specimens was evaluated at intervals during a 4 hr period in the holding tanks. Holding period was influenced on the first cuise by tank space availability and the time interval of travel between stations. In most cases, there was a clear resolution to the status of specimens after the 4 hr duration, i.e. clear morbidity or else no apparent evidence of negative effects. The possibility that longer exposure times might increase any potential artifacts from the holding was reduced by the use of the 4 hr time interval for testing.

The number and type of specimens utilized in the survivorship tanks was dependent both on the abundance of a species in the hauls and the tendency of a species to survive the trawling process. Therefore, total number of specimens examined varied widely among species.

Impacts on Bottom Communities

A secondary goal of the study was to evaluate the impact of scallop trawling on infaunal bottom communities. The proposed method involved experimental, repetitive trawling within a defined area, with benthic grab sampling before and after the trawling. During the course of the study, it was decided that it would be preferable to sample benthos in trawled and untrawled areas in conjunction with the activities of commercial scallop trawlers. However, a drastic decrease in the standing stock of living scallops occurred during the study period, and commercial scallop boats did not work the scallop grounds during the study period. A small scale investigation using the available half scale scallop trawl on the research vessel was therefore carried out on the September cruise.

At the North station, a buoy was placed to mark the trawling area. Two 0.04 m^2 Shipek grab samples were taken from the bottom near the buoy. The research scallop trawl was then dragged on an east-west heading beside the buoy for a total of six passes. Each tow leg was approximately 5 min at 2.5 kn, at which time the ship executed a 360 degree turn to retrawl the area on the opposite heading. The width of the band trawled was estimated at

approximately 50 yds. Immediately following recovery of the trawl, approximately 20 min later, two additional Shipek grabs were obtained within the trawling area. From each grab sample, two 7.6 cm diameter cores were taken. One sample was used for sediment grain size analysis and the second sample was preserved and used for analysis of benthic infauna.

RESULTS

Composition of the By-Catch

Species lists for fishes and invertebrates collected as by-catch in scallop trawling are given for each cruise in Table 1. Total numerical abundance of the by-catch was dominated by echinoderms on the February and September cruises, and by bony fish on the June cruise (Table 2). Elasmobranchs and mollusks were rare items in the by-catch.

A total of 30 species of fishes were collected during the scallop trawling (Table 1). Fishes typical of the by-catch included several species of small flounders and soles (Bothus robinsi, Bothus ocellatus, Syacium papillosum, Gymnachirus melas, Cyclopsetta fimbriata), various batfishes (Halieutichthys aculeatus, Ogcocephalus radiatus, Ogcocephalus sp. A., Bradbury), and searobins (Prionotus roseus, Prionotus tribulus). Other fishes commonly encountered included the planehead filefish (Monacanthus hispidus) and barbfish (Scorpaena brasiliensis).

On the cruises in February and June, flounders were relatively more frequently encountered than on the September cruise (Tables 3-5). Batfishes and searobins were frequently encountered on all three cruises.

On 2 cruises, the North station samples possessed higher numbers of fish species in the by-catch, although differences among stations were not great. Species richness of fishes in the by-catch for the North, Central and South stations was 15, 13 and 7

Table 1. Species collected as by-catch by scallop trawling during the three cruises during 1991. The South station was not sampled in September.

Species	Cruise Date 2/12	6/5	9/19-20
SOUTH STATION			
Fishes			
Bothus ocellatus	X	X	
Bothus robinsi	X	X	
Centropristis philadelphica	X		
Diplectrum formosum		X	
Gymnachirus melas		X	
Ogcocephalus radiatus	X	X	
Prionotus roseus	X		
Scorpaena brasiliensis	X		
Syacium papillosum	X	X	
Symphurus diomedianus		X	
Synodus foetens	X		
Crustaceans			
Calappa flammea	X	X	
Callinectes ornatus	X	X	
Callinectes sapidus	X	X	
Hepatus epheliticus	X	X	
Libinia emarginata		X	
Ovalipes stephensoni	X	X	
Portunus depressifrons		X	
Portunus gibbesii	X	X	
Portunus spinicarpus	X		
Sicyonia brevirostris		X	
Echinoderms			
Arbacia punctulata	X		
Astropecten articulatus	X	X	
Goniaster tessellatus	X		
Luidia clathrata	X		
Lytechinus variegatus	X	X	
Ophioderma brevispinum	X		
Ophiolepis elegans	X	X	

Table 1. (Cont.)

Species	Cruise Date 2/12	6/5	9/19-20
CENTRAL STATION			
Fishes			
Balistes capriscus			X
Bothus ocellatus	X	X	
Bothus robinsi	X	X	
Centropristis philadelphica	X		
Cyclopsetta fimbriata	X		
Etropus crossotus	X		
Gymnachirus melas	X		
Halieutichthys aculeatus			X
Lactophrys quadricornis			X
Monacanthus hispidus			X
Narcine brasiliensis	X		
Ophidion grayi	X	X	
Ophidion holbrooki	X	X	X
Prionotus roseus	X	X	
Scorpaena brasiliensis	X	X	
Sphoeroides parvus	X		
Stenotomus chrysops	X	X	X
Syacium papillosum			
Crustaceans			
Calappa flammea	X	X	
Callinectes ornatus	X		X
Callinectes sapidus		X	X
Hepatus epheliticus	X	X	
Libinia emarginata	X		X
Ovalipes stephensoni	X		
Penaeus sp.	X		
Portunus depressifrons		X	
Portunus gibbesii	X	X	
Portunus spinicarpus	X		
Sicyonia brevirostris	X		
Echinoderms			
Arbacia punctulata	X	X	X
Astropecten articulatus	X	X	X
Echinaster sentus			X
Eucidaris tribuloides			X
Goniaster tessellatus	X		X
Luidia clathrata	X		
Lytechinus variegatus	X	X	X
Ophioderma brevispinum	X		X
Ophiolepis elegans	X	X	X
Mollusks			
Octopus burryi			X

Table 1. (Cont.)

Species	Cruise Date 2/12	6/5	9/19-20
NORTH STATION			
Fishes			
Bothus ocellatus	X	X	X
Bothus robinsi	X	X	
Centropristis philadelphica	X		
Diplectrum formosum	X		
Gymnothorax nigromarginatus	X	X	
Halieutichthys aculeatus	X	X	X
Hemipteronotus novacula		X	
Hippocampus erectus	X		
Lactophrys quadricornis	X		
Monacanthus hispidus	X		
Ogcocephalus radiatus	X	X	X
Ogcocephalus sp. A, Bradbury	X		
Prionotus roseus	X	X	X
Prionotus tribulus	X		
Raja eglanteria		X	
Scorpaena brasiliensis	X		
Scorpaena dispar		X	
Sphoeroides parvus	X		X
Syngnathus louisianae	X		
Syacium papillosum		X	X
Synodus foetens	X		
Crustaceans			
Calappa flammea	X		
Callinectes ornatus	X		X
Callinectes sapidus	X	X	X
Hepatus epheliticus	X		
Hypoconcha sp.			X
Ovalipes stephensoni	X		X
Pagurus sp.		X	
Paguridea sp.			X
Portunus gibbesii	X		
Portunus spinicarpus	X	X	
Sicyonia brevirostris		X	

Table 1. (Cont.)

Species	Cruise Date 2/12	6/5	9/19-20
NORTH STATION			
Echinoderms			
Arbacia punctulata	X	X	X
Asterias forbesii			X
Astropecten articulatus	X	X	X
Echinaster sentus	X		
Encope michelini		X	
Eucidaris tribuloides			X
Goniaster tessellatus	X		X
Luidia clathrata	X		
Lytechinus variegatus	X	X	X
Ophioderma brevispinum	X	X	X
Ophiolepis elegans	X	X	X

Table 2. Total composition of the by-catch from scallop trawling sorted by major taxonomic groupings.

	Feb. 12-13	June 5-6	Sep. 19-20
Bony Fish	366	108	34
Elasmobranchs	0	2	0
Echinoderms	232	39	81
Crustaceans	596	68	17
Mollusks	0	0	1
Total	1194	217	133
Mean No./Haul	199.0	72.3	66.5

species in February, and was 10, 8, and 7 species in June. There were 6 species at both the North and Central stations in September. Species composition of fishes in the by-catch was relatively similar at the three stations (Table 1).

Invertebrates were commonly collected in the by-catch at all stations. Invertebrate by-catch was dominated by two groups, the decapod crustaceans (14 species) and the echinoderms (11 species). Additionally, an octopus (Octopus burryi) was collected on one occasion. Commonly occurring decapods included portunid crabs (Callinectes sapidus, Callinectes ornatus, Portunus gibbesii, Portunus spinicarpus) and the calappid Calappa flammea. The rock shrimp Sicyonia brevirostris was frequently collected in the by-catch. Echinoderms consisted primarily of starfish, brittle stars, and sea urchins (Table 1).

Species composition of the invertebrate by-catch was generally extremely similar among stations and sample dates (Tables 1). Among station similarity was much greater for the invertebrates than for the fishes collected in the by-catch. Calculation of Jaccard's index of similarity (Boesch, 1977) for pairwise comparison of stations within sample dates yields a mean similarity index for invertebrates of 0.64 and for fishes of 0.30. This difference was statistically significant ($t=3.84$, $df=12$, $p<0.01$).

Composition, abundances, and wet weights of the by-catch collected during the February sampling cruise are given in Table 3. Mean total by-catch abundance per haul and mean fish by-catch abundance per haul did not differ significantly among the three sample

Table 3. Numbers and wet weights for day versus night hauls for the c
12-13, 1991. North and South stations were sampled during the
station was sampled at night (n=1).

	DAY				NIGHT	
	Total No.	Total wet wt. (kg)	Mean No.	Mean wet wt. (kg)	Total No.	Tot wet (k
Fish						
Bothidae spp.	150	7.62	30.0	1.52	28	
Centropristis philadelphica	5	0.42	1.0	0.08	1	
Diplectrum formosum	8	0.78	1.6	0.16		
Gymnachirus melas					1	
Gymnothorax nigromarginatus	1	0.02	0.2	<0.01		
Hippocampus erectus	1	0.01	0.2	<0.01		
Lactophrys quadricornis	1	0.31	0.2	0.06		
Monacanthus hispidus	4	0.20	0.8	0.04	2	
Ogcocephalidae spp.	31	1.07	6.2	0.21	3	
Ophidion holbrooki					1	
Ophidion grayi					1	

Table 3. (cont.)

	DAY				
	Total No.	Total wet wt. (kg)	Mean No.	Mean wet wt. (kg)	Total No.
Prionotus roseus	66	2.32	13.2	0.46	16
Prionotus tribulus	1	0.12	0.2	0.02	
Scorpaena brasiliensis	18	0.54	3.6	0.11	20
Sphoeroides parvus	1	0.06	0.2	0.01	1
Stenotomus chrysops					1
Syngnathus louisianae	2	0.26	0.4	0.05	
Synodus foetens	2	0.21	0.4	0.04	
Echinoderms	225	7.68	45.0	1.54	7

Table 3. (cont.)

	DAY				NIGHT	
	Total No.	Total wet wt. (kg)	Mean No.	Mean wet wt. (kg)	Total No.	Tot wet (k
Crustaceans						
Portunidae	426	12.26	85.2	2.45	122	
Calappidae	10	0.8	2.0	0.16	24	
Libinia emarginata	1	0.4	0.2	0.08	3	
Penaeus sp.					1	
Sicyonia brevirostris					9	
TOTAL	953	35.08	190.6	7.02	241	

* weight not taken, ** weight estimated from mean of individuals take

Table 4. Numbers and wet weights for day versus night hauls for th
1991. The North station was sampled during the day (n=1), the
were sampled at night (n=2). ** total weight excluding specie

	DAY		NIGHT		M
	Total No.	Total wet wt. (kg)	Total No.	Total wet wt. (kg)	
Fish					
Bothidae spp.	44	2.95	20	1.35	1(
Gymnachirus melas			2	0.05	
Gymnothorax nigromarginatus	1	<0.01			
Halieutichthys aculeatus	3	0.05	4	0.5	
Hemipteronotus novacula	1	<0.01			
Narcine brasiliensis			1	0.25	
Ogcocephalus radiatus	2	0.20	1	0.02	
Ophidion holbrooki			1	0.05	
Prionotus roseus	5	0.25	11	0.09	
Raja eglanteria	1	<0.01			

Table 4. (cont.)

	DAY		NIGHT		
	Total No.	Total wet wt. (kg)	Total No.	Total wet wt. (kg)	Mean No.
Scorpaena brasiliensis			1	0.35	0.5
Scorpaena dispar	10	0.9			
Symphurus diomedianus			1	<0.01	0.5
Sphoeroides parvus			1	<0.01	0.5
Echinoderms	23	0.50	16	0.55	8.0
Crustaceans					
Calappa flammea			4	0.04	2.5
Hepatus epheliticus			14	0.84	7.0
Libinia emarginata			5	0.07	2.5
Pagurus sp.	1	<0.01			
Portunidae	2	<0.01	33	0.16	16.5
Sicyonia brevirostris	4	<0.01	4	<0.01	2.0
Total	97	4.85**	119	4.86**	59.5

Table 5. Numbers and wet weights for day versus night hauls for the collections of September 19-20, 1991. The North station was sampled during the day (n=1), the Central station was sampled at night (n=1).

	Day		Night	
	Total No.	Total wet wt. (kg)	Total No.	Total wet wt. (kg)
Fish				
Balistes capriscus			2	0.02
Bothus robinsi	6	0.12		
Halieutichthys aculeatus	9	0.12	1	0.18
Lactophrys quadricornis			1	0.34
Monacanthus hispidus			1	0.02
Ogcocephalus radiatus	1	0.06		
Prionotus roseus	5	0.11	2	0.06
Sphoeroides parvus	1	0.05		
Syacium papillosum	3	0.04	2	0.28
Echinoderms	60	0.51	21	0.18
Crustaceans - Callinectes sapidus	1	0.02		
Callinectes ornatus	3	0.02		
Hypochoncha sp.	2	0.02		
Ovalipes stephensoni	1	0.06		
Paguridea sp.	1	<0.01	1	<0.01
Sicyonia brevirostris			8	<0.01

Table 5. (cont.)

	Day		Night	
	Total No.	Total wet wt. (kg)	Total No.	Total wet wt. (kg)
Mollusks				
Octopus burryi			1	0.04
TOTAL	93	1.13	40	1.12

dates (one way ANOVA; total abundance $F_{2,6} = 2.01$, $p=0.19$; fish abundance $F_{2,6} = 2.16$, $p=0.18$).

At the South station, the fish component of the by-catch was dominated by various small flatfishes, primarily Bothus spp., followed in abundance by the blue-spotted searobin Prionotus roseus. At both the Central and North stations, abundance and biomass of fishes in the by-catch were also dominated by these same species, while the barbfish (Scorpianidae) and batfishes (Ogcocephalidae) were also relatively important. Among the invertebrate components of the by-catch, crabs of the family Portunidae were the abundance and biomass dominant at all stations. Echinoderms were relatively more abundant at the South and North stations than at the Central station.

On the summer cruise, the fish component of the by-catch at all three stations was again dominated by bothid flat fishes, searobins, batfishes and scorpionfishes (Table 4). Most other species were represented by single individuals present at one station only. Both echinoderms and crustaceans were reduced in abundance and biomass in the by-catch at all stations compared to the February cruise. Portunid crabs were particularly less prevalent at the South and Central stations (Table 4).

As was the case with the February and June cruises, the fish component of the scallop by-catch samples obtained in September was dominated by bothid flatfishes, batfishes, and searobins at both the Central and North stations (Table 5). The relatively few additional fish species which were collected at this time included 2 grey triggerfish, Balistes capriscus, and 1 each of the scrawled cowfish,

Lactophrys quadricornis, the planehead filefish, Monacanthus hispidus, and the least puffer, Sphoeroides parvus (Table 1). A variety of starfish, brittle stars and sea urchins were collected in the by-catch at both stations (Tables 1, 5). Composition and abundance of crustaceans collected differed from previous cruises. No Calappa or Libinia were collected at either station. The total catch of portunid crabs (Table 5) was lower than that in June (Table 4), and was only 3% of the mean number per haul collected in February (Table 3).

Day-Night Comparisons

Total abundance of by-catch was greater in pooled daytime trawls than for pooled night trawls (mean ± s.d.: day = 163.3±111.8 per haul; night = 100.3±94.8 per haul). Total fish by-catch was also greater in daytime trawls than in night trawls (mean ± s.d.: day = 57.0±31.1 per haul; night = 31±29.7 per haul). These differences were not statistically significant (t-test; total abundance, t=0.99, df=9, n.s.; total fish, t=1.35, df=9, n.s.).

Inspection of Tables 3-5 does not indicate any marked difference in composition or biomass of by-catch in day versus night trawls. For example, the day versus night catch per haul of bothid flatfish in February was 30 versus 28, while that of the dominant invertebrate group, the portunid crabs, was 85.2 versus 122 (Table 1).

Survivorship of the By-Catch

The ability of organisms to survive the stresses associated with trawling varied with taxon. On the February cruise, 28% of bothid flatfish (5 of 18) died within 20 min of being placed in the holding tanks, and 44% had died after 4 hrs (Table 6). The blue-spotted

searobin showed considerable mortality, with 63% of specimens (5 of 8) dead after 20 min, although there was no further mortality at 4 hrs (Table 6). For the sand perch, Diplectrum formosum, 88% of individuals (6 of 7) failed to survive for 4 hr (Table 6), while 100% of the lizard fish (2 of 2), Synodus foetens, failed to survive (Tables 7,9).

In contrast, all batfish (5 Ogcocephalus radiatus), barbfish (8 Scorpaena brasiliensis), rock sea bass (3 Centropristis philadelphica), and the least puffer (2 Sphoeroides parvus) survived for 4 hrs (Table 6). Survival of crustaceans was relatively good. Only 9% of crab and shrimp specimens (3 of 33) failed to survive for 4 hrs. All crustacean mortality was observed after 20 min, with no further mortality being incurred during the additional observation period (Table 6).

Survivorship of the batfishes (Halieutichthys aculeatus, O. radiatus, Table 7) was again good on the June cruise, with 100% of specimens (7 of 7) surviving the 4 hr period of observation. One specimen of the blackedge moray, Gymnothorax nigromarginatus, survived as did a specimen collected in February (Table 6). All 6 specimens of crustaceans survived the 4 hr. observation period (Table 7).

All specimens which were collected at the two stations sampled on the September cruise and placed in the holding tanks for examination survived. The fishes surviving were the batfishes H. aculeatus and O. radiatus (4 individuals total), the gray triggerfish Balistes capriscus (2 individuals), and 1 individual each of

Table 6. Survivorship over a 4 hr test period of individuals removed from scallop by-catch on February 12-13, 1991 A = animal alive after time interval, D = animal dead after time interval. * - survivor with obvious scale damage, alive but unresponsive.

Taxon Station	No.	Time: .3hr	4hr
Fishes			
Bothidae			
South	2	A	A
South	2	A	1A/1D
South	2	A	1A/1D
South	1	D	
South	2	1A/1D	1A*
South	2	1A/1D	1A*
South	1	A	A
South	2	1A/1D	2D
South	2	1A/1D	1A
South	2	A	A
Centropristis philadelphica			
South	1	A	A
Central	1	A	A
North	1	A	A
Diplectrum formosum			
North	2	A	D
North	1	A	D
North	1	A	D
North	2	A	1A/1D
North	1	D	
Gymnachirus melas			
Central	1	A	D
Gymnothorax nigromarginatus			
North	1	A	A
Lactophrys quadricornis			
North	1	A	A
Monacanthus hispidus			
Central	1	D	
Central	1	A	D
North	1	D	
North	1	A	A
Ogcocephalus radiatus			
South	3	A	A
South	2	A	A

Table 6. (cont.)

Taxon / Station	No.	Time: .3hr	4hr
Ophidion gravi			
Central	1	A	A
Ophidion holbrooki			
Central	1	D	
Prionotus roseus			
South	1	D	
South	1	D	
South	2	1A/1D	1A
South	2	1A/1D	1A
South	2	1A/1D	1A
Scorpaena brasiliensis			
South	3	A	A
Central	5	A	A
Sphoeroides parvus			
Central	1	A	A
North	1	A	A
Syngnathus louisianae			
North	2	A	A
Synodus foetens			
South	1	A	D
North	1	D	
Crustaceans			
Calappa flammea			
Central	3	A	A
Central	3	A	A
Libinia emarginata			
Central	1	A	A
Central	1	A	A
Sicyonia brevirostris			
Central	9	7A/2D	7A
Portunidae			
South	3	A	A
South	3	A	A
South	3	2A/1D	2A
South	4	A	A
South	3	A	A

Table 7. Survivorship over a 4 hr test period of individuals removed from scallop by-catch on June 5-6, 1991. A = animal alive after time interval, D = animal dead after time interval.

Taxon Station	No.	Time: .5hr	1hr	4hr
Fishes				
Bothus robinsi				
Central	1	A	A	A
Gymnothorax nigromarginatus				
North	1	A	A	A
Hemipteronotus novacula				
North	1	A	A	A
Halieutichthys aculeatus				
Central	2	A	A	A
North	3	A	A	A
Ogcocephalus radiatus				
North	2	A	A	A
Raja eglanteria				
North	1	A	A	A
Crustaceans				
Calappa flammea				
South	1	A	A	A
Callinectes sapidus				
Central	2	A	A	A
Hepatus epheliticus				
South	2	A	A	A
Libinia emarginata				
South	1	A	A	A

Table 8. Survivorship over a 4 hr test period of individuals removed from scallop by-catch on September 19-20, 1991. A = animal alive after time interval, D = animal dead after time interval.

Taxon Station	No.	Time: .5hr	1hr	4hr
Fishes				
Balistes capriscus				
Central	2	A	A	A
Halieutichthys aculeatus				
Central	1	A	A	A
North	2	A	A	A
Lactophrys quadricornis				
Central	1	A	A	A
Monacanthus hispidus				
Central	1	A	A	A
Ogcocephalus radiatus				
North	1	A	A	A
Crustaceans				
Portunidae				
Callinectes ornatus	3	A	A	A
Callinectes sapidus	1	A	A	A
Ovalipes stephensoni	1	A	A	A
Paguridea sp.				
Central	1	A	A	A
North	1	A	A	A
Sicyonia brevirostris				
Central	2	A	A	A
Mollusks				
Octopus burryi				
Central	1	A	A	A

the scrawled cowfish, Lactophrys quadricornis, and the planehead filefish Monacanthus hispidus (Table 8). For the crustaceans, 5 portunid crabs, 2 rock shrimp and 1 hermit crab survived the 4 hr observation period. One specimen of octopus, Octopus burryi, also survived the observation period.

Benthic Impacts

Densities of benthic infauna in the sediment cores obtained from the Shipek grab samples taken on the September cruise were rather low. Samples obtained before trawling had a mean of only 4.5 individuals and 3 taxa per core (Table 9). Curiously, following 6 drags of the scallop trawl through the marked area, the mean abundance of benthic infauna collected was nearly 4 times greater, with 16 individuals and 5 taxa per core being collected. However, because of the low number of replicates taken, the difference in abundance was not statistically significant (t-test, $t= -2.04$, $df=2$, $p>0.05$).

Analysis of sediment data before and after the trawling showed consistent differences for the replicate before and after trawling sediment samples. There was little change in the percent fine sediment in samples, but there was a major increase in the percent representation of coarse size particles in the sediment cores post-trawling (Figure 3). Sediment particle size spectra for the two before-trawl (Figure 4, 5) and the two after-trawl (Figure 6, 7) samples clearly reflect a shift towards large particle sizes. After trawling, sediment distributions had larger mean grain sizes, greater standard deviations, were more negatively skewed and were increasingly leptokurtic (Table 10). The mean grain size increased by 1 phi class

(1.68 before, 0.65 after), while average sediment skewness changed from +0.38 before trawling to -2.37 after trawling. Neither of these changes were statistically significant because of the low sample sizes (t-test; mean grain size, t=2.7, n.s., df=2; skewness, t+2.82, n.s., df=2). These results are consistent with finer sediments being suspended in the water column by the trawl activity.

Table 9. Composition and abundance of benthic infaunal organisms sampled before and after experimental trawling of an offshore scallop bed.

Taxon	Before (1)	Before (2)	After (1)	After (2)
Polychaeta	3	1	7	9
Nemertinea	2	-	-	-
Decapoda	1	-	-	-
Bivalvia	-	1	1	1
Amphipoda	-	1	5	1
Ophiuroidea	-	-	-	1
Anthozoa	-	-	-	5
Pogonophora	-	-	-	1
unidentified	-	-	-	1
Total Abundance	6	3	13	19
Total Taxa	3	3	3	7
Mean Abundance	4.5		16.0	
Mean No. of Taxa	3.0		5.0	

Table 10. Summary of sediment grain-size distribution statistics (phi units) for samples taken before and after trawling.

Statistic	Before (1)	Before (2)	After (1)	After (2)
Mean	2.00	1.35	0.45	0.85
Std. Deviation	1.64	1.30	2.26	2.64
Skewness	0.75	0.00	-3.50	-1.23
Kurtosis	9.69	12.06	27.03	12.24

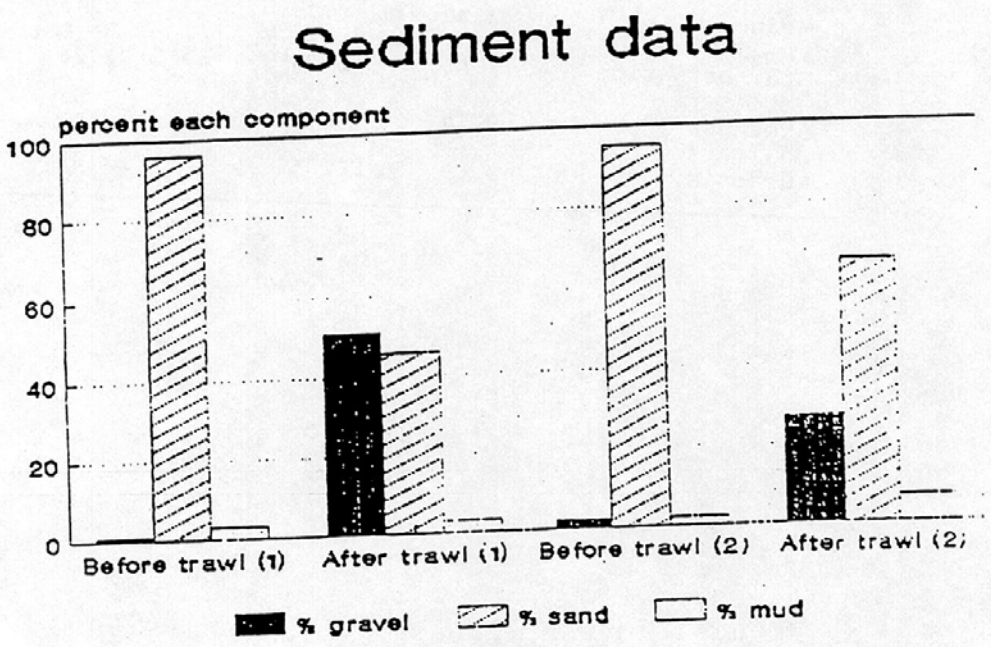


Figure 3. Percent composition of gravel, sand and mud fractions of replicate sediment samples collected before and after scallop trawling. Six hauls of the scallop net through the experimental area were done.

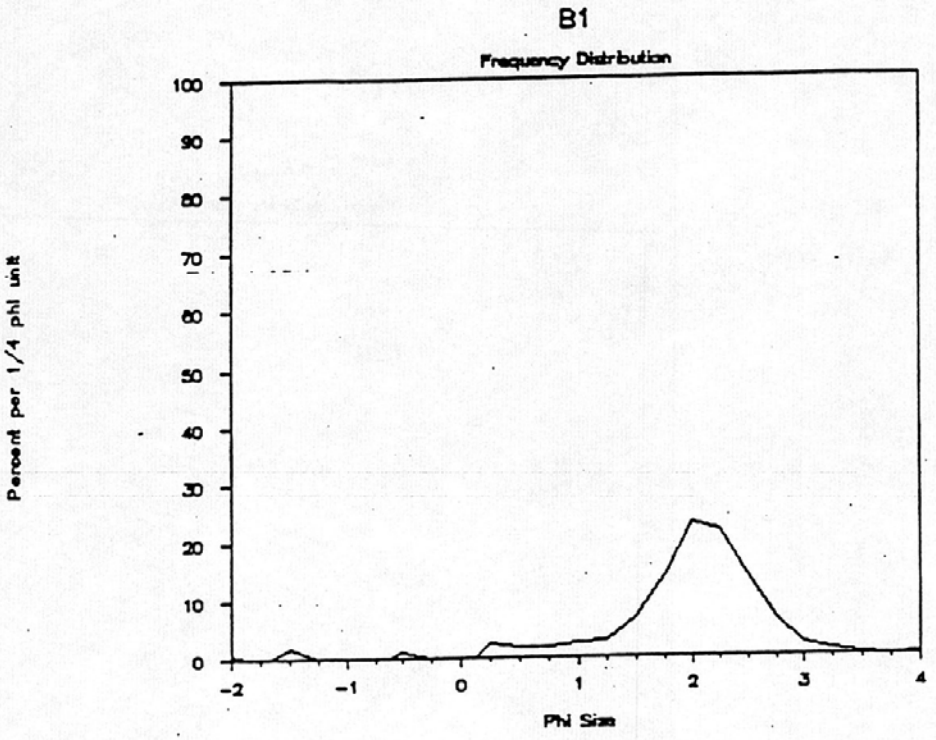


Figure 4. Particle size frequency distribution for before trawling sediment sample 1.

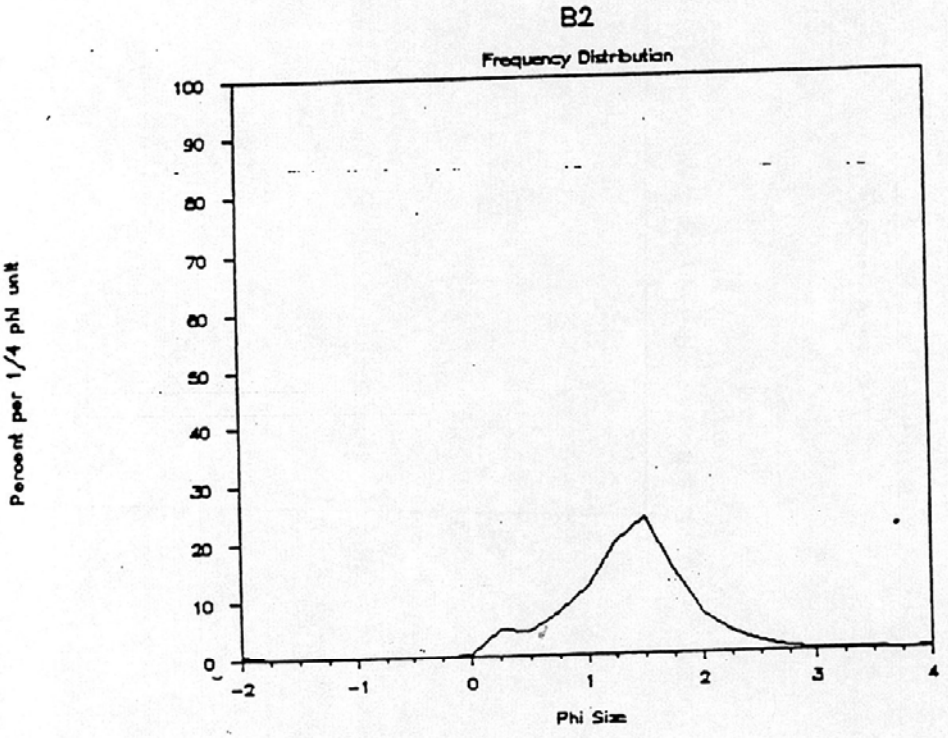


Figure 5. Particle size frequency distribution for before trawling sediment sample 2.

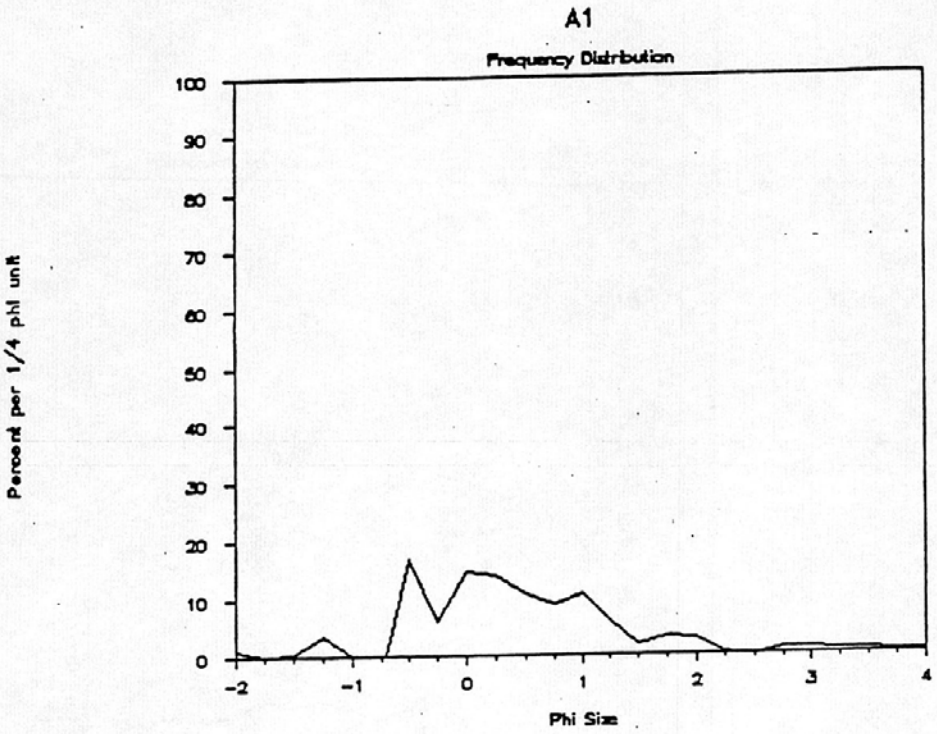


Figure 6. Particle size frequency distribution for after trawling sediment sample 1.

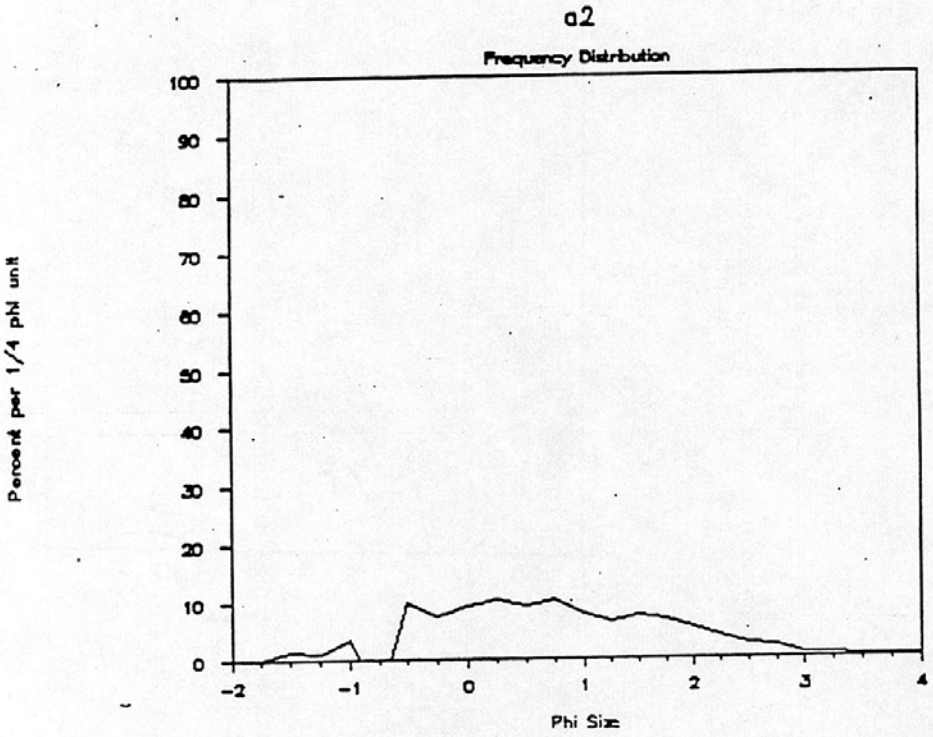


Figure 7. Particle size frequency distribution for after trawling sediment sample 2.

DISCUSSION

Composition of Scallop By-Catch

The composition of the by-catch collected consisted of 30 species of fishes and 25 species of macroinvertebrates. Species composition was broadly similar for both fishes and invertebrates both among stations and among sampling dates, although some variability of the species list in space and time was seen, particularly due to collection of single specimens. Dominant species in the scallop trawl by-catch were similar to those collected during a previous study off Cape Canaveral. There was an 8 month trawling study in 1974 investigating the fishes collected as part of a rock shrimp survey in an area close to the stations used in the present study (G. Gilmore, unpublished data). Many of the fish and invertebrate species were the same as those collected in samples taken from calico scallop beds off the North Carolina coast (Schwartz and Porter, 1977). Gut contents of two species of batfishes (Winans, 1975), two species of lizardfishes (Prappas, 1985), and three species of flatfishes (Eames, 1985) which were collected during the rock shrimp survey, and also in the present study, have been described.

The magnitude of the by-catch from commercial scale operations can be estimated based on the estimated catch weight of the typical experimental trawl. Mean biomass of by-catch per trawl was 8.8 kg in February, 3.6 kg in June and 1.1 kg in Sept. McGuffey (1984) gives the range in weight of a typical commercial scallop boat deck load as from 20.0 to 31.3 tons. With the "half size" trawl landing a load of approximately 0.5 ton, the estimated magnitude of the by-catch in

commercial scallop landings would be 354 - 528 kg for February, 146 - 218 kg for June, and 44 - 67 kg for September. On the basis of percent of total trawl weight, the maximum estimate would be 1.5% for the by-catch.

There were no statistically significant differences in by-catch abundance between day versus night hauls for all samples combined, although abundances were consistently higher during the day on all cruises. Species composition between day and night hauls was similar on all cruise dates, with most differences resulting from the capture of individual specimens among the fishes.

There were no statistically significant differences in numerical abundance of total by-catch or of the fish component of by-catch among sample dates. Although not significant, the consistent trend was a decrease in the mean number and mean biomass of by-catch per haul moving from February to September. While this trend may be a result of normal seasonal changes, the fact that there was also a continued decrease in the scallop resource during this period, which may have negatively affected the food supply for some species, may also have played a role.

It is possible that the bothid flatfish populations may be negatively impacted by the scallop fishery given their abundance in the scallop trawls and their tendency to be damaged during trawling (below). During the period of maximum flatfish abundance in the by-catch in February, the mean number per haul of approximately 30 fish (Table 3) would translate into an estimated catch of 1200 - 1800 flatfish (49 - 89 kg) per commercial scallop load. Total portunid

crab landings in a commercial scallop load, based on the maximum values obtained in February (Table 3), would be estimated at from 3640 - 5460 individuals or 112 - 168 kg. Without knowledge of the population dynamics of these groups it is difficult to evaluate the importance of this level of mortality.

The species collected as by-catch in the scallop trawl do not, for the most part, appear to be species for which there are commercial fisheries. For example, Bothus robinsi, does not reach a maximum size sufficient to be important commercially (Topp and Hoff, 1972). There would also not be a recreational fishery demand for most species collected. While Callinectes sapidus was taken in the trawl, numbers of the portunid crabs were dominated by other portunids, particularly Portunus spp., which are not commercially fished. This would suggest that by-catch from the calico scallop fishery may have relatively low impacts on species of commercial or recreational importance.

Survival of Scallop By-Catch

The use of trawl nets for fishing inevitably results in the collection of organisms not targeted by the fisherman. After a target species is removed, the by-catch in many fisheries is typically discarded over the side (van Beek et al., 1990). It has been suggested that virtually all discarded by-catch are dead, but research indicates that considerable survival can occur, although this is a function of trawling duration and handling times (Wassenburg and Hill, 1989), gear type (van Beek et al., 1990) and taxon (Berghahn, 1990; Hill and Wassenburg, 1990).

For the by-catch from the scallop trawl, survivorship varied primarily with regard to the taxonomic composition. The bothid flatfish which composed a major portion of the fish component of the by-catch on all sample dates showed low survival compared to other groups. Only 58% of specimens showing signs of life and placed in holding tanks survived for 4 hr. Estimated total survival of bothid flatfish for all cruises (total number surviving trawl + 4 hr in tank/ total number collected) was only 4%. Flatfish commonly were observed with large areas of scale damage and many specimens were dead before they could be removed from the considerable amounts of shell material retained by the trawl. Other groups with relatively poor survivorship included the bluespotted searobin (38% survival in tanks, 2.5% total survival), the sand perch (14% survival, tank = total survival), and the lizard fish (0%, tank = total survival, sample size was small).

Species with stouter bodies or other protective elements fared much better in terms of post-trawl survivorship. Survival of such groups as the batfishes (Ogcocephalidae) and scorpionfishes (Scorpaenidaë) was 100% for specimens placed in tanks. Total survival was considerably less, however, with 27% and 20% survival for batfishes and scorpionfishes, respectively. Other species which survived the rigors of the scallop trawl relatively well included the scrawled cow fish (100%, tank = total survival), the black edged moray (100%, tank = total survival), and the rock sea bass (100% tank, 50% total survival), although the total number of specimens tested for these species was low.

Decapod crustaceans generally survived the scallop trawling

relatively well due to the protection provided by the heavy exoskeleton. Even the smaller portunid species, which possess a less heavy carapace than such species as the shame faced crab Calappa flammea and the spider crab Libinia emarginata, were able to survive the scallop trawl, although some specimens were damaged or crushed by the mass of shell material typically brought up in the net. Overall, crustacean survival for 4 hr in the holding tanks was 94%.

There was no indication from the survivorship data of differences in survivorship that were dependent on the time of year of the scallop trawling.

A high mortality for flatfish in the by-catch of trawl nets has also been described by van Beek et al. (1990). Experiments examining the survival rates of plaice (Pleuronectes platessa) and sole (Solea solea) discards were carried out on board trawlers operating under normal commercial conditions. The condition of plaice discards was poorer in beam trawls compared to otter trawls, indicating the importance of gear type to by-catch survival. In both methods, the condition of both plaice and sole decreased with increased trawling time. Discard survival was estimated between 0 and 50% in plaice and between 4 and 40% in sole. Higher survival rate occurred with conveyer belt catch processing as opposed to traditional methods. While holding times were longer in the experiments of van Beek et al., mortality of flatfish from the experimental scallop trawling of the present study were of similar magnitude.

Kelle (1977) studied the injuries of undersized plaice and dab (Limanda limanda) collected as by-catch from the German shrimp

fishery. Hemorrhages in the brain were the dominant (>50%) injury. Lab experiments demonstrated that injuries and death were a result of stress by chasing of the fish and hindered respiration which reduced blood oxygen and led to brain hemorrhages.

Several studies have indicated that the ecological effect of the discards from trawl fisheries is a tendency to transfer organic material from the bottom to the surface where it is made available to surface scavengers such as seabirds (Berghahn, 1990; Hill and Wassenberg, 1990; Wassenberg and Hill, 1990). Sharks, dolphins and seals have also been indicated as benefiting from trawler discards (Berghahn, 1990; Hill and Wassenberg, 1990)

It is important to note that the conditions of the survivorship experiments in the present study represent the theoretical optimum survivorship for species in the by-catch for scallop trawling. This is due to the fact that specimens with signs of life were immediately removed from the trawl contents and placed in seawater. The stress on by-catch species during the experiments is not representative of commercial conditions, since in commercial operations the by-catch is not returned to the water (McGuffey, 1984). The entire trawl contents are generally returned to shore for sorting at the packing house. Therefore it is highly likely that under commercial practice, all by-catch would be dead.

The survival experiments provide information on the species and percentages which might be saved providing a conscientious effort were made under industrial conditions to return by-catch to the water. Such efforts would require at-sea sorting of catch and would probably

require major vessel modifications and the installation of mechanized sorting equipment to be feasible on a commercial scale. Because the modified shrimp trawlers can easily convert to working the shrimp fisheries if scalloping becomes unprofitable, vessel owners have been reluctant to make any additional changes to their vessels (Sainsbury, pers. contact). However, the considerable stability problems experienced by the scallop fleet (McGuffey, 1984) would be helped if the after deck load were reduced through sorting at sea. Modification of vessels to achieve this could be expected to involve a mechanical sorting table, fed from a hopper into which each haul is emptied, with only the useful catch being retained. Such equipment is used in other fisheries worldwide, and could be adapted for this purpose. Careful attention to stability and loading problems would be needed to design a system suitable for installation on the vessels. However, a properly designed system would combine benefits of improved vessel safety with increased survival for the by-catch.

Effects on the Bottom Community

In addition to the potentially significant effects resulting from by-catch mortality, trawling gear can result in disturbance to the benthic ecosystem (Caddy, 1973). Disturbance of the sea floor could conceivably result in alterations of the species composition and hence the productivity of the benthic organisms which are supporting demersal fishing resources.

The calico scallop tends to occur on medium sand substrate, often on bottoms with a high percentage of shell material present (Allen and Costello, 1972). The abundance of shell material brought up in the

scallop trawl at the sampling stations examined in the present study are consistent with this observation.

The examination of the effects of scallop trawling in the present study was limited. There was no evidence for a decrease in either abundance or species richness immediately following scallop trawling. This was true in spite of the fact clear alterations in sediment properties were caused by the trawling activities. The observed shift of sediment grain size distribution to larger particle sizes after trawling was somewhat unexpected. The most likely mechanism to explain the transition from finer to coarser sediments following trawling would be for there to have been a relatively shallow layer of sand overlying shell deposits. The action of the heavy scallop trawl may have removed a portion of the upper sand layer, revealing coarser shell material lying below.

Riemann and Hoffman (1991) examined the effects of mussel dredging and eel trawling in the Limfjord, Denmark, by comparing areas experimentally fished with nearby unfished reference areas. Both dredging and trawling significantly increased suspended particulate matter immediately after dredging, with a return to normal levels after 60 min. Ammonia increased after both dredging and trawling, but horizontal variations made interpretation of this parameter difficult. Oxygen significantly decreased in the dredged area, particularly near the bottom. For nitrate, phosphate and silicate, only silicate increased after dredging, although not significantly. Trawling generated no significant increases in these nutrients.

The effects of experimental scallop dredging on the physical and

biological characteristics of a shallow (10 m) sand bottom community in Scotland were examined by Eleftheriou and Robertson (1991). While bottom topography was altered, there were no significant effects on grain size distribution, organic carbon content or chlorophyll content. Mobile infauna of the sediments were not affected by dredging. Sessile infaunal forms, and larger epifaunal species such as echinoderms and crabs, were strongly decreased in the dredge area.

The effects of trawls as contrasted with dredges on the benthos may be somewhat different. Significant decreases of two dominant infaunal polychaete species were seen following experimental shrimp trawling on an intertidal sand flat in Germany (Vorberg, 1991). A study of trawling effects in a Swedish fjord found no significant differences for any benthic group between areas subjected to and protected from commercial trawling (Tunberg, 1990).

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Appendix K. Marine Fishes of the Calico Scallop Community and Inshore Reef Fish Community Off Cape Canaveral, Florida

MARINE FISHES OF THE CALICO SCALLOP COMMUNITY AND INSHORE REEF COMMUNITY OFF CAPE CANAVERAL, FLORIDA

George C. Miller

ABSTRACT

Fishes were taken at two stations in 20 and 22 m off Cape Canaveral. The species taken on a calico scallop bed by trawl were of the calico scallop community while those occurring in cages were of the inshore reef community. The trawl fishes were similar in species and occurrence to those reported by Struhsaker (1969) and Schwartz and Porter (1977) from the South Atlantic coast of the United States. The fishes caught in cages off Cape Canaveral were of the inshore reef community and were nearly identical to those reported in the northern Gulf of Mexico by Hastings, Ogren, and Mabry (1976).

The largest numbers of species and fishes occur on or near the scallop beds in summer and early fall when a large mortality of the calico scallop occurs. Terminology used by Struhsaker (1969) is discussed and changes made.

INTRODUCTION

The fish fauna of the different shelf depth zones along the south Atlantic coast of the United States have been sampled extensively using trawls and dredges (Anderson, 1968; Anderson and Gehringer, 1965; Barans and Burrell, 1976; Bearden and McKenzie, 1971; Bullis and Thompson, 1965; Keiser, 1976; Schwartz and Porter, 1977; Struhsaker, 1969). Trawls and dredges when used in a normal towing time (usually greater than 15 minutes) are none-selective, taking fishes from different communities, habitats, and depth zones.

During a study of the calico scallop biology on the Cape Canaveral grounds in 1970 and 1971 by personnel of the NMFS Miami Lab an opportunity occurred to sample by trawl directly on a calico scallop bed of commercial importance. The fishes of the calico scallop community could then be compared to fishes taken in cages (which simulated an inshore reef community) from the same locations.

The purpose of this paper will be to list the fish species captured or observed at two locations off Cape Canaveral; list the species abundance, relative occurrence, and seasonal occurrence of fishes taken by trawls and cages; and compare the calico scallop community fishes and inshore reef community fishes off Canaveral with similar studies in other areas.

Calico scallops on the Cape Canaveral calico scallop grounds are generally found on a sand or shell bottom. From surveys made using a Remote Underwater Fisheries Assessment System (RUFAS) sand is the predominant bottom type on the grounds.

Scallop abundance on the grounds may be classified into five catagories: (1) non-existant; (2) widely scattered singles; (3) low commercial concentrations; (4) medium commercial concentrations; and (5) high commercial concentrations (from David Sutherland, NMFS, verbal communication).

Calico scallops in beds of commercial concentration harbor not ony a distinct community associated with their values (Wells, Wells, and Gray, 1964) but also an invertebrate and vertebrate community associated with the scallop bed (Schwartz and Porter, 1977). When a calico scallop bed disappears from an area, the community composition and food habits of the animal existing there also changes (Hulings, 1961; Hulings and Hemlay, 1963).

Location. Two stations were chosen for the calico scallop biological investigations on the Cape Canaveral grounds. The criteria for the selection of the first site, because it was to be marked by an unlighted Coast Guard buoy, were the following: 1) inshore, where unlighted buoys could be placed; 2) in an area previously described as having calico scallops in commercial abundance; 3) in an area where calico scallops were presently found; and 4) in a depth at which SCUBA divers would have sufficient work time on the bottom.

A site meeting these conditions was found between Cape Canaveral and Ponce de Leon Inlet. At this location there was a strong shoreward intrusion of the 18 m (10 fm) line. A Coast Guard buoy, designated Buoy 1, was located 5.4 nautical miles offshore, at 28°48.5'N lat, 80°38.6'W long, in 20.1 m (11 fm) (Figure 1).

The second site differed in that it was to be marked by a lighted Coast Guard buoy. The requirements for the second site follow: 1) it would mark a calico scallop bed of heavy commercial concentrations; 2) it would be located in deeper water east of Buoy 1; and 3) it would occur at a depth shallow enough for SCUBA observations.

The second station, designated Buoy 2, was located 13.8 nautical miles offshore, 8.4 nautical miles east of Buoy 1, at 28°49.6'N lat, 80°29.2'W long, in 21.9 m (12 fm).

Description of Station. Buoy 1 station occurred on the south side of a major reef. The bottom at the station was relatively smooth and sandy. Immediately to the north of the station the bottom was of hard, flat sand conglomerate rock, slightly elevated above the sand surface. A prominent

reef, with a pronounced drop-off ledge, occurred 1/3 mile NNE of Buoy 1. South of Buoy 1 the bottom was smooth and sandy. The reef was fished by commercial fishermen, but was not shown on Map II of this area given by Moe (1963).

Buoy 2 station was located on a fine white sand bottom, immediately east and adjacent to a major calico scallop bed. Trawls made to the north, east, and south of Buoy 2 were on sand bottom, and produced few or no scallops. A major bed of sand dollars occurred ESE of Buoy 2. West of Buoy 2, a calico scallop bed of commercial concentration was found on a live-shell bottom.

Gear. A small shrimp trawl (trynet) was modified and used for sampling the scallop bed. The trawl was used at Buoy 1 only on the beginning cruises. Its use was abandoned due to the small numbers of scallops and fishes caught, and the hard untrawlable bottom at this location. One trawl and set of trawl doors were used during the entire investigation at Buoy 2. A trawl's life period was one 5-minute drag on a scallop bed without the modifications by chafing gear.

The trawl's description and measurements follow: trawl of nylon webbing, 35 mm stretched mesh; headrope 395 cm; ground rope 360 cm, weighted with 40 mm link chain; single tickler chain, between trawl doors, 400 cm of 40 mm links; ground rope covered and protected by 10 mm polypropelene rope; bottom of net protected by heavy 35 mm mesh chafing gear; and trawl doors heavy, 44 x 76 cm.

Cages of various size mesh were used to hold scallops for growth, density, and mortality studies. The cages between sampling periods became encrusted with sessile organisms, such as barnacles, corals, and tube

worms, producing a reef-like niche. Many fish which adopted the cages as homes when smaller than the mesh size were unable to leave when their growth prevented escape through the cage mesh. The minnow cages were placed within other cages for protection.

The following type cages and their dimensions were used during the study: Ca-A, triangular cage, 61 cm base, 53.5 cm height, 80 cm length, of 6.6 mm square mesh hardware cloth; Ca-B, 2 meter cage, rectangular, 100 cm width, 200 cm length, 40 cm depth, of 13.5 mm square mesh hardware cloth; Ca-C, fish cage, rectangular, 94 cm width, 72 cm length, 46 cm depth, of 22 x 30 mm chicken wire; Ca-D, open insert cage, 53 cm width, 87 cm length, 30 cm depth, open with 9-11 cm between supporting bars; and Ca-E, cylindrical plastic minnow cage, 43 cm long 23 cm diameter at center, 16 cm diameter at ends, of 3.6 to 4.9 mm mesh.

Sampling Periods. During the time period from March 30, 1970, to October 27, 1971, 12 cruises using four different vessels were made to Buoys 1 and 2 off Cape Kennedy. The time between cruises varied from four to eight weeks. The first four cruises in 1970 were: Bowers Cr. 90, March 30-April 1; Bowers Cr. 92, May 28; Riptide, July 21-24; and Dan Moore, August 26-28. The remaining eight cruises may be seen in Table 3.

Methods of Sampling. (1) Trawls. All nets were set 100 meters west of Buoy 2 and drags were made on a due west course for five minutes. Two tows were made on each cruise on the scallop bed. All drags were made during daylight hours, with the exception of one night tow on Bowers cruise 90. All fishes were not saved on the first two cruises but were on the following cruises. Fishes when grouped for relative occurrence in the catch (because of the small number of tows of short duration) were considered as a single tow for each cruise. Fishes taken on 50% of the cruise

(6 or more of 12) were classified as very common; common, 25% to 49% (3 to 5 cruises); and as uncommon, when less than 25% (1 or 2 cruises). Occurrence of fish in the trawl catch at Buoy 1 was disregarded as trawls were made only on the beginning two cruises.

(2) Cages. Cages were attached at varying intervals to a polypropelene rope groundline, anchored at each end by a heavy weight with a buoy line to a surface float. At Buoy 2 the cages were placed out immediately west of the buoy, and at Buoy 1 to the north. Some drift of the arrays did occur in very bad weather. The cages were recovered twice immediately south and once west of Buoy 1, and once south of Buoy 2.

On each cruise the cages Ca-C and Ca-E were replaced. Cages Ca-A, Ca-B, and Ca-D were cleaned of fouling upon recovery and were returned to the water on the same cruise. In the specimens collected on the last trip the data lists old Ca-C cages. These cages were put out at Buoy 2 on the Dan Moore cruise, 27 August 1970, and were not recovered until Bowers cruise 108, 27 October 1971. All fishes were saved unless noted otherwise in the data.

(3) Observed. Species that were observed from the vessel or by SCUBA divers are listed. Some species recorded as found on the ships deck near cages and buoy lines were probably within the cages and fell out.

SPECIES OF FISHES COLLECTED OR OBSERVED

The species of fish collected off Cape Canaveral during the calico scallop biological investigations, 1970-1971, are given together with the station collected, type of gear, vessel and cruise number followed by the number of specimens and size range (SL) in parentheses. Fishes below 100 mm were measured to the nearest 0.1 mm while those above were measured to

the nearest 1.0 mm. The smaller sizes were rounded to the nearest millimeter in Appendix 1. The total length was measured for the rays and eels, and from top to bottom for seahorses. The species caught in relation to time sampled may be seen in Appendix 1.

CONFUSING TERMINOLOGY

The terminology used by Struhsaker (1969), although well defined, is confusing for the following reasons. The term habitat as applied to the continental shelf were not habitats but shelf depth zones. The Coastal Zone ranges from 0-18 m (0 to 8-10 fms); Open-Shelf Zone from 18-55 m (10 to 25-30 fms); Shelf-Edge Zone from 55-110 m (30 to 60 fms); and the Lower-Shelf Zone 110-183 m (60 to 100 fms). In using these areas as zones it is then not necessary to classify a habitat within a habitat, e.g. Live-Bottom Habitat within the Open-Shelf Habitat, of Struhsaker (1969).

Struhsaker (1969) adequately described the reef habitat and distinguished two types of reef fauna: the inshore reefs of 10 fms which harbor black sea-bass; and the intermediate reefs from 13 to 23 fathoms which harbored subtropical and tropical fishes. Unfortunately, he gave the name Live-bottom Habitat to the Reef Habitat.

It is my opinion that Struhsaker did not distinguish between the abundant fauna of the benthic Live-shell habitat and that of the low elevated reef habitat. The Live-shell habitat consists of live mollusks in moderately dense concentrations in beds on sand and recently dead-shell substrate. Off Cape Canaveral the calico scallop is the chief provider of this habitat and the calico scallop community is the chief occupier. The habitat provides haven for not only sessile organisms which occur on the valves up off the bottom, but provides refuge for many marine animals

which hide under the recently dead, cupped valves.

A third habitat, which I call the Dead-shell habitat, is the result of an expired mollusk community and harbors a depauperate fauna. The scarcity of organisms in this habitat is believed due to the following: the flat, eroded shell fragments are not elevated high enough above the substrate to support a micro-reef community; the small fragments are so flat and compacted there is little or no space for an animal to hide beneath them; and small marine animals which depend upon burrowing cannot bury themselves easily in the hard substrate.

In this paper reference made to the inshore reefs are to the reefs occurring in 14 fathoms or less.

FISHES OF THE CALICO SCALLOP COMMUNITY

The species of fishes taken directly on the scallop bed at Buoy 2 offshore differed primarily from those taken in cages at Buoys 1 and 2 and by trawls at Buoy 1. On the scallop bed 38 species were captured by trawl of which 28 species were never caught in cages.

Abundance. A total of 318 fish were taken by trawl of which 10 species accounted for 76.7% (244 fish) of the total catch (Table 1). Prionotus roseus was the most abundant fish taken on the bed (19.5%) and was considered to be the leading member of the calico scallop community.

Relative Occurrence. For a comparison with our study and that of Struhsaker's (1969) the fish species in Table 5 of Schwartz and Porter (1977) were classified as very common if they occurred in 50% or more of the total monthly samples, common in 25% to 50%, and uncommon in less than 25% of the total months sampled.

Twenty of the most common fishes taken by trawl and cages in our study were compiled for a comparison with studies by Struhsaker, 1969 and Schwartz and Porter, 1977 (Table 2). It may be seen in Table 2 that some species were shared by both communities while other were specific to a single community.

A good correlation was found to exist in relative occurrence between species caught off Cape Canaveral and the two studies previously mentioned with only a few exceptions.

Scorpaena calcarata was listed as being uncommon by Struhsaker (1969) while in the other two studies it was very common. Struhsaker, however, listed Scorpaena brasiliensis as being very common whereas in Schwartz and Porter (1977) it was uncommon and it was only common in our studies. It is possible that S. calcarata specimens were misidentified as S. brasiliensis by Struhsaker's identifiers.

Prionotus roseus was very common in Struhsaker's (1969) study and ours. Schwartz and Porter (1977) did not list this species in their yearly study 1972 and recorded only 2 specimens in 1971. Prionotus scitulus, however, was very common in Schwartz and Porter's (1977) study and was uncommon in ours. Prionotus scitulus in Florida is uncommon beyond 10 fathoms on the Florida east coast and is common in estuaries. This species is typical of the sand-mud inshore sciaenid community. It would appear from the sciaenids and bothids in the catch that the inshore sciaenid commonly extends to a greater depth off North Carolina than in Florida.

Halichoeres caudalis occurred seasonally on the scallop bed at Cape Canaveral and off North Carolina when a scallop mortality occurred

(Schwartz and Porter, 1977). Hastings, Ogren, and Mabry (1976) reported that H. caudalis in the northern Gulf of Mexico was a benthic reef species associated with natural rock outcrops, or on the shell hash bottom beneath offshore oil platforms; was diurnal; and when inactive at night might bury in the sand-shell hash bottom. The species occurrence near reefs, possible buryial at night, and its ability to escape throuth the trawl mesh during long tows might account for its rarity in Struhsaker's (1969) catches. H. caudalis appears to be a reef species shared with a live-shell bottom community.

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Gobiosoma ginsburgi, a common species in the cage catch at Buoy 1 and trawl catch at Buoy 2 was not listed by either Struhsaker (1969) or Schwartz and Porter (1977). The specimens caught in cages at Buoy 1 were considerably smaller than those taken by trawl at Buoy 2. This might indicate that the juveniles and young are inshore reef fishes moving offshore onto live bottom when they mature; or that the species may feed on the calico scallop community a portion of the year like Halichoeres caudalis.

Nine species of fish were very common on the scallop bed: Synodus foetens; Centropristes striata; Monacanthus hispidus; Diplectrum formosum; Centropristes ocyurus; Syacium papillosum; Ogcocephalus sp.; Scorpaena calcarata; and Prionotus roseus. The first four species were found to feed heavily on calico scallops off North Carolina (Schwartz and Porter, 1977).

Three species of batfish are found commonly in 18 to 55 m (10 to 30 fms) on the scallop grounds off Cape Canaveral. Halieutichthys aculeatus and Ogcocephalus corniger occur offshore from the study area and were not

taken in our study. Winan (1976) found a single species of batfish fed heavily on small juvenile calico scallops from December through June and on gastropods from July through November. I presume that the batfish which Winan found to be a scallop predator was the common polka-dot batfish of our study (Ogcocephalus radiatus of Walls, 1975), or Ms. name in reference to rostrum by Bradbury, Unpubl.). The polka-dot batfish is a member of the calico scallop community and was listed by Hastings et.al., (1976 as a benthic reef species.

Syacium papillosum, a flatfish was a member of the calico scallop community and was common on the scallop grounds. Etropus rimosus was another common bothid in our study but was uncommon in North Carolina (Schwartz and Porter, 1977). A large number of bothids were listed on the scallop grounds off North Carolina, however, many of these might also be associated with the inshore sciaenid community.

Uncommon fish of interest, captured by trawling, were the following. Serraniculus pumilio was captured at Buoys 1 and 2. Schwartz and Porter (1977) extended the range of this species north to North Carolina.

Gobiesox strumosus was captured at Buoy 2 by trawling in 22 m. Schwartz and Porter (1977) listed a specimen from off North Carolina at depths from 20 to 28 m. Gilbert (1968) classified this fish as a resident species, inhabiting rocky shores, frequently in intertidal areas, and seldom occurring in water much deeper than 10 or 20 feet. It would appear that G. strumosus, along with the blenny, Hypleurocheilus geminatus, is not an uncommon fish to depths of 30 m.

The scorpion fish, Scorpaena isthmensis, was reported to occur in North Carolina by both McEachran and Eschmeyer (1974) and Schwartz and

Porter (1977). The species was not taken during our studies at Buoys 1 and 2 but was taken offshore during our faunal surveys of the Cape Canaveral scallop grounds. S. isthmensis has a distribution similar to the shrimp Penaeus brasiliensis (Farfante, 1969, Fig. 77) in extending north along the South American coast to Cabo Catoche, Yucatan, and from the Florida east coast to North Carolina. The exclusion of these species from the Gulf of Mexico is believed not due to a lack of habitat or favorable environmental conditions but due to competition with a more aggressive species.

Seasonal Occurrence. The number of species and fishes caught by station and gear for the period from November 1970 to November 1971 are given in Table 3.

The number of species caught by trawl on the scallop bed at Buoy 2 ranged from 10 to 12 from October to May. A substantial increase occurred in June and August with 15 and 19 species respectively. A similar correlation also occurred with the number of fish caught: from 16 to 39 fish from October to May; increasing to 46 and 93 in June and August.

The increase in species and numbers of fish in June and August is believed primarily not due to increased summer recruitment. During this period the water temperatures fluctuate rapidly from greater than 25°C to less than 20°C. The effects of these temperature fluctuations is an expiration of the oldest age class and mortality of the oncoming year class of scallops. Dying or dead scallops are an attractant to fish and other predators on the bed.

Fishes of the inshore reef community were captured in cages at Buoys 1 and 2. The habitat at Buoy 1 differed from Buoy 2 as the cages were placed at the southern extremity of a natural reef. No concentrations of scallops occurred at Buoy 1 with only scattered single scallops found. The cages of this station simulated a small accessory outcrop reef.

Cages at Buoy 2 were placed adjacent to the calico scallop bed. They simulated a small isolated outcrop reef. Fishes caught in cages at Buoy 2 would not be attracted from an adjacent reef but would be drifters, stragglers, or migrators who found an open niche with available food supply nearby.

Abundance. A total of 336 fish were captured in cages placed at Buoy 1 and Buoy 2 (Table 1). Ten species, comprised 91.4% of the total catch (307 fish). Over 53% of the catch consisted of the two leading species Centropristes striata and C. ocyurus. The large number of spadefish (C. faber) captured was not indicative of its occurrence but was due to a large influx of fish into the cages in two sampling periods and fast growth which trapped them.

Relative Occurrence. When the most common species of fishes occurring in cages are examined (Table 2) the two most abundant species are (Table 1) sea-bass C. striata and C. ocyurus which also occur in trawls. They were not, however, taken equally by both types of gear. C. striata occurred 15 times in cages and 3 in trawls, whereas C. ocyurus was taken 8 times by trawls and 4 in cages. This might indicate that C. striata is predominately a reef fish foraging out into the surrounding habitats while C. ocyurus is a live-shell bottom species using reefs for a juvenile sanctuary.

The other common species taken by cages D. formosum, H. caudalis, H. geminatus, P. umbrosus, A. pseudomaculatus, O. tau? (comparable to O. pardus in the Gulf of Mexico), C. faber, and H. aurolineatum (Table 2) were reported as common inshore reef species in the northern Gulf of Mexico by Hastings, et al. (1976). In addition to the common reef species listed above, the following were also taken at Buoys 1 or 2: Centropristis philadelphica; Belted sandfish Serranus subligarius; Lutjanus campechanus; Orthopristis chrysoptera; Gymnothorax vicinus; Antemarius ocellatus; Decapterus punctatus; Chromis euchrysurus; Blennius marmoreus; and Menasenthus ciliatus.

The red snapper, Lutjanus campechanus, juveniles were only taken in cages at Buoy 1 station near a natural reef. During the calico scallop biology study, other small red snappers were taken in cages in 10 fathoms adjacent to the Hetzal School reefs off Canaveral. It would appear that in the Cape Canaveral area that the natural inshore reefs of 10 to 14 fathoms are the primary niche for juvenile red snappers.

The common reef species taken by cages at Cape Canaveral, if they were not shared with the live-shell community, were generally uncommon or not taken in the trawl catches by Struhsaker (1969) and Schwartz and Porter (1977) Table 2.

Seasonal Occurrence. The species and number caught by cages were definitely biased by the type and size of cage and size of mesh. Fast growth prevented the escape of spadefish from the crab cages and also probably prevented them from entering. This same factor also entrapped gobies, blennies, and cardinal fishes in the minnow traps.

Buoy 1 Cages. When the number of species and specimens caught by sample period are examined in Table 3, the following may be seen. The number of species caught in cages at Buoy 1 from November to June was consistant ranging from 2 to 4 and then increased to 6 in August and October. This increase is believed to be normal coming from increased summer-fall recruitment.

The number of fishes caught in cages at Buoy 1 were significantly biased by large catches of spadefish in November and January (Table 3). The fish caught from March-May ranged from 3 to 8, whereas a substantial increase occurred from June to October ranging from 10 to 15.

Buoy 2 Cages. The number of species caught in cages at Buoy 2 was small ranging from 0 to 4 during the period from November to July. In late summer and early fall the number of species caught in the cages increased to 10 to 11. This large influx of fishes is believed not due to summer recruitment, but due to a scallop mortality of the older age class at this time which attracted them.

The number of fish caught at Buoy 2 were few in numbers (less than 9) from November to July with the exception of March. In March 21, specimens of a single species entered the catch. Substantial increases in the fishes caught also occurred in late summer and early fall, increasing from 27 to 74. It is believed that if these fishes had not been attracted to the dying scallops and the predators feeding on them, the number of species and fishes caught would have remained low similar to Buoy 1.

Comments. Urophycis earlli was taken trawling on the rough rock bottom north of Buoy 1. This species like H. caudalis is probably associated with rock outcrops and reefs. This would account for its rarity in the trawl catches of Struhsaker (1969).

CONCLUSION

The fishes of the calico scallop community taken by trawl on an inshore bed off Cape Canaveral were similar in species composition and occurrence to those reported by Struhsaker (1969) from the Open-Shelf Habitat (Depth Zone from 10 to 25-35 fms) off the southeastern United States, and by Schwartz and Porter (1977) from scallop grounds off North Carolina.

Inshore reef fishes taken in cages in the Cape Canaveral study area were similar in species composition to those reported under shallow-water offshore platforms in the northeastern Gulf of Mexico by Hastings et. al. (1976).

A close inter-relationship exists between fishes occupying a reef type habitat and an adjacent live-shell habitat. Species may be shared between both communities. Reef habitat may be instrumental in the formation of a live-shell bottom habitat (Hastings et. al., 1976).

The largest numbers of fishes and species occur on the calico scallop bed off Canaveral in summer and early fall. Large natural mortalities of age class I calico scallops occur at this time. Widely fluctuating bottom water temperatures caused by upwelling of slope water on the shelf during the summer may also cause heavy mortalities of age class 0 juveniles. Fishes occurring on the scallop bed may be predators directly on the scallops or on other marine organisms that are scallop predators (Schwartz and Porter, 1977).

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APPENDIX I

FISHES ASSOCIATED WITH TWO MARINE

BENTHIC LOCATIONS OFF CAPE CANAVERAL, 1970-71

RAJIDAE

Raja eglanteria Bosc: B2, B105, tr (1,120).

MURAENIDAE

Gymnothorax saxicola: B2, B90, tr (1,460).

Gymnothorax vicinus (Castelnay): B2, B108, Ca-C (1,360).

CONGRIDAE

Conger oceanicus (Mitchill): B2, B108, Ca-B (1,160)

OPHICHTHIDAE

Ophichthus ocellatus (LeSueur): B2, B90, tr (2,225-385)

SYNODONTIDAE

Synodus foetens (Linnaeus): B2, all tr, JdeV (2,233-272); B100 (2,280-300); B103 (1,231); B105 (2,234-238); B107 (1,212); B108 (2,?).

Trachinocephalus myops (Forster): B2, all tr, JdeV (2,114-117); B99 (1,112); B100 (3,111-155); B105 (1,148).

BATRACHOIDIDAE

Opsanus sp: B1, B101, Ca-C (1,112); B103, Ca-C (1,171); B105, Ca-C (5,22-120); B107, Ca-A (3,24-72), Ca-E (2,29-31). B2, B108, Ca-C (2,27-111), Ca-E (1,118). B2, all tr, B90 (3,38-97); B107 (1, 110).

GOBIESOCIDAE

Gobiesox strumosus Cope: B2, Rip, buoy rope (1,13). B2, B101, tr (1,18).

ANTENNARIIDAE

Antenmarius ocellatus (Bloch and Schneider): B2, B101, tr (1,47). B2, B108, Ca-C (1,83).

OGCOCEPHALIDAE

Ogcocephalus sp.: B2, all tr, JdeV (1,102); B99 (5,108-146); B100 (1,137); B101 (2,108-120); B103 (1,82); B105 (3,118-158); B107 (3,102-144).

GADIDAE

Urophycis earlli (Bean): B1, all tr, B90 (1,75); B92 (1,179).

Urophycis regius (Walbaum): B2, B107, tr (1,152).

SYNGNATHIDAE

Hippocampus erectus Perry: B2, all tr, B99 (1,81); B101 (1,79).

SERRANIDAE

Centropristis ocyurus (Jordan and Evermann): B1, B108, Ca-A (1,145). B2, DM, Ca-B (30,43-82), Ca-C (1,105); B107, Ca-B (7,48-59); B108, Ca-B (10,54-66), Ca-C (1,115). B2, all tr, Rip D(1,92); JdeV (1,85); B99 (1,103); B100 (1,125); B103 (1,114); B105 (2,74-120); B107 (10,50-99); B108 (1,54).

Centropristis philadelphica (Linnaeus): B1, Rip, Ca-C (1,132). B2, DM, Ca-C (1,126).

Centropristis striata (Linnaeus): B1, Rip, Ca-C (3,107-116); JdeV, Ca-C (2,119-133); B99, Ca-C (2,127-136); B100, Ca-C (7,109-120); B101, Ca-A (1,84), Ca-C (1,118); B108, Ca-A (3,120-162); Ca-C (3,105-192). B2, DM, Ca-B (15,52-81), Ca-C (10,99-119); B99, Ca-A (1,70); B100, Ca-C (21,93-119); B101, Ca-E (1,21); B105, Ca-B (8,46-59); B107, Ca-B (8,54-74); B108 Ca-B (2,56-58); old Ca-C (37,98-143). B2, all tr, Rip (1,87); B105 (1,64); B107, Ca-B (8,54-74); B108 Ca-B (2,56-58); old Ca-C (37,98-143). B2, all tr, Rip (1,87); B105 (1,64); B107 (37,39-109).

Diplectrum formosum (Linnaeus): B2, DM, Ca-B (1,73); B99, Ca-A (1,99); B107, Ca-B (1,61). B2, all tr, B105 (1,138); B107 (8,42-94); B108 (6,84-105).

Serraniculus pumilio Ginsburg: B1, B90, tr (1,66). B2, B103, tr (1,62).

Serranus subligarius (Cope): B1, B108, Ca-E (1,29). B2, B107, Ca-E (1,27).

PRIACANTHIDAE

Priacanthus arenatus Cuvier: B2, B105, tr (2,84-88).

APOGONIDAE

Apogon psuedomaculatus Longley: B1, B107, Ca-E (2, muhl-30). B2, B101, Ca-E (4,18-24); B107, Ca-E (2,15-26), Ca-B (1,37); B108, Ca-E (2,22-30).

RACHYCENTRIDAE

Rachycentron canadum (Linnaeus): B2, Rip, obs. surf (1,8 lbs).

CARANGIDAE

Chloroscombrus chrysurus (Linnaeus): B2, B108, near Ca. (2,25-30).

Decapterus punotatus (Agassiz): B2, B107, Ca-B (1,71).

Seriola sp.: B2, DM, obs. bottom (1,8 lbs).

LUTJANIDAE

Lutjanus campechanus (Poey): B1, all Ca-C, Rip (1,100); B100 (1,83).

POMADASYIDAE

Haemulon aurolineatum Cuvier: B1, B107, Ca-C (1,117). B2, B108, Ca-B (4,61-65), dd Ca-C (4,113-125).

Orthopristis chrysoptera (Linnaeus): B1, B108, Ca-C (2,135-145); Ca-A with hole (1,121). B2, B99, tr (1,165)

SPARIDAE

Pagrus sedecim Ginsburg: B2, B103, tr (1,74).

SCIAENIDAE

Cynoscion nothus (Holbrook): B2, B108, tr (1,21).

Pareques umbrosus (Jordan and Eigenmann): B1, B90, tr (2,?). B1, DM, Ca-E (1,77); JdeV, Ca-C (2,96-108); B108, Ca-A (1,112), Ca-C (1,111). B2, DM, Ca-B (7,46-86); B105, Ca-B (1,56); B107 Ca-B (1,49); B108, Ca-B (1,74), old Ca-C (5,92-123).

MULLIDAE

Mullus auratus Jordan and Gilbert: B2, B107, tr (2,93-99).

EPHIPPIDAE

Chaetodipterus faber (Broussonet): B1, JdeV, Ca-C (15,61-127); B99, Ca-C torn (22, average size 79-86)

POMACENTRIDAE

Chromis enchrysurus Jordan and Gilbert: B2, B107, Ca-E (1,21).

LABRIDAE

Halichoeres caudalis (Poey): B2, B107, Ca-B (1,54); B108, Ca-E (2,35-38). B2, all tr, JdeV (1,142); B103 (4,88-111); B105 (6,86-134); B107 (5,107-132).

Hemipteronotus novacula (Linnaeus): B2, all tr., Rip (1, 98); B100 (2,110-113); B105 (1,129).

BLENNIIDAE

Blennius marmoreus Poey: B2, B99 Ca-E (1,58); B107, Ca-E (1,25 yellow phase).

Hypleurochilus geminatus (Wood): B1, Rip, Ca-C (2,32-39); DM, Ca-E (1,38); JdeV, Ca-E (3,25-50); B99, Ca-A (4,24-38); B101, Ca-A (1,13); B103, Ca-E (1,18); B105, Ca-E (4,22-29); B107, Ca-E (2,34-46), Ca-A (2,30-40); B108, Ca-E (1,27). B2, B99, Ca=E (4,23-43). B2, Rip, sub surf. spat trap (1,15).

GOBIIDAE

Gobiosoma ginsburgi Hildebrand and Schroeder: B1, B99, Ca-A (1,24); B103, Ca-E (1,26); B105, Ca-E (1,23); B107, Ca-A (1,23). B1, B90, tr (1,24). B2, all tr, B100 (1,26); B101 (2,30-32); B107 (1,30).

SCOMBRIDAE

Scomberomorus cavalla (Cuvier): B2, Rip, obs. near surface (5, approx. 5-10 lbs).

SCORPAENIDAE

Scorpaena brasiliensis Cuvier: B2, all tr, B100 (2,72-89); B103 (1,126); B105 (1,109).

Scorpaena calcarata Goode and Bean: B2, all tr, JdeV (6,61-85); B99 (4,56-88); B100 (2,60-78); B101 (4,72-92); B103 (3,69-88); B105 (2,69-104); B107 (1,85); B108 (2,48-87).

Scorpaena sp: B2, B101, Ca-E (1,14) possibly juvenile of S. calcarata.

TRIGLIDAE

Bellator militaris (Goode and Bean): B2, B107, tr (3,49-52).

Prionotus carolinus (Linnaeus): B2, B101, tr (1,115).

Prionotus ophryas Jordan and Swain: B2, all tr, B100 (1,96); B108 (2,73-111).

Prionotus roseus Jordan and Evermann: B2, all tr, Rip (4,86-95); JdeV (13,64-84); B99 (5,70-95); B100 (4,93-106); B101 (2,58-92); B103 (1,51); B105 (20,52-98); B107 (7,67-99); B108 (6,70-97).

Prionotus salmonicolor Fowler: B1, B90, tr (5,?).

Prionotus scitulus Jordan and Gilbert: B2, all tr, DM (1,92); JdeV (2,130-165).

BOTHIDAE

Bothus ocellatus (Agassiz): B2, all tr, Rip (1,81); JdeV (2,71-73); B99 (1,86); B107 (1,83).

Bothus robinsi: B2, all tr, B107 (4,69-84); B108 (2,99-103).

Etropus rimosus Goode and Bean: B2, all tr, Rip (1,85S); JdeV (2,73-88); B108 (5,80-88).

Syacium papillosum (Linnaeus): B2, all tr, JdeV (6,77-115); B99 (3,106-121); B100 (4,110-154); B101 (2,130-145); B103 (1,89); B107 (1,197); B108 (6,73-164).

BALISTIDAE

Alvterus schoepfi (Walbaum): B2, B105, tr (1,73).

Balistes capriscus Gmelin: B2, B108, tr (1,99).

Monacanthus ciliatus (Mitchill): B2, B107, Ca-B (2,42-47). B2, B107, tr (1,65).

Monacanthus hispidus (Linnaeus): B2, all tr, Rip (2,46-60); JdeV (1,49); B99 (3,66-93); B101 (1,117); B103 (1,45); B105 (2,40-52); B107 (5,60-84); B108 (1,48).

TETRAODONTIDAE

Sphoeroides spengleri (Bloch): B2, B107, tr (1,57).

Table 1. The ten most abundant fish species in the trawl and cage catch ranked by numbers from the Cape Canaveral survey, 1970-71.

CALICO SCALLOP COMMUNITY				INSHORE REEF FISH C	
Rank	Species	No. fish	Total Trawl Fish (318) %	Rank	Species
1	Prionotus roseus	62	19.5	1	Centropristes striata
2	Centropristes striata	39	12.3	2	Centropristes ocyurus
3	Scorpaena calcarata	24	7.5	3	Chaetodipterus faber
4	Syacium papillosum	23	7.2	4	Hypleurochilus geminatus
5	Diplectrum formosum	20	6.3	5	Pareques umbrosus
6	Centropristes ocyurus	18	5.7	6	Ospanus sp.
7	Monacanthus hispidus	16	5.0	7	Apogon pseudomaculatus
8	Halichoeres caudalis	16	5.0	8	Haemulon aurolineatum
9	Ogcocephalus sp.	16	5.0	9	Gobiosoma ginsburgi
10	Synodus foetens	10	3.1	10	Prionotus salmonicolor
	TOTAL	244	76.7		TOTAL

Table 2. Relative occurrence of 20 species in the catch with comparisons to Struhsaker (S. Atlantic coast of U.S.) and Schwartz and Porter (North Carolina).

Species	Gear	Relative Occurrence		
		Miller	Struhsaker (Trawl)	Schwartz and Porter (Trawl)
Synodus foetens	Tr	VC	VC	VC
Centropristis striata	Tr, Ca	VC	VC	VC
Centropristis ocyurus	Tr, Ca	VC	VC	VC
Syacium papillosum	Tr	VC	VC	VC
Monacanthus hispidus	Tr	VC	VC	VC
Diplectrum formosum	Tr, Ca	VC	VC	VC
Ogcocephalus sp.	tr	VC	VC	U
Scorpaena calcarata	Tr	VC	U	VC
Scorpaena brasiliensis	Tr	C	VC	U
Prionotus roseus	Tr	VC	VC	*
Trachinocephalus myops	Tr	C	VC	C
Halichoeres caudalis	Tr, Ca	C	U	C
Hemipteronotus novacula	Tr	C	C	VC
Gobiosoma ginsburgi	Tr, Ca	C	*	*
Bothus ocellatus	Tr	C	C	C
Etropus rimosus	Tr	C	C	U
Hypleurochilus geminatus	Ca	VC	*	*
Opsanus tau?	Tr, Ca	C	C	U
Pareques umbrosus	Ca	C	*	U
Apogon pseudomaculatus	Ca	C	U	U

Gear: Tr - Trawl, Ca - Cage

Relative Occurrence: * = not listed, U = Uncommon, C = Common, VC = Very Common

Table [redacted] The number of species and fish caught by trawl [redacted] cages at Buoys 1 and 2, from Nover

Cape Canaveral.

Vessel and Cruise No.	Date Collected	NUMBER OF SPECIES					
		Cages Buoy 1	Cages Buoy 2	Trawl Buoy 2	Total Number of Species Collected	Cages Buoy 1	Ca Bu
Joie de Vivre	Nov. 11-12, 1970	4	0	12	16	22	
Bowers 99	Jan. 23-24, 1971	4	4	10	16	29	
Bowers 100	Mar. 16, 1971	2	1	11	14	8	2
Bowers 101	Apr. 20, 1971	3	3	11	15	3	
Bowers 103	May 25-26, 1971	4	0	11	15	4	
Bowers 105	June 26, 1971	3	2	15	19	10	
Bowers 107	Aug. 24, 1971	6	11	19	27	15	2
Bowers 108	Oct. 27, 1971	6	10	12	24	14	7

Appendix L. An Account of the Development and Economic Attributes of the Calico Scallop Fishery

The fishery for calico scallops has developed slowly and catches have fluctuated widely in all areas where commercial concentrations have been located. This is usually attributed to a combination of factors: yearly variations in the location and productivity of beds and problems of economically sorting, shucking, and eviscerating scallops because of their shape and small size.

Lack of knowledge by industry and resource agencies on the distribution and abundance of the calico scallop resource is one reason for the slow development of a commercial fishery until the late 1950s. Although calico scallops had been taken by trawl fishermen sporadically since 1949, no directed fishery developed from these early observations, partly because these trawlers were primarily equipped for shrimp fishing in different areas and depths and partly because of the absence of an established market for calico scallops.

Exploratory fishing by private organizations from 1954 to 1958 located concentrations of calico scallops in the northeastern Gulf of Mexico in the general area of Cape San Blas, Florida (Bullis and Ingle, 1959; Carpenter, 1967). Exploratory fishing by the Bureau of Commercial Fisheries from 1957 to 1960 revealed extensive beds of scallops in 19 to 46 m (62.3 to 150.9 ft) between Carrabelle, Florida, and Mobile, Alabama.

Beginning in March 1958, a large bed of scallops in 13 to 37 m (42.7 to 121.4 ft) northwest of Cape San Blas was fished commercially, at first using shrimp trawls and later with four-foot wide dredges (Bullis and Ingle, 1959). The catch was shucked by hand and during the spring and summer of 1958, four boats produced 1,200 to 2,000 gallons of shucked meats per week. By September 1958, the yield of meat per scallop had declined to the point that fishing was no longer profitable.

Between 1959 and 1975, the commercial fishery for calico scallops in the northeastern Gulf of Mexico operated sporadically. Over this 16-year period, maximum production of approximately 16,000 pounds of shucked meats (adductor muscles) occurred in 1962 and again in 1969. In 1975, landings increased significantly and peak production in this area occurred in 1976 when 1.8 million pounds of meat valued at approximately $1.2 million was produced by the 54 vessels operating in the fishery.

In 1959, calico scallops were discovered near Cape Lookout, North Carolina, by exploratory vessels of the Bureau of Commercial Fisheries (Cummins, 1971). This discovery stimulated development of a commercial fishery off Carteret County which continued sporadically to 1973. The principal scallop grounds have been located northeast and southwest of Cape Lookout in 19 to 31 m (62.3 to 101.7 ft) (Figure 8-1; Appendix A).

Scallops were first caught with sea scallop dredges which were soon replaced (in 1966) with scallop trawls. Despite higher maintenance and repair costs, trawls proved to be a more efficient means of harvest (Cummins, 1971).

Commercial production of calico scallops from North Carolina waters has fluctuated widely since 1959 when three boats produced 6,500 pounds of meat valued at $2,600 (computed as ex-vessel or dockside price of meats). Peak landings occurred in 1966 when 20 vessels operating in the fishery produced 1.86 million pounds of meat valued at $369,000.

As had been the case in 1962, 1963, and 1964, scallop production from the North Carolina grounds did not exist in 1968 and 1969. While the fishery resumed again in 1970, production was below 1966 levels and from 1974 to 1978, no production came from this area. In 1979 a productive bed was again located; harvesting occurred in 1979 and 1981.

In January 1960, large quantities of calico scallops were discovered off Daytona Beach, Florida, by the Bureau of Commercial Fisheries (Taylor, 1967). Further explorations conducted by the Bureau from 1960 to 1968 defined a 3,108 square kilometer (1,200 square mile) scallop bed lying in 19 to 74 m (62.3 to 242.8 ft) of water from the St. Johns River south to Ft. Pierce (Cummins, 1971) (Figure 8-1; Appendix A). Publication of these observations also stimulated development of a commercial fishery in this area which is referred to as the Cape Canaveral beds.

Since 1973 trawls have been the only gear employed in the fishery (Table 8-1; Appendix A). Commercial production has generally increased since 1967 when four shrimp-type scallop vessels produced approximately 21,000 pounds of meat from the Cape Canaveral beds. In 1975, production of approximately 1.4 million pounds of meat valued at $900,000 was produced by 13 vessels trawling on the Cape Canaveral grounds. In October, 1980, harvesting began on a new viable bed located about 8.1 to 9.7 km (5 to 6 mi) offshore of New Smyrna at a depth of approximately 20 m (66 ft). However, mass mortality of this bed caused fishing to cease by January 1981, and the fishery moved to other productive beds located in the Cape Canaveral area. Peak production occurred in 1981 when approximately 14.4 million pounds of meat valued at $13.6 million were produced by about 75-150 vessels trawling on the Cape Canaveral grounds.

South Carolina's first commercial scallop bed (Anderson and Lacey, 1979) was located in June of 1977 approximately 97 km (60 mi) offshore of the South Carolina-Georgia border. In early January of 1978, seven scallop trawlers moved up from Florida and began harvesting scallops from the South Carolina beds in depths of 37 to 45 m (121 to 148 ft). By March of 1978, approximately 45 major vessels from Florida, North Carolina, Georgia, and South Carolina were actively involved in this fishery. Numerous other fishermen, particularly shrimpers, entered the fishery toward the end of the harvest, attracted by the size and quality of the beds. A total of 611,000 pounds of meat valued at $803,000 were harvested during 1978. Commercial activity continued through mid-May until production was drastically reduced due to meat size reductions during spawning. In the fall of 1981, another bed of scallops was located off South Carolina.

Three boats landed over a thousand bushels in two days during January 1982. Scallop explorations have historically been very limited offshore of Georgia, although small numbers of calico scallops have occasionally been found by shrimp trawlers and during research cruises. During 1979, large amounts of calico scallops were harvested off Key West adjacent to the Dry Tortugas shrimp grounds, shifting some activity from the Cape Canaveral beds.

THE COMMERCIAL FISHERY

The domestic fishery for calico scallops is entirely commercial. Natural fluctuations in the abundance of the resource have precluded development of a long-term, directed fishery for calico scallops in many areas where concentrations have been located. Consequently, much of the commercial production has been by shrimp fishermen who have fished for scallops, when they are available, as an alternative to shrimp fishing during poor seasons or as means of supplementing their income during the off season. (R. Cummins, Fishery Management, NMFS, S.E. Center, Charleston, S.C.; pers. comm.) has estimated that between 40-50 shrimp vessels engaged in the calico scallop fishery on a part-time basis in the early 1980's.

An exception to this is off the east coast of Florida where, due to the large size of the Cape Canaveral beds, commercial production has occurred fairly consistently since 1967. In this area, up to 10 factory-type vessels, which were specially equipped for processing calico scallops,

have been engaged in the fishery intermittently since 1969. During 1980, one factory-type vessel was fishing in the area and plans were made for two more to enter the fishery in the spring of 1982. Currently there is one at-sea processing vessel in the fishery.

During 1980 and 1981, the number of vessels harvesting scallops increased to between 75 and 150. These numbers included 15 processor owned shrimp vessels which had been rigged for use in the calico scallop fishery out of Cape Canaveral. More recent information from scoping meetings and the Council's Calico Scallop Advisory Panel indicates there are approximately 25 vessels currently operating in the fishery.

VESSELS AND GEAR

Three basic types of vessels have been used in the calico scallop fishery. They, in turn, have used three types of gear with some interchange of gear between vessel types. These are shrimp trawlers, scallop vessels designed for use in the sea scallop fishery, and specialized calico scallop vessels with processing equipment aboard. The first two vessel types have basically sought to land shellstock (i.e., intact scallops including shell, viscera, and edible adductor muscle meat after sorting from debris) for processing ashore. The specialized calico scallop vessels are designed to produce scallop meats with the shucking and evisceration done at sea. The gear used has included modified otter trawls, modified sea scallop dredges, and calico scallop dredges (Figure 8-2; Appendix A).

Almost all of the calico scallops harvested commercially in recent years have been taken by shrimp vessels using modified otter trawls. These offshore shrimp trawlers have wood, aluminum, steel or fiberglass hulls and generally range from 15.2 to 25.9 m (50 to 85 ft) in length. Many of the newer, larger offshore vessels (22.9-27.4 m; 75-90 ft in length) are double-rigged for towing two nets simultaneously (Figure 8-3; Appendix A). Typically, the vessels are diesel-powered with pronounced variations between length and horsepower in single and double-rigged vessels. Generally, the vessels in the 15.2-21.3 m (50-70 ft) class are powered by 100-200 horsepower diesels. A large portion of the vessels are equipped with electronic navigational and fish finding aids. Cost of vessels depends upon size, date of purchase, and amount of equipment on board.

Calico scallop landings by vessel size category from 1994, 1995, and 1997 were provided by Martha Norris, FL DEP (Table 4); there were no landings in 1996. Data were provided for vessels less than 50 feet, 50-59.9 feet, 60-69.9 feet, 70-79.9 feet, and 80-89.9 feet. In order to not show confidential data, landings were combined into the two vessel size categories shown in Table 4. The "Unknown" category includes landings by Florida Salt Water Products Licenses (SPLs) with no associated vessel information. Vessels in the 70-89.9 foot category harvested approximately half of calico scallops landed between 1994 and 1997. In 1994 there were two vessels under 50 feet, one in 1995, and none in 1997. In fact the smallest vessels harvesting calico scallops during 1997 were in the 60-69.9 foot category.

Table 4. Calico Scallop Landings by Vessel Size Category. Source: Martha Norris, Department of Environmental Protection, Florida Marine Research Institute, Division of Marine Resources. July 29, 1998. Note: Pounds are in meat weight.

VESSEL SIZE CATEGORY	YEAR					
	1994		1995		1997	
	POUNDS	# DEALERS	POUNDS	# DEALERS	POUNDS	# DEALERS

UNKNOWN	1,411,480	27	252,784	8	604,768	12
<70 FT	1,319,384	11	161,416	6	67,424	4
70-89.9 FT	2,258,736	17	530,893	10	873,100	11
TOTAL	4,989,600	55	945,093	24	1,545,292	27

Trawls

The otter trawl used in the shrimp fishery basically consists of: 1) a cone-shaped bag in which the shrimp catch is gathered in the tail or codend, and 2) trawl doors or otter boards at the extreme end of each wing for holding the wings apart and the mouth of the net open. The trawl doors are attached to the net by top and bottom leg lines on each wing of the trawl.

The following description of a scallop trawl is from Rivers (1962). The otter trawl net commonly employed in the calico scallop fishery is similar to the two-seam, semi-balloon design used in the shrimp fishery with modifications to maximize contact with the substrate while minimizing damage to the net's webbing. Unlike the otter trawl nets used in the shrimp fishery, the scallop trawl net was designed so that it fishes with either side down, i.e., there is no overhang, and top and bottom sections are identical (Figure 8-3; Appendix C). This feature increases the longevity of the equipment in that when the original bottom section becomes worn, the trawl may be turned over so that the relatively unworn top becomes the new bottom. The 7.6 to 10.7 m (25 to 35 ft) scallop trawl nets are fitted with a "Texas drop chain" on the footrope and one to three "tickler chains." The latter chains are stretched across the mouth of the trawl and attached near the trailing bottom corner of each door.

The Texas chain, similar to that used on shrimp trawl nets, consists of a length of chain cut one foot shorter than the length of the leadline and fastened to it at regular intervals by 2, 4, or 6-link chain drops. The extra "tickler" chains used on the scallop trawl are designed to increase the scraping and digging action of the trawl.

The belly sections of the scallop trawl are short so that the amount of webbing exposed to wear is as small as possible. Both the nets belly and the tail-bag are reinforced with heavy chafing gear of polyethylene strands or automobile innertube strips in order to decrease the shearing and abrasive effects of the calico scallops on the nets. For added protection, a false belly of heavy webbing is often laced over the bottom belly of the trawl. In addition, the leg lines between the doors and net wings are relatively short in order to facilitate the funneling effect of the doors. The complete scallop rig (boards, trawl, and accessories) is fished from a single cable that is connected to the boards by a 18.3 m (60 ft) bridle of 9.52 mm (3/8-in) wire rope.

The trawl is usually set and dragged from outrigger booms in the familiar shrimp-boat fashion. Owing to its light weight and small size, the trawl is easily handled. At the end of a drag, the splitting strap is brought to the rail of the boat and hooked to the hoisting tackle. The codend is brought aboard, and the catch dumped on deck. The trawl is then reset. Any scallops that might be in the webbing above the splitting-strap beckets are left in the net until the end of the next drag, or are allowed to spill back into the water. The time that would be consumed in making a second lift of the net to shake the scallops down into the codend and bring them aboard is used more profitably in making an additional drag. By limiting drags to 15-30 minutes or less, the catches usually fit well within the codend, and little loss is experienced.

Dredges

Dredges landed significant amounts of calico scallops from Florida beds between 1968 and 1972. While some of the vessels which have employed this gear include New England sea scallopers using 10-foot Georges Bank-type scallop dredges, most of the vessels were shrimp

trawlers using scallop trawls and experimenting with tumbler dredges.

A typical calico scallop dredge is shown in Figure 8-2 (Appendix A). It consists essentially of a rectangular frame measuring approximately 2.4 m wide by 0.46 m high (8 ft by 1.5 ft). The bag is made up of 50.8 mm (2 in) inside diameter rings held together with dredge links and attached to the rectangular frame. The dredge is towed on three flexible bridles (of chain or wire rope) attached at each end and center of the frame. This feature allows the dredge to "roll over" obstructions which would otherwise damage a trawl (Bullis and Cummins, 1961; Rivers, 1962).

PROCESSING

Early in 1969 four factory-type processing vessels were engaged in the calico scallop fishery off Cape Canaveral, Florida. Two of these vessels, owned by a single firm, were steel hulled, and 26.2 m (86 ft) in length. They were powered by 335 horsepower diesels and had a cruising speed of ten knots. These vessels, and two similar ones, were equipped with culling, shucking, and eviscerating equipment capable of processing the catch as it was brought aboard by trawl or dredge. (For a complete description of this on-board processing equipment see Cummins and Rivers, 1970.) The processing time from culler to "ready for packing" required about 6 to 7 minutes. Three of the four vessels were "ice boats" which landed processed scallop meats in 10-pound containers packed in ice.

The seagoing processing machines were removed from these vessels after a few years and the reasons given are varied: the machine made the vessel unstable, the machinery was not designed for shipboard use in rough seas, and problems in maintaining constant hot water and steady temperatures (96°C; 205° F) necessary in the shucking procedure.

There is currently one processing vessel engaged in the calico scallop fishery. This vessel is owned by Mr. William H. Burkhardt who serves on the Council's Calico Scallop Advisory Panel. Mr. Burkhardt provided a detailed description and diagrams of the separation and evisceration process (see Appendix B.). Mr. Burkhardt reports that "when scallops are harvested from a typical bed, shell percentages can vary from approximately 90/10 to 10/90. On the average one half of shell stock is unwanted old dead shell. The other half becomes clean new shell once the meats are removed in steam process." Mr. Burkhardt designed the adjustable separator to do the following: "A. Select the targeted scallop size. Adjust to varying shell size/meat size with a simple mechanical adjustment. B. Immediately return to the sea alive, small scallops under the targeted size, attached spat & other species bycatch. Research has shown that most will live if quickly returned to the sea. C. Separate the clean scallops and immediately discharge overboard the mud, shell & bycatch." In Mr. Burkhardt's opinion, at-sea processing has the following advantages: "1. Reduces weight improving vessel safety. 2. Improves product quality by removing bacteria in the washing process. 3. Reduces or eliminates same species & other species bycatch. 4. Return shell to the original bed."

EMPLOYMENT

Employment in the harvesting sector of the calico scallop fishery depends, to a large extent, on the distribution/abundance of the resource which fluctuates widely on a year-to-year basis.

Since 1970, the number of fishermen employed on vessels which have participated in the scallop fishery has ranged from 32 (in 1974) to 350-450 (in 1981) over the region as a whole, including the mid-Atlantic and New England areas. For many, if not most, of these fishermen, scalloping is a part-time and/or seasonal activity which provides a means of supplementing the

income they derive from other fisheries. However, with the discovery of new beds, and the opening of new processing lines, the proportion of total income derived from calico scalloping has increased significantly. For many fishermen, during 1981, income obtained from fishing for scallops represented as much as 75 percent of the total for the year.

Machine processing has generated a sizable increase in the number of laborers in the processing houses. As of December 1981, the number was estimated to be over 200 people working nearly full time at an average of $5 per hour. Previously only a portion of total income had been derived from scalloping. During 1981, however, especially in North Carolina where shrimping was poor, a greater proportion of income was derived from processing calico scallops. In regard to total wages for processing all types of shellfish and finfish, calico scallop processing has shifted from playing a minor role to one which is fairly significant.

FISHING AND LANDING AREAS

Concentrations of calico scallops and principal fishing areas are located off North Carolina, northeast and southwest of Cape Lookout; off the east coast of Florida from Ft. Pierce northward to the St. Johns River; and in the northeastern Gulf of Mexico between Carrabelle, Florida and Mobile, Alabama (Cummins, 1971) (Figure 8-1; Appendix A).

It should be noted that the location and productivity of beds within these three principal fishing grounds fluctuate annually and, to a lesser extent seasonally, and consequently, so does the distribution of fishing effort both within these areas and over the region.

In addition to the three traditional fishing areas identified above, some commercial scalloping activity has occurred offshore of Tampa and Key West, Florida, and offshore of the South Carolina/Georgia border.

Calico scallops are generally landed at ports where suitable shore-based processing facilities are located or at ports in reasonably close proximity to fishing grounds where the scallops can be quickly unloaded and transported to processing facilities. Basically, landing ports are chosen for having four criteria: 1) a sufficient depth of water on all tides, 2) a strong dock for offloading with turning space for tractor trailers, 3) adequate fuel facilities, and 4) processing plants to handle the scallops. Ports within the management area where scallops have been landed are listed below.

North Carolina:
Beaufort/Morehead City
Sneads Ferry

South Carolina:
Georgetown
McClellanville
Mt. Pleasant

Georgia:
Brunswick
Darien
Savannah

Florida:
Apalachicola
Carrabelle
Ft. Myers
Ft. Pierce
Key West
Mayport
Port Canaveral
Port St. Joe
St. Augustine
Tampa
St. Marys

CONFLICTS AMONG DOMESTIC FISHERMEN

The calico scallop fishery of the South Atlantic and Gulf coast has been free of competition from foreign fleets and sport fishermen. However, during late 1981, the number of boats and vessels fishing the Cape Canaveral grounds increased dramatically. Estimates of the number of boats and vessels vary from 75 to 150. More recently the number of vessels in the fishery is reported to be 25 (Calico Scallop Advisory Panel and Scoping Meetings) In addition, these boats and vessels hailed from home ports along the Gulf of Mexico and the entire East Coast of the U.S. This large increase in number of boats and vessels, combined with the diverse makeup of the new entrants, resulted in stress and controversy. Competition became intense leading to near collisions, fishing in areas with large concentrations of small scallops, and fishing in areas with parasite infested scallops. Recriminations among fishermen and processors became common.

ASSESSMENT OF U.S. HARVESTING CAPACITY

U.S. harvesting capacity is largely determined by the location and availability of scallops which vary constantly. For example, if scallops are located near a suitable port for short vessel runs to and from the grounds during cold weather periods, the shellstock would be landed and trucked to all available processing machinery presently located from North Carolina to the Florida west coast. Another example is when scallops are located many miles from the nearest suitable port during warm weather. Because shellstock is normally transported on deck, operations must be conducted at night in order to preserve quality; actual fishing time is reduced by vessel running time to port. Still another example is when scallops are located near a port such as Key West where weather is warm all year and trucks are weight limited to 36,000 pounds over the Keys bridges, thus increasing freight cost and at the same time causing a reduction in the amount of sellable finished product.

In recent years some 40 to 50 vessels have been involved sporadically on a part-time basis, the number depending upon conditions in the shrimp industry. About 25 vessels work the scallop beds on a full-time basis, which includes time spent in locating new scallop beds. During late 1981 and early 1982 the number of vessels fishing the Cape Canaveral grounds varied from 75 to 150. Only one vessel had reported landings in 1998, as of July 30. Some processors in North Carolina and Florida offer a sizable reward to shrimpers who locate a commercial size bed of scallops.

Scallop production and meat yield is so variable that the only meaningful measure is the pounds of finished product (edible meats) produced. Double-rigged shrimp-type vessels typically make four or five single-day trips per week, weather permitting. Drags are normally of short duration (10 minutes or less). Vessels are paid on a yield basis (i.e., on the amount of meats processed from landed shellstock) which reportedly ranges from two pounds to as much as six pounds per bushel. When large amounts of "trash" (old, broken, or empty shells) are encountered the yield is much lower. Processors are now starting to grade according to size (meat count), with larger meats commanding high prices. It is possible for a good shellstock vessel to produce several hundred 8-pound gallons per day. When scallops are found in abundance, harvesting capacity in the U.S. has been greater than processing capacity to date. However, the introduction of several new processing lines in 1981 (North Carolina and Florida) has brought processing capacity equal to or greater than harvesting capacity.

ASSESSMENT OF U. S. PROCESSING CAPACITY

In 1978 there were some 16 scallop processing lines located in the southeastern U. S. and in 1979 and 1980 more were being built. However, much of the older equipment is outdated and some is not in operational condition. In 1980, two at-sea processing vessels were being outfitted with one or more processing lines. With the most effective updated shore-based processing equipment, steam is utilized in lieu of hot water for shucking. Some equipment is capable of sustained production rates well in excess of 100 gallons of meats per hour depending upon the size and condition of the meats and the amount of barnacle encrustation on the shells.

Patent rights are held on most of the processing equipment and there is patent infringement litigation on a continuing basis. When large increases in scallop abundance occur, temporarily processing capacity is less than available shellstock. However, during slack periods, processing capacity is greater than available calico scallops.

The development of machine processing has greatly changed the amount of effort required to process stock in relation to harvest effort. This has been referred to as the Processing/Harvesting Ratio (PHR) (Maiolo, 1982). The PHR is based on Paredes et al. (1976). Prior to machine processing, hand shuckers were reluctant to process calicos because of the size which limited financial remuneration. When they did hand shuck, it is estimated that it took 13 units of effort to process stock that took one unit of effort to harvest. This ratio has been reversed to 1:5, or one unit of effort to process what it takes five to produce (the estimates were made in terms of hours) (Maiolo, 1982).

Currently there are three land-based processors and one at-sea processing vessel (Scoping Meeting Minutes; Appendix B.). This processing capacity is more than sufficient to process the available catch of calico scallops in recent years.

ECONOMIC CHARACTERISTICS OF THE FISHERY

Prices paid to fishermen are determined on a per gallon basis, rather than per pound. However, reported statistics at the ex-vessel level are recorded on a per pound of meats basis so they will be consistent with other reported seafood prices per pound. Prices in this section can be converted to a gallon basis using 8 pounds per gallon.

The ex-vessel prices of calico scallops have increased steadily over the years for which continuous data are available, ranging from $0.20 per pound of meats for the region in 1966 to $1.49 per pound in 1979 (Table 9-1; Appendix A). Prices decreased to $1.40 per pound in 1980 and further decreased to $.95 per pound in 1981. Florida east coast prices rose from $0.38 per pound in 1967 to $1.55 in 1979 but decreased to $0.94 in 1981. Florida east coast ex-vessel prices for calico scallops were comparable to Florida west coast prices in 1975, but have been higher since that time. North Carolina calico scallop prices were lower than Florida prices after 1961 but again exceeded Florida prices in 1979 and 1981.

There is a general lack of detailed marketing data from published sources for calico scallops. Much of the limited data on calico scallops is aggregated with market data for sea and bay scallops. In fisheries statistics, calico and bay scallops were grouped together until 1962. For these reasons, published statistics for all three species are presented, and comparisons are made to provide an indication of marketing and demand parameters for calico scallops.

Florida bay scallops have been landed only on the west coast of Florida, except for 2,000 pounds on the east coast in 1978. Ex-vessel prices have shown some cyclical movement, with peaks occurring in 1961, 1964, 1968, 1973, 1976, and 1981, reaching a high of $2.86 in 1981 (Table 9-2; Appendix A). North Carolina bay scallop prices have also risen with peaks occurring about the same years, but at lower levels.

Price and quantity relationships in the entire Gulf and South Atlantic region for calico and bay scallops are shown in Figure 9-1(Appendix A). Ex-vessel prices paid to U.S. fishermen for all three species generally follow the same upward and year-to-year trends over time (Table 9-3 and Figure 9-2; Appendix A). Calico scallop prices have moved in the same direction as bay and sea scallop prices with the exception of only a few years. However, calico scallop prices paid to fishermen in the Gulf and South Atlantic the last three years have been about 40 percent of that paid for bay scallops and approximately 38 percent of the price paid for sea scallops.

Extreme price increases occurred for sea and bay scallops between 1977 and 1981 and between 1977 and 1980 for calico scallops, principally due to general inflation. U.S. calico scallop prices increased 87 percent while sea and bay scallop prices increased 127 and 82 percent respectively. However, calico scallop prices decreased significantly in 1981 and are still considerably below other scallop prices. Exceptionally large 1981 calico scallops production caused at least some of the price decline in 1981 (Table 9.1; Appendix A). The similar price trends among species suggest the three species are substitutes at the consumer level of the market system. Some of the price differentials between species at the fishermen level may be explained by transportation cost differences between production and consumption locations. However, the large differential between calico scallop ex-vessel prices and the other scallop prices is too great to be explained by transportation cost differences. One possible reason for the lower relative prices of calico scallops is a lack of a developed competitive market system because of the relatively small size of the fishery and the extreme variation in annual landings. If this is not the case, then there must be a lower consumer demand for calico scallops than for other scallops.

Regional Ex-Vessel Prices

Calico scallop prices received by fishermen in the States of Florida, through North Carolina follow the same overall trend for bay scallops (Figure 9-2; Appendix A). Bay scallop prices are, however, considerably lower in the region than for the U.S. as a whole (Table 9-3; Appendix A). Calico scallop prices are generally equal to U. S. prices because essentially all U. S. calico scallops are landed in the region. Average sea scallop prices in North Carolina are slightly lower than those in the U. S. with the exception of 1981.

Wholesale and Retail Prices

Retail prices for calico scallops are not available from published secondary sources. However, since the quantities and values of processed scallops are published at the wholesale levels, it is possible to derive estimates of wholesale prices. The wholesale price per gallon of bay scallops has been greater than for either sea or calico scallops since 1974. Prior to that time, relative bay and sea scallop wholesale prices often changed positions annually. Shucked, fresh and frozen bay scallop wholesale price per gallon was $40.08 in 1980 while sea scallop price was $32.72 per gallon.

Shucked, fresh, and frozen calico scallop wholesale price per gallon has always been lower than bay scallop wholesale price and was higher than sea scallop wholesale price per gallon only in 1976, 1977, and 1978. Calico scallop wholesale price per gallon was at its highest level in 1980 at $26.31. The value added in processing shucked, fresh and frozen calico scallops indicated that from 1975 to 1979, between $11.54 and $12.93 was added to the dockside value of each gallon processed. In 1980 this value added increased to $15.14 per gallon.

The wholesale price of all breaded, raw and cooked scallops has also increased with the high of $3.65 per pound reported in 1980 (Table 9-4; Appendix A). The wholesale price per

pound of breaded calico scallops was $2.84 in 1980, while that of bay and sea scallops was $3.73 and $3.68, respectively. Breaded calico scallops have always had a lower price per pound than sea and bay scallops.

Consumption (Taken from Profile; SAFMC, 1982

Aggregate consumption of all scallops reached a record high of 66.5 million pounds (meat weight) in 1981. Year-to-year variations in aggregate consumption is considerable with as much as 30 percent variation from one year to the next. Sea scallop consumption makes up most of total consumption and thus shows similar trends and changes in aggregate consumption. Aggregate consumption of bay and calico scallops was extremely variable from year to year. A close examination of the data suggest aggregate consumption of bay and calico scallops is essentially equal to annual domestic landings and thus is the reason for the wide annual variation in consumption.

Per Capita Consumption

Per capita consumption of all scallops reached a record high of 132 g (0.290 lb) per person in 1981. Minimum per capita consumption was recorded at 58.5 g (0.129 lb) per person in 1973. There appears to be no overall consistent trend in per capita consumption of all scallops.

Per capita consumption of sea scallops follows the pattern of aggregate per capita consumption since sea scallops make up most of total scallop consumption. Per capita consumption of bay and calico scallops is relatively low, ranging from 3.2 g (0.007 lb) in 1959 to 30.4 g (0.067 lb) in 1981. No overall trend exists and annual variations are due mainly to variations in domestic landings.

Scallop consumption does appear to be related to socioeconomic characteristics of consumers. (These per capita consumption data are for 1969; however, there is no reason to assume that they have changed appreciably by relative income groups, race, etc.) Per capita consumption by race is highest for races other than the white or black races. These are probably members of the Asian race who have an average per capita consumption of 181.4 g (0.400 lb) per person per year. By religious category, members of the Jewish faith lead with per capita consumption of 108.0 g (0.238 lb) per person. As expected, scallop consumption is positively related with income. Persons with per capita incomes less than $1,000 consume 13.6 g (0.030 lb) per year while persons with per capita incomes over $3,500 consume an average of 64.4 g (0.142 lb) per person.

Surprisingly, per capita consumption appears to be higher in the "working" class of individuals. Highest per capita consumption is by individuals in clerical and sales, craftsmen and foremen, and service workers and laborers. This appears consistent with consumption by education groups where highest consumption is by persons with a high school diploma, but less than four years of college so that income only partially explains consumption levels.

Scallop consumption is regionalized. Highest per capita consumption is in the New England area where average consumption is 85.3 g (0.188 lb) per person (Table 9-6; Appendix A). This consumption level may be due to availability or familiarity with the product. The mid-Atlantic states rank third in consumption. Per capita consumption tends to decline as one moves in from the coastal states. The lowest per capita consumption is recorded for the East South Central states.

Household Scallop Consumption

The 1977-78 Nationwide Food Consumption survey provided data with which household at-home consumption could be analyzed. Data were reported on a weekly basis

by several socioeconomic classifications. Preliminary analyses show the following scallop consumption characteristics.

Average at-home per capita consumption of scallops was estimated to be 0.191 pounds per year. This compares with an average total per capita consumption of 0.273 pounds during 1977 and 1978 (Table 9-5; Appendix A). The at-home consumption estimate, however, includes product weight as consumed. That is, weight of breading materials is included in the at-home consumption data. Thus the estimate of 0.191 pounds of scallop consumption per person is an overstatement of consumption when only scallop meats are considered. Approximately one third of processed scallop volume reported in Processed Fishery Products are breaded products. Thus the difference between total per capita scallop consumption and at-home scallop consumption is a minimum estimate of the volume of scallops consumed away from home.

Household scallop consumption is related to socioeconomic characteristics of family members making up the household. Consumption varies by location. Suburban and non-metro households both average consuming 0.44 pounds per household per year. Central city households consume approximately 7 percent less per year. Households in the Northeast consume nearly seven times more scallops per household than households in the remaining regions of the country. Household consumption in the Northeast during 1977-1978 averaged 1.259 pounds per year.

Household scallop consumption tends to be seasonal. Consumption during spring and fall months is approximately 100 percent and 50 percent higher, respectively, than consumption levels in the winter and summer months (Table 9-6.1; Appendix A). Lowest consumption occurs at 0.293 pounds per household in the winter months. Prices paid by households were highest in the winter quarter and lowest in the spring quarter. It thus appears that the seasonal nature of consumption is related, at least in part, to price variations.

Household scallop consumption is highly related to household income as was the case for per capita estimates presented in Table 9-6. The quantity of scallops consumed per household per year increased from .268 pounds for households with annual income less than $10,000 to 3.07 pounds for households with incomes in excess of $50,000

Race and education of the homemaker are also related to levels of scallop consumption. White households consume nearly twice the volume consumed by Black. Households with college educated homemakers consume 0.663 pounds per household per year compared to 0.059 pounds in households where the homemaker has an elementary school education or less. Both of these factors could, at least in part, be related to household income levels. For example, households with college educated homemakers most likely have higher incomes than those households where the homemaker has not attended college.

Utilization

Beginning inventory plus domestic landings and imports determine total stocks of scallops available for consumption. No exports are recorded in published statistics. Subtracting ending inventory from the total gives "apparent consumption" (Table 9-7; Appendix A). Supply and utilization data are not available separately for calico or bay scallops. With the exception of 1968, an increase in total supply of scallops available resulted in an increase in consumption, presumably due to negative price effects of increased supply. Ending inventories or stocks are the net effects of changes in consumption and total supply, and are apparently not directly related to size, on an individual basis of either consumption or total supply. For example, ending stocks

in 1967 were the lowest and consumption was below average, while the third largest ending stocks in 1973 were associated with the lowest apparent consumption. In other years, 1965 and 1976 for example, high ending inventories were associated with high levels of consumption.

In all years, annual consumption exceeded domestic landings. Imports have trended upward to fill the excess demand. Imports exceeded domestic landings each year between 1969 and 1977. However, after that time domestic landings have exceeded imports. Imports were 39 percent of apparent consumption in 1981.

Demand and Consumption Parameters

Price and income parameters have not been estimated for bay or calico scallops in literature published prior to this document. Price and income parameters have been estimated for sea scallops in at least three separate studies. Patterned somewhat after these estimated models, a price response equation was estimated for calico scallops for this profile. The final equation form is given as:

$$P=0.126791 - 0.186073Q + 0.005664Q2 - 0.0110961 + 0.000846Y$$
$$(-3.15)^* \quad (0.92) \quad (-0.89) \quad (6.18)^*$$

$R^2=0.91$
DW 1.84
Years of data = 1965-1980
Numbers in parentheses are "t" statistics
*Significant at the 0.01 level

where:
P = U.S. dockside price of calico scallops in current dollars per pound of meats.
Q_1 = Landings of calico scallops in the U.S. in millions of pounds of meats.
Q_2 = Landings of sea and bay scallops in the U.S. in millions of pounds of meats.
I = Imports of all scallops into the U.S. in millions of product pounds.
Y = Total personal income in the U.S. in current billions of dollars.

Notice that the new equation does not include 1981 data. Several equations were estimated but because the quantity of calicos (14 plus million pounds) was so far out of the historical range, the estimates were not realistic for any of the other years.

Several alternative model formulations were specified and estimated. However, they appeared inferior to the above specification. One model included an average annual cold storage holding variable which was not statistically significant in explaining calico scallop price variation and it resulted in double counting of at least some of the scallop supply. Several other variables were also considered in preliminary equation estimates. These were annual beginning scallop inventories and a variable for total supplies (beginning stocks plus landings and imports) of all scallops except calico. These measures of substitute products for calico scallops proved unsuccessful because beginning inventories were highly correlated with income and the aggregate measure was less explanatory.

A model of per capita scallop consumption related to price and per capita income proved unsuccessful. This model lacked statistical significance although it was patterned after a similar model for sea scallops. The most probable reason is that quantity dependent models are appropriate for data at the consumer market level or at the producer market level when producers have control over supply and have the ability to adjust production rapidly. Neither of these cases fit the calico scallop situation.

Current prices and income were used rather than deflated prices for two reasons. First, all of the current profile is presented in current prices and this is the price most frequently used by the industry. Second, models with a real income (deflated) specification do not show the total effects of price and quantity changes. That is, total price changes consist of both a price and real income effect.

Price Parameters

Based on the estimated equation for calico scallops, a million pound increase in the landings of calico scallop meats is associated with a $0.186 decrease (19 cents) in dockside calico scallop prices. This parameter estimate when valued at the means yields a price flexibility for calico scallops of -0.345 which means that a one percent increase in landings is associated with approximately a one-third percent decrease in price. The inverse of the price flexibility coefficient gives an approximated price elasticity of -2.90. Since the elasticity is greater than an absolute one (elastic), a decrease in supply will result in higher prices but a lower total revenue to the industry. (An elasticity of 1 without regard to sign is equal to unitary elasticity at which point the percentage change in price is equal to the percentage change in quantity demanded.)

A study by Altobello et al. (1977) estimated price elasticities for sea scallops ranging from -1.55 to -2.18 for the 1952-1972 time period. Another estimate by the U.S. Department of Commerce (1973) of price elasticity for sea scallops during the 1947-71 period was -0.66 (inelastic). This elasticity estimate indicates total industry revenue would be increased if supply were decreased. However, because substitutes for scallops were not included in the U.S. Department of Commerce (1973) estimate, this is likely an under estimate of elasticity. Some estimates for shorter time periods in the Altobello et al. (1977) study were also inelastic but the overall conclusion of their study was that sea scallop demand was elastic.

Assuming that calico and sea scallops are fairly close substitutes and since both models most appropriately specified gave elastic price elasticity estimates, it appears the demand for calico scallops is probably elastic. Theoretically, landings of bay and sea scallops could act as a substitute for calico scallops. Thus, the expected relationship between bay and sea scallop landings and calico scallop prices is negative. Using an appropriate one-tail test for this hypothesis results in the conclusion that there is no statistically significant relationship between bay and sea scallop landings and calico scallop prices. The relatively wide variation in U.S. prices for calico scallops in relation to bay and sea scallop landings tends to support this conclusion.

Increased scallop imports are estimated to have a negative effect on calico scallop prices. The estimated effect of $0.0ll per million pounds of imports however was not statistically different from zero.

The relatively low price flexibility (-0.345) for calico scallops suggests variations in landings will result in relatively small price changes. This indicates a relatively stable market in terms of prices. In addition, the insignificance of the effect of bay and sea scallop landings on calico scallop prices further suggests a rather stable market. The effect of the calico scallop market on markets for other scallops is likely to be insignificant because calico scallops make up a small part of the total scallop supply. This, however, may not be the case on a monthly basis when large landings would compete for shucking facilities.

Income Parameters

Estimated income parameters for both the price-supply calico scallop equation and the published consumption-price sea scallop equation are consistent in that they show a positive

relation between income levels and scallop consumption. This is consistent with the per capita consumption estimates by income class presented in the previous section for all scallops. Price-income elasticities show the percentage change in consumer prices associated with a one percent change in income. Based on the calico scallop equation, a one billion dollar increase in total U.S. per capita personal income is associated with a $.000846 increase in calico scallop prices. This parameter estimate yields an income flexibility estimate of 1.34 which means that each one percent increase in total personal income is associated with a 1.34 percent increase in calico scallop dockside prices.

Income elasticity estimates made for sea scallops by Altobello et al. (1977) ranged from +0.13 to +0.99. These estimates indicate consumer prices increase with increased incomes. However, a second study by Waugh and Norton (1969) estimated sea scallop price-income elasticities in excess of +1.8. Another estimate by U.S. Department of Commerce (1973) estimated the quantity-income elasticity for sea scallops. This estimate showed consumption to increase by 0.74 percent for a one percent increase in income.

DOMESTIC PROCESSING SECTOR

Processed Products

The shucked, fresh, and frozen category sea scallop products are significantly larger than either bay or calico quantities and values (Table 9-8; Appendix A). For most years, calico products are the smallest of the three species in quantity and value. After 1974, the quantity of fresh and frozen shucked sea scallops increased over 600 percent by 1978. Specialties also increased substantially. No trends occurred for bay and calico scallops.

The largest quantity of calico scallops in the U.S. shucked (fresh and frozen) product form occurred in 1975 at 394 thousand gallons worth $6.5 million. In 1980 a record $8.1 million of calico scallops were shucked. Calico scallops represented 25, 6 and 22 percent of the scallop frozen market in 1978, 1979, and 1980 respectively.

Processing Yield

Average yield of scallops by state and species in the South Atlantic region is shown in Table 9-9 (Appendix A). Perhaps the most interesting feature of the data is the lower yield per bushel in Florida as compared with that in North Carolina. Florida yield per bushel is lower than that in North Carolina for calico scallops in all years that yields are reported. The same is true for bay scallops for the years 1959-64 and 1970-74. However, for the years 1965-69, Florida yield is higher for bay scallops. Whether these differences, especially those pertaining to calico, are due to environmental factors and/or shucking procedures is unknown. For example, if hand shucking techniques are more predominant in North Carolina than in Florida, yields could be affected. Finally, calico scallop yields tend to exhibit a slightly downward trend over time.

More recent information on yield was provided by Mr. William H. Burkhardt to the Florida Marine Fisheries Commission at their February 24, 1998 Commission meeting (Appendix C.).

OTHER SECTORS OF THE U. S. FISHING INDUSTRY

A relationship exists between scallop fishermen and shrimpers. Economic conditions in the shrimp fishery determine the number of part-time vessels entering the calico scallop fishery. When shrimp are not being caught, or when the season is over, shrimpers are likely to enter the calico scallop fishery when beds are producing. Employment in other sectors of the fishing industry and the relationship to the calico scallop fishery are presented in Section 3.7.

INTERNATIONAL TRADE

Domestic Landings and Imports

U.S. landings of all scallops peaked in 1981 at 45.6 million pounds of meat, principally due to the large increase in calico landings (Table 9-10 and Figure 9-4; Appendix A). Part of the lower 1981 average price may be explained by large landings and part by the larger share of the lower valued calico landings in the total. Except for two short-lived increases, landings fell steadily from a previous peak in 1961 to a low of 8.0 million pounds in 1973. Landings rebounded strongly after the low in 1973. Sea scallop landings dwarf both bay and calico landings. In addition to the large increase in calico landings in 1981 from those recorded in earlier years, discovery of new beds off Coos Bay, Oregon resulted in landings of 3.4 million pounds in Oregon ports (Shellfish Market Review, June 1982).

The trend in imports is illustrated in Figure 9-3 (Appendix A). Except for relatively small downturns, quantities imported (product weight) have shown an upward trend from 1955 through 1977. Imports fell significantly from 1977 quantities of just under 30 million pounds to the 1980 quantity of just under 21 million pounds. Imports exceeded domestic landings for the first time in 1967 and continued to do so through 1977 except for 1968 despite recovered U.S. landings and average wholesale import prices of $1.88 in 1975, $2.10 in 1976, and $1.78 in 1977 (Table 9-11; Appendix A). However, since 1978 U.S. landings have exceeded imports, and by a large margin in 1981. Import prices per pound of product generally stayed below $0.50 through the 1950s and early 1960s. The first large jump occurred in 1968 to $1.08, and have ranged above $1.50 since 1972. These price movements coincide with the large apparent increase in import demand resulting from reduced domestic landings. Much higher domestic ex-vessel prices were also realized during this period (Table 9-3; Appendix A). The 1977 average import price did decline moderately from the 1976 average. Import prices, however, increased substantially in the 1978-81 period. This at least in part may explain the decrease in import quantities during the period 1978-80. It is interesting to note that imports increased in 1981, even with record domestic landings and a higher average import price.

Almost all U.S. imports were from Canada throughout the 1960s. The Canadian share of U.S. imports fell in the 1970s, in part attributable to significantly lower Canadian landings. However, imports from Canada comprise about 75 percent of total imports in 1976, and almost 90 percent in 1977. By 1981 Canadian imports dropped to just under 73 percent of total imports. During the 1970s, significantly increased quantities were imported from Iceland, the United Kingdom, and other countries. Imports from Japan remained below earlier (1950s) levels and were not reported separately in 1978 or 1979. However, imports from Japan in 1981 equaled some of the yearly quantities imported during the 1950s.

World Landings and Consumption of Scallops

Landings of scallops by U.S. fleets dominated world landings in 1950 and 1951. Though the share of world landings accounted for by U.S. landings declined steadily, it did not fall below 50 percent until 1963. The U.S. share bottomed out at 15.6 percent of world landings in 1974, and then increased to current levels of about 25-30 percent.

Canadian landings increased significantly in the early 1960s, leveled off for several years and declined until 1973. Japanese landings declined to a lower level during the 1960s from that of the 1950s, then increased dramatically in the early 1970s. Japan's share of World landings in the 1977-80 period has ranged from just under 30 percent to almost 34 percent. Total world

landings peaked in 1978 at 952.7 million pounds (live-weight) in the period for which data are available (through 1980).

U.S. consumption alone constitutes about 40 percent of the worlds total for the mid-1970s. The proportion was even greater for prior years. Consumption exceeded French landings in the late 1960s. Japanese consumption exhibits a decline in the 1960s from previous levels and increases in 1969-70. Australian consumption also exhibits an interesting pattern, but reversed that of Japan.

In summary, the size and share of calico landings relative to the magnitudes of U.S. consumption and trade suggest that further investigation of more detailed world trade or consumption data does not appear warranted. Perhaps more examination of domestic demand, seasonality, and short-run price effects would be appropriate. However, relative to trade or other measures, the calico scallop appears to represent the small fishery case. In most years we would not expect it to have much impact on prices or trade flows, except for perhaps some temporary regional effects. However, for years similar to 1981 when large quantities are landed, price effects may be more pervasive. Timing of landings relative to those of other species could then become more important in maximizing economic returns to harvesting calico scallops, and at the same time, minimizing adverse effects on prices of other species in the region (such as bay scallops).

UPDATED ECONOMIC INFORMATION

The following information presents the current status of the harvesting sector in terms of vessel economics. This information was provided by two calico Scallop Advisory Panel members, Mr. William Burkhardt (owns an at-sea calico scallop processing vessel), and Mr. David Bates (owns a shell stock calico scallop vessel that makes day trips) through personal communication during the Joint Calico Scallop Committee and Advisory Panel meeting in Charleston, South Carolina on July 30, 1998.

There are two types of vessels involved in the calico scallop fishery in the South Atlantic region. The Type I vessel is referred to as the at-sea processor. Only one vessel operates in the calico scallop fishery at the present time. All of the calico scallops harvested by this vessel are processed at sea. The second type of vessel, referred to as the Type II vessel, is also called a shell stock vessel, because all the calico scallops harvested are brought to port in the shells. Processing of calico scallops harvested by these vessels is done at shore based facilities. In 1997, 25 Type II vessels reported harvests of calico scallops. As of July 30, 1998 none of the Type II vessels had participated in the calico scallop fishery during the 1998 calendar year. The only vessel that reported calico scallop harvest during the 1998 calendar year as of July 30, 1998 is the Type I vessel.

Table 6. Costs and Earnings of At-Sea Processor vs. Shellstock Vessel

	TYPE I: AT-SEA PROCESSOR	**TYPE II: SHELL STOCK**
VESSEL LENGTH	85 feet	65 feet - 100 feet
VESSEL AGE (AV.)	15 years	3 - 25 years
LENGTH OF SEASON	Could be throughout the year. There is no defined season. The fishery operates when calico scallop beds are found. Calico scallops live for approximately 48 months.	

DURATION OF TRIP	3 - 5 days	Daily trips (12 - 15 hours)
AV. # OF TRIPS / SEASON	0 - 40 per year	Av. 4 days/week (40 weeks). Could be from 0 - 160 trips.
# OF VESSELS IN FISHERY	1 (1997/1998)	25 (1997). None has entered the fishery in 1998.
CREW SIZE	3 - 6 men	2 -3 men
AV. CATCH /TRIP	500 gal. - 2,000 gal. (shucked). 8 lbs. = 1 gal. (shucked weight)	250 - 300 gal. 8 lbs. = 1 gal. (shucked weight)
AV. EXVESSEL PRICE	$16 / gal. - $32 / gal. (shucked meat)	$4 / gal. - $10 / gal. (shell stock)
AV. REVENUE/TRIP	$8,000 - $32,000	85' vessel: $1,500 / trip 100' vessel: $2,000 / trip
CREW SHARE	30% of gross revenue	30% of gross revenue
BOAT OWNER SHARE	70% of gross revenue	70% of gross revenue
VESSEL OPERATING COSTS	$500 per day	$300 - $500 per trip
VESSEL FIXED COSTS (ANNUAL)	$100,000. Includes annual vessel maintenance, etc.	Depends on vessel size.
BREAK EVEN REVENUE PER TRIP	Av. $2,500 per day	$1,200 -$1,500 per trip

BUSINESSES, MARKETS AND ORGANIZATIONS ASSOCIATED WITH THE FISHERY

Relationship Among Harvesting, Brokering and Processing Sectors

Fishermen and vessels involved in the calico scallop fishery are concentrated in North Carolina and Florida, close to areas which have a history of frequent appearance of harvestable quantities of calico scallops, and close to the processors. Nineteen out of 21 calico scallop vessels operating on a regular basis in 1978 and 1979 were from North Carolina. Some of these North Carolina vessels, as well as some Florida vessels, are owned wholly or partly by processors. These companies, engaged primarily in the calico scallop fishery, operate automated scallop processing equipment. Most of the shucking takes place in processing plants although some of this equipment can be mounted on a tractor-trailer rig to be moved to the shore nearest the harvesting location. This expedites rapid shucking which is desirable since calico scallops have a relatively short product life unless frozen.

In Florida, four shucking machines were operating in 1982. The capacity of the processing machines, over 100 gallons of meats per hour, compensates for the small number of machines available for shucking calico scallops. In North Carolina, several machines regularly shuck calico scallops, but other machines are available for use with heavy demand.

The high cost of patented shucking machines requires capital of $150,000 to $200,000 to enter the market. This high investment, plus rapid physical depreciation and/or obsolescence (one or two years), plus sporadic use, partially accounts for the relatively small number of firms in this industry.

In 1978, the cost of preparing an already existing scallop processing plant for operation was given as approximately $6,000 to $7,000. One processor explained that for this sum, the

shucking machines would be overhauled, building made ready for a sanitation inspection, and preparations made for freezer storage of the product.

About 90 percent of the harvest of calico scallops is sold directly to wholesalers in the New York City area, with some products marketed in Boston and Baltimore. Small lots are sold to local restaurants. Wholesale firms distribute the scallops to retail markets.

Scallop shells often have marketable value and have been used in a variety of ways. In North Carolina, for instance, used calico scallop shells sold for about $0.10/bushel seven or eight years ago, to be used for oyster beds, drain fields, and road fill. In Florida, two firms currently use shells to build up low land for resale as homesites.

Fishery Cooperatives or Associations

The calico scallop fishery is organized on an individual entrepreneurial basis; there are no cooperatives. Further, there is no association specifically associated with the calico scallop fishery. However, a number of the fishermen and processors are associated with the Organized Fishermen of Florida (OFF), the Southeastern Fisheries Association, Inc., or the National Fisheries Institute (NFI).

The calico scallop industry did form a self-regulating association called the Calico Scallop Conservation Association (Blake and Moyer, 1991). This association was formed to allow self-regulation and to prevent harvest until 75% of the target stock had achieved 38 mm shell height; however, the association is no longer operational (N. J. Blake, pers. comm. as reported in Arnold, 1995).

Labor Organizations

No segment of the calico scallop fishery is unionized.

Foreign Investment

Currently, there is no foreign investment in the calico scallop fishery. However, in the mid 1970s, there was a company owned by foreigners processing calico scallops in Florida.

Appendix M. South Atlantic Fishing Communities as Defined in the Sustainable Fisheries Act Amendment

South Atlantic Fishing Communities as Defined in the Sustainable Fisheries Act Amendment (SAFMC, 1998a

"4.3.3 Fishing Communities - Identify and define fishing communities

Identifying fishing communities provides a basis for analyzing impacts of management measures on fishing communities rather than on a fishery-wide basis. This would be more relevant in situations where impacts are differential because of the location, level of activity and dependency on fishing, availability of alternative job opportunities, etc. in different fishing communities. This measure would allow fishery managers to obtain information on the impacts of future management measures on different fishing communities. It could make for the formulation of management measures that would minimize impacts on fishing communities that have less opportunities to adapt to changes imposed by the measures.

Identification and definition of fishing communities would normally have a positive impact, except that, for the South Atlantic, there are no data collected on fishing communities. National Standard 8 imposes requirements on the council and the fishery management regulatory process that cannot be satisfied given existing data. Current data available do not allow for a meaningful definition of fishing community, moreover, do not provide a measure of dependence upon fishing and will not contribute to useful impact analysis.

At its March meeting, the Gulf of Mexico Fishery Management Council's Socio-economic Panel recommended that further research be initiated and funded by National Marine Fisheries Service as soon as possible to aid in the identification and definition of fishing communities in the Southeast. The panel also recommended the scope of this problem be addressed at a national level, such that impacts upon fishing communities can be analyzed across regions as well as within. A key area for expanded research is ethnographic and survey research to identify, not only communities, but those who provide supporting services to the economy and culture of fishing communities. Especially important in the Southeast is the need to provide a realistic portrayal of recreational fishing, diving, and eco-tourism and their importance to a fishing community.

The Council concluded incorporating all available information at this time will meet the mandates of the recent Magnuson-Stevens Act amendments relative to fishing communities.

With the addition of National Standard 8, FMPs must now identify and consider the impacts upon fishing communities to assure their sustainable participation and minimize adverse economic impacts [MSFCMA section 301 (a) (8)].

The proposed guidelines for this new standard state: *"... fishing communities are considered geographic areas encompassing a specific locale where residents are dependent on fishery resources or are engaged in the harvesting or processing of those resources. The geographic area is not necessarily limited to the boundaries of a particular city or town. No minimum size for a community is specified, and the degree to which the community is 'substantially engaged in' or 'substantially dependent on' the fishery resources must be defined within the context of the geographical area of the FMP. Those residents in the area engaged in the fisheries include not only those actively working in the harvesting or processing sectors, but also ``fishery-support services or industries," such as boat yards, ice suppliers, or tackle shops, and other fishery-dependent industries, such as ecotourism, marine education, and recreational diving."* [Federal Register Volume 62, Number 149 (August 4, 1997)]

"The term 'sustained participation' does not mandate maintenance of any particular level or distribution of participation in one or more fisheries or fishing activities. Changes are inevitable in fisheries, whether they relate to species targeted, gear utilized, or the mix of seasonal fisheries during the year. This standard implies the maintenance of continued access to fishery resources in general by the community. As a result, national standard 8 does not ensure that fishermen would be able to continue to use a particular gear type, to target a particular species, or to fish during a particular time of the year." [Federal Register Volume 62, Number 149 (August 4, 1997)]

"The term 'fishing community' means a community that is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew, and fish processors that are based in such communities. A fishing community is a social or economic group whose members reside in a specific location and share a common dependency on commercial, recreational, or subsistence fishing or on directly related fisheries-dependent services and industries (for example, boatyards, ice suppliers, tackle shops)." [Federal Register Volume 62, Number 149 (August 4, 1997)]

In order to determine a community's "substantial dependence" or "sustained participation" on fishing, those communities must first be identified. Presently, the NMFS has not identified fishing communities, nor their dependence upon fishing in the South Atlantic. Moreover, there are no ongoing data collection programs to gather the necessary information that would allow for the identification of fishing communities in the South Atlantic or other regions. Also, there are no future plans to implement any such data collection program that would determine dependence upon fishing in order to provide the Councils with important information necessary for social and economic impact analysis of fishing communities. This leaves the councils with existing data collected through other agencies, not always specific to fisheries management, i.e., census data, regional economic census, and previous research on specific fisheries. Although this data can be useful, it is often not specific enough to identify or provide a clear representation of a community and its dependence upon fishing. One reason for this difficulty is that fishermen in a specific fishery often do not reside within one particular municipality that can easily be identified as a fishing community or one that is substantially dependent upon fishing. Also, that information is often not provided at the municipality level, but more often at the county level.

Commercial fishermen may have a domicile (home) in one community and dock their boat in another. They may sell their fish in either place or an entirely different location. Recreational fishermen often do not live on the coast, but drive from inland counties and may launch their boats or fish from several different sites. For these reasons, identifying a "fishing community" becomes problematic in that such a community does not fit the normal geographic boundaries or fall within the metes and bounds that would surround a normal incorporated municipality.

The impacts of fisheries management may be minimal in a single community, but, when taken overall may be substantial to an entire county or several county area. Those same measures may have a small impact on a large metropolitan area, but, to a neighborhood where most fishing families live or most fishing activity originates it could be substantial. Therefore, a "fishing community" may encompass a single municipality, a county, several counties or one neighborhood within a major metropolitan area depending upon a variety of demographic, social, economic and ecological factors that one must consider.

One important circumstance to consider when assessing the impacts upon fishing communities is the difference between rural and urban areas, as many fishing communities exist in rural areas on the Southeast coast. There are several ways in which rural areas differ from the more urban or metropolitan as illustrated in *Understanding Rural America* (ERS-USDA, 1993). Rural areas have consistently lagged behind urban areas with respect to real earnings per job and education levels. Rural areas have also seen a rise in subgroups who are prone to economic disadvantage--families headed by single mothers and minorities. However, these differences vary across the country and are influenced by several factors, one of which is the availability of natural resources. In order to explain and examine some of these differences, counties within the U.S. have been classified as either metropolitan or non-metropolitan. A further subdivision of non-metro counties provides a more clear understanding into each subtype's dependence upon certain economic specialization and the importance of those differences to the residents of those counties (ERS-USDA, 1993). The following classification system may also suggest a possible method for defining an area's dependence upon fishing using the appropriate criteria.

Six types of non-metro counties have been classified, three of which are based upon economic specialization - farming, manufacturing and services. The other three county classifications are based upon their relevance to policy -- retirement-destination; Federal lands; and persistent poverty. Using earned income as a measure of dependence, the classification for counties based upon economic specialization is as follows:

Farming counties - 20% or more earned income from farming
Manufacturing - 30% or more earned income from manufacturing
Services - 50% or more earned income from services industries

Those counties whose classification is based upon economic specialization are mutually exclusive; the other three classification types are not mutually exclusive (ERS-USDA, 1993).

This type of classification system, based upon a percentage of earned income or other measure, might be used to determine a community, county or region's dependence upon fishing. However, like farming counties, those dependent upon fishing have likely seen a decline in the dependence upon fishing over time. This is probably due to significant increases in the population of coastal areas since the 1970's. Much of the population growth has been in the form of immigration of people 60 and older who seek coastal areas for retirement destinations. The increase in this population sector, in turn, brings a greater dependence upon service industries. Choosing such a measure of dependence is not possible at this time and would have to be developed through further analysis and/or research.

Griffith and Dyer developed a typology of fishing community dependence for the Northeast Multi-species Groundfish Fishery (MGF) (Aguirre, 1996). In that typology, they identified critical indicators of dependence which included specific physical-cultural and general social-geographic indicators, i.e., number of repair/supply facilities; number of fish dealers/processors; presence of religious art/architecture dedicated to fishing; presence of secular art/architecture dedcicated to fishing; number of MGF permits; and number of MGF vessels. Using previous results and supplemental research of their own, they were able to develop a fishery dependence index score for the five primary ports in the MGF.

From their research Griffith and Dyer were able to document five variables which best predicted dependence upon the MGF:

1. Relative isolation or integration of fishers into alternative economic sectors, including political participation. To what extent have the fleets involved in the MGF enclaved themselves from other parts of the local political economy or other fisheries? How much have the MGF fleets become, similar to an ethnic enclave, closed communities?
2. Vessel types within the port's fishery. Is there a predominance of large vessels or small vessels, or a mix of small, medium, and large?

3. Degree of specialization. To what extent do fishers move among different fisheries? Clearly, those fishers who would have difficulty moving into alternative fisheries or modifying their vessels with alternative gears are more dependent on the MGF than those who have histories of moving among several fisheries in an opportunistic fashion.

4. Percentage of population involved in fishery or fishery-related industries. Those communities where between five and ten percent of the population are directly employed in MGF fishing or fishing-related industries are more dependent on the MGF than those where fewer than five percent are so employed.

5. Competition and conflict within the port, between different components of the MGF. Extensive competition and conflict between fishers within the same port--as well as between different actors in the MGF, such as boat owners and captains--seem to be associated with intensive fishing effort and consequent high levels of dependence on the MGF. In this case, dependence may have a strong perceptual dimension, with fishers perceiving the resources they are harvesting to be scarce and that one fleet's gain is another fleet's loss.

It is important to understand that these factors are appropriate for the MGF and are not necessarily the best predictors for all fishing communities. Fisheries in the Southeast will differ markedly from those in other regions of the country, especially with regard to their integration into other economies and notably the tourist economy. Recreational fishing is an integral part of the tourism and service economy that has developed for coastal communities in the South Atlantic. For these communities, dependence upon fishing will undoubtedly be tied to commercial and recreational fishing and their associated businesses. Therefore, it is important for fishery dependence models to be developed specifically for the South Atlantic.

Griffith and Dyer (Aguirre 1996) also discuss their description of fishing communities as it relates to the term Natural Resource Community (NRC). Dyer et. al define a NRC as "a population of individuals living within a bounded area whose primary cultural existence is based upon the utilization of renewable natural resources" (1992:106). Natural Resource Communities possess an elementary connection between biological cycles within the physical environment and socio-economic interactions within the community. An adaptation to working on the water by fishermen has important implications for the community as a whole because of the necessary support activities that take place on land, i.e., net hanging & mending; fish handling & preparation; boat building & repair. This important tie to the physical environment not only dictates occupational participation, but structures community interaction and defines social values for those living in Natural Resource Communities. While fishing communities in the MGF are not bounded or set apart from the larger community in which they reside, they still manifest certain recognizable features that would classify them as NRCs (Aguirre 1996). Fishing communities in the South Atlantic will also show signs of being integrated into the larger

economy, but may still maintain certain vestiges of an NRC. Fishermen in the South Atlantic, like those in the Northeast MGF, will not likely see their ecological systems being closed, but affected by a host of other forces, both globally and locally. Far more detailed research will need to be conducted among South Atlantic fishing communities to determine changes in integration of the larger economy. One of the most likely changes will be an increasing dependence upon the service sectors as recreational fishing and other recreational activities play an increasing role in the economies of coastal communities. While there will continue to be a connection between the social and physical environments, the nature of that interaction will undoubtedly change.

At this time there is insufficient data to completely identify and define fishing communities in the South Atlantic. The following description of fishing communities provides information to explore ways of defining fishing communities that range from geographical regions to a well bounded municipality. With varied levels of research or data available for each state, descriptions of fishing communities will depend upon the amount of data available and the specific nature and timeliness of that data. In some cases, it may be possible to find a municipality that will clearly fit a definition of fishing community and meet a criterion for dependence upon fishing. In others, it may be a series of communities or counties designated a "fishing community" or possibly a particular sector of a large metropolitan area.

Readily available data will be discussed to allow for public input on the best way to identify fishing communities and determine their dependence upon fishing. Following the discussion of fishing communities in the South Atlantic a discussion of data needs and format will provide possible directions for data collection and analysis. The Council welcomes comments on all aspects of incorporating this new national standard, in order to devise a classification system which will assist in assessing the impacts of fishery management upon fishing communities.

4.3.3.1.1 South Atlantic Fishing Communities

According to NMFS, South Atlantic commercial fishermen have harvested well over 250,000 pounds of seafood in each of the years 1995 and 1996 (Table 1). Those landings have represented over $200,000,000 in harvest value. The value of those landings can become even greater once it diffuses throughout South Atlantic fishing communities as it provides employment and other benefits to other sectors within each community's economic base.

Table 1. U.S. Domestic Commercial Fishing Landings by Region, 1995 and 1996. Source Fisheries of the United States, 1996

	1995		1996	
Region	**Thousand pounds**	**Thousand dollars**	**Thousand pounds**	**Thousand dollars**
New England	592,665	580,957	641,821	564,169
Middle Atlantic	240,413	179,747	241,936	181,869
Chesapeake	845,632	174,229	728,830	158,736
South Atlantic	**277,035**	**238,112**	**268,990**	**209,407**
Gulf of Mexico	1,464,718	724,619	1,496,875	680,304

Commercial seafood landings also represent other forms of expenditure which have an impact upon fishing communities, such as: fuel, gear, groceries, etc. Support industries like, gas

stations, tackle shops, grocery stores all have an investment in the harvesting capability of the local fishing fleet.

As with commercial fishing, recreational fishing activity will also contribute to the economic base of a fishing community as fishermen buy fuel, bait, tackle and food & beverage for fishing trips. Figure 1 demonstrates an increasing trend in recreational fishing trips for most South Atlantic states, but, also substantial variation in the number of trips over time. Such variation can mean significant economic impacts for those communities that rely upon recreational fishing.

South Atlantic fishing communities will depend upon both recreational fishing and commercial fishing for determining the importance of fishing to their economic base. The supporting role of associated businesses will also need to be incorporated into any measure of dependence. Such businesses as: seafood dealers and processors, marinas, gas stations, bait and tackle shops, dive shops, trucking firms, restaurants and many others, all have some role in determining dependence upon fishing. Unfortunately, data that is robust and/or specific enough does not exist to include in such a determination.

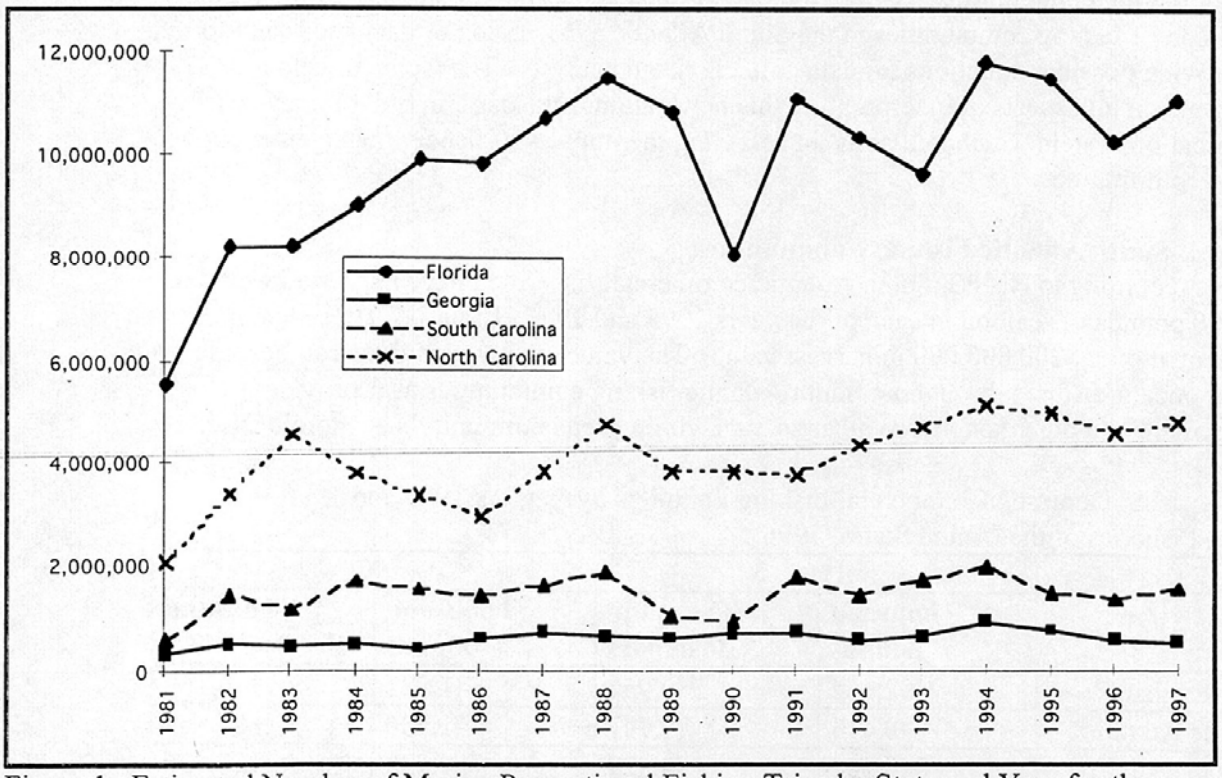

Figure 1. Estimated Number of Marine Recreational Fishing Trips by State and Year for the South Atlantic. Source: Personal communication from the National Marine Fisheries Service, Fisheries Statistics and Economics Division.

To identify fishing communities in the South Atlantic one might begin with the National Oceanic and Atmospheric Administrations publication *Fisheries of the United States* (1996). Among the various statistics listed are commercial landings of major U.S. ports. These ports could be considered to be substantially dependent upon fishing. Table 2 lists the major ports for the South Atlantic in 1996 and 1995 for quantity and value of landings. Some ports are listed as

individual communities while others are a combination of several communities over a limited geographical range. This characterization may be useful as we attempt to further delineate fishing communities in each state. Other sources of information helpful in defining fishing communities include the United States Census and Bureau of Economic Research, which include economic information for many areas of the U.S.

Table 2. Quantity, Value and Rank of Commercial Landings for South Atlantic Ports among Major U.S. Ports Source: Fisheries of the United States, 1996.

Port	1995 Quantity*	1995 Rank	1995 Value*	1995 Rank	1996 Quantity*	1996 Rank	1996 Value*	1996 Rank
Key West	23.4	32	66.7	5	23.7	37	62.8	4
Beaufort-Morehead City, NC	87.0	16	35.0	15	75.4	18	20.3	34
Wanchese-Stumpy Point, NC	39.0	25	25.0	24	43.4	24	24.6	27
Charleston-Mt.Pleasant, SC	11.0	58	19.0	32	---	--	---	--
Cape Canaveral, FL	10.1	--	16.9	35	21.2	43	17.7	42
Darien-Bellville, GA	---	--	11.0	50	---	--	---	--
Beaufort, SC	---	--	11.0	51	---	--	---	--
Englehard-Swanquarter, NC	11.0	58	---	--	15.0	50	---	--
Oriental-Vandemere, NC	9.0	--	10.0	--	14.0	53	13.3	50
Bellhaven-Washington, NC	---	--	6.0	--	---	--	11.5	58

*Value and quantity are in millions of dollars and pounds respectively.

4.3.3.1.2 North Carolina

The 1990 Census of Population and Housing provides the following information for North Carolina regarding individuals who reported their occupation as fisher in Table 3. This data will likely include those individuals who commercially fish fresh water areas and others who are not impacted by fisheries management of marine fisheries at the council level. This information does provide data for comparison and could help set parameters for a measure of dependency upon fishing. It is not recommended that these figures be used to determine dependency upon fishing, however. The 1990 Census classifies year-round full-time workers as all persons 16 years old and over who usually worked 35 hours or more per week for 50 to 52 weeks in 1989.

Table 3. Number of Fishers and Mean Annual Income for North Carolina in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of fishers			
Male	989	1,271	2,260
Female	47	105	152
Total	1,036	1,376	2,412
Mean Annual Income ($)			
Male	16,315	13,069	14,489
Female	11,518	4,489	6,662
Total	16,097	12,414	13,996

The 1990 Census also provides the following information for North Carolina regarding individuals who reported their occupation as captain of a fishing vessel in Table 4. It is interesting to note that there were no females listed as captain of fishing vessels. This concurs with the much of the research on the occupation of fishing which finds very few women in this

role. Although women often play an important role in the fishing operation, they are rarely in the position of captain of fishing vessels.

Table 4. Number of Captains of Fishing Vessels and other officers and Mean Annual Income for North Carolina in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of Captains			
Male	102	141	243
Female	0	0	0
Total	102	141	243
Mean Annual Income ($)			
Male	26,917	33,640	30,818
Female	0	0	0
Total	26,917	33,640	30,818

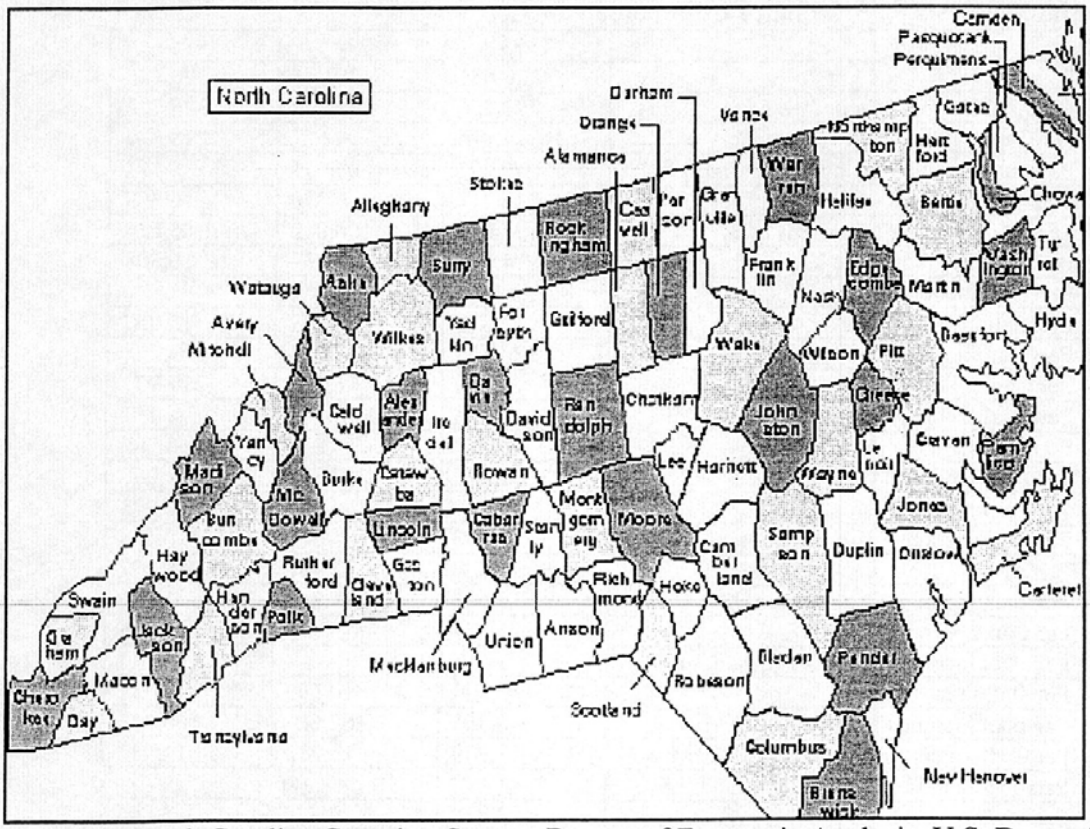

Figure 2. North Carolina Counties. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Johnson and Orbach (1996) have divided North Carolina into six areas for their research on effort management of North Carolina commercial fisheries. Those areas were determined to be distinct with regard to species/gear combinations in addition to sociological, ecological and environmental differences. The areas defined are as follows:

Area 1: Albermarle Area - Currituck, Camden, Pasquotank, Perquimans, Chowan, Bertie, Washington, and Tyrell Counties.

Area 2: Dare County

Area 3: Southern Area - Brunswick, Pender, New Hanover, and Onslow Counties

Area 4: Pamlico Area - Craven, Pamlico, Beaufort, and Hyde Counties.
Area 5: Carteret County
Area 6: Inland Counties.

Area 1: Albermarle Area

The Albermarle area includes the following counties: Currituck, Camden, Pasquotank, Perquimans, Chowan, Bertie, Washington and Tyrell. Johnson and Orbach (1997) found that commercial fishermen in this area had two primary gear types, pots and gill nets. They also concluded that fishermen here move in and out of gill netting on an annual basis.

Table 5. Population and Economic Information for Counties included in Area 1. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 1-County		1993	1994	1995
Bertie	Population	20,631	20,665	20,745
	Personal Income (Thousands of $)	291,226	303,292	328,227
	Per Capita Pers Income ($)	14,116	14,677	15,822
	Personal Income Fishing (Thousands of $)	71	75	84
Camden	Population	6,211	6,370	6,399
	Personal Income (Thousands of $)	92,875	100,012	105,636
	Per Capita Pers Income ($)	14,953	15,700	16,508
	Personal Income Fishing (Thousands of $)	0	0	0
Chowan	Population	13,815	13,909	13,958
	Personal Income (Thousands of $)	226,563	234,453	247,428
	Per Capita Pers Income ($)	16,400	16,856	17,727
	Personal Income Fishing (Thousands of $)	128	134	151
Currituck	Population	15,215	15,831	16,285
	Personal Income (Thousands of $)	251,885	269,871	291,055
	Per Capita Pers Income ($)	16,555	17,047	17,873
	Personal Income Fishing (Thousands of $)	358	376	423
Pasquotank	Population	33,220	33,488	33,759
	Personal Income (Thousands of $)	510,623	534,860	574,433
	Per Capita Pers Income ($)	15,371	15,972	17,016
	Personal Income Fishing (Thousands of $)	- - - -	- - - -	- - - -
Perquimans	Population	10,644	10,692	10,737
	Personal Income (Thousands of $)	148,365	162,627	160,912
	Per Capita Pers Income ($)	13,939	15,210	14,987
	Personal Income Fishing (Thousands of $)	- - - -	0	- - - -
Tyrell	Population	3,918	3,875	3,846
	Personal Income (Thousands of $)	56,056	58,138	52,738
	Per Capita Pers Income ($)	14,307	15,003	13,712
	Personal Income Fishing (Thousands of $)	476	500	562
Washington	Population	14,136	14,276	14,138
	Personal Income (Thousands of $)	220,429	229,038	238,124
	Per Capita Pers Income ($)	15,593	16,044	16,843
	Personal Income Fishing (Thousands of $)	225	236	266

Using multidimensional scaling, Johnson and Orbach were able to examine the spatial relationship of various types of fishing in each area. For Area 1, crab potting was the most central fishery. In other words most fishermen in the area do some crab potting. Referring to cliques, they found that for this area fishermen who peeler pot, eel pot, crab pot and gill net flounder differ from those that long haul. Fishermen that long haul will crab pot and gill net flounder but do not engage in peeler pots or eel pots.

In examining the categories which would include fishermen for Area 1 (Table 6) there seems to be no trend regarding either those in Farm/Fish/Forest occupations or the Agriculture, Fishing, Mining Industries. There are both increases and decreases in the number of those within each categories from 1970 to 1990 which varies by county.

Table 6. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for North Carolina Coastal Counties included in Area 1 for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	Occupation/Industry	1970	1980	1990
Bertie County	Farm/Fish/Forest	923	1035	839
	Agri.,Fishing,Mining	1050	1038	884
Camden County	Farm/Fish/Forest	203	220	114
	Agri.,Fishing,Mining	220	181	137
Chatham County	Farm/Fish/Forest	740	904	832
	Agri.,Fishing,Mining	927	934	1286
Currituck County	Farm/Fish/Forest	194	247	316
	Agri.,Fishing,Mining	215	296	309
Pasquotank County	Farm/Fish/Forest	444	491	469
	Agri.,Fishing,Mining	552	478	508
Perquimans County	Farm/Fish/Forest	417	513	299
	Agri.,Fishing,Mining	445	524	316
Tyrrell County	Farm/Fish/Forest	197	249	208
	Agri.,Fishing,Mining	225	273	233
Washington County	Farm/Fish/Forest	408	511	551
	Agri.,Fishing,Mining	462	557	526

Area 2 : Dare County

Within Dare county the following communities have been described through recent research of the snapper grouper fishery and might be considered fishing communities: Manns Harbor, Manteo, Wanchese, Hatteras, Stumpy Point (Iverson 1997). Johnson and Orbach (1997) found that commercial fishermen in this area had two primary gear types, pots and gill nets. In their analysis of fishery networks for Area 2 they again found crab pots to be central. Another interesting difference revealed was that fishermen who shrimp trawl in this area will gillnet for sharks but do not engage in crab potting.

Dare County shows a higher personal income from fishing over the three years listed (Table 7) than most other coastal counties in North Carolina.

Table 7. Population and Economic Information for Counties included in Area 2. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 2				
County		**1993**	**1994**	**1995**
Dare				
	Population	24,300	25,106	26,074
	Personal Income (Thousands of $)	429,564	465,011	502,474
	Per Capita Pers Income ($)	17,678	18,522	19,271
	Personal Income Fishing (Thousands of $)	5,426	5,688	6,392

Dare County (Table 8) shows a general increase in the number of individuals in the listed occupations and industries over the twenty years from 1970 to 1990.

Table 8. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for Dare County (Area 2) for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	**Occupation/Industry**	**1970**	**1980**	**1990**
Dare County	Farm/Fish/Forest	11	376	637
	Agri.,Fishing,Mining	181	446	655

Snapper Grouper Fishing

Most of the snapper grouper permit holders in Area 2 work out of Hatteras and only a small portion of their annual commercial fishing activity is devoted to targeting snapper grouper species. Black sea bass, snowy grouper, and blueline tilefish are the most frequently targeted species by commercial snapper grouper fishermen from this area. Surface longlining for tuna and swordfish is apparently the most productive and profitable style of commercial fishing in the area, and the small towns of Manteo and Wanchese serve as refuge for a large number of both local and non-local longlining boats (Iverson, 1997).

Area 3: Southern Area

The Southern Area includes the following counties and communities (in parenthesis): Brunswick (Southport). Pender, New Hanover, Onslow (Sneads Ferry). Johnson and Orbach (1997) found that commercial fishermen in this area had four primary gear types: hook-and-line, gill net, hand harvest of shellfish, and trawling. Pot fishing was classified as secondary gear but they report that increasing usage over time could possibly make it a primary gear. It is interesting to note that they also reported that pot fishing showed an increase in all five areas over time. Area 3 showed much more complexity in annual rounds of fishing than Areas 1 or 2 with shrimp trawling, hand clamming and crab potting all central to the network (Johnson and Orbach 1997).

Table 9. Population and Economic Information for Counties included in Area 3. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 3				
County		**1993**	**1994**	**1995**
Brunswick				
	Population	56,350	58,386	60,697
	Personal Income (Thousands of $)	878,453	941,247	1,024,954
	Per Capita Pers Income ($)	15,589	16,121	16,886
	Personal Income Fishing (Thousands of $)	1,595	1,674	1,885
Pender				
	Population	32,554	33,894	33,759
	Personal Income (Thousands of $)	510,623	534,860	574,433
	Per Capita Pers Income ($)	15,681	16,341	17,253
	Personal Income Fishing (Thousands of $)	----	----	----
New Hanover				
	Population	131,091	135,317	139,906
	Personal Income (Thousands of $)	2,620,539	2,800,024	3,036,665
	Per Capita Pers Income ($)	19,990	20,692	21,705
	Personal Income Fishing (Thousands of $)	----	----	693
Onslow				
	Population	145,638	144,951	144,259
	Personal Income (Thousands of $)	1,962,312	2,030,075	2,149,074
	Per Capita Pers Income ($)	13,474	14,005	14,897
	Personal Income Fishing (Thousands of $)	667	700	787

Counties included in Area 3 (Table 10.) show a general increase in numbers of individuals within the selected occupations and industries, with the exception of Pender County which shows a decline from 1970-1990.

Table 10. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for North Carolina Coastal Counties included in Area 3 for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database.

County	**Occupation/Industry**	**1970**	**1980**	**1990**
Brunswick County	Farm/Fish/Forest	370	668	1028
	Agri.,Fishing,Mining	505	645	971
Pender County	Farm/Fish/Forest	772	562	627
	Agri.,Fishing,Mining	892	669	690
New Hanover County	Farm/Fish/Forest	289	550	782
	Agri.,Fishing,Mining	564	615	984
Onslow County	Farm/Fish/Forest	754	869	996
	Agri.,Fishing,Mining	906	800	987

Snapper Grouper Fishing

For Area 3, the small community of Sneads Ferry, is unique in that the majority of the commercial reef fishermen fish with sea bass pots. According to the 1993 federal permit list for the South Atlantic region, there were 58 permit holders who indicated that sea bass pots were their primary gear type. Of those, 13 permit holders worked out of Sneads Ferry (Iverson, 1997).

Overall, 72% of fishermen using sea bass pots as their primary gear work out of home ports in North Carolina.

Area 4: Pamlico Area.

The Pamlico area includes these counties and communities (in parenthesis): Craven, Pamlico (Vandemere, Oriental), Beaufort (Bellhaven, Washington), Hyde (Ocracoke, Swanquarter, Englehard). Johnson and Orbach (1997) found that commercial fishermen in this area had three primary gear types, pots, gill nets, and trawls. In terms of annual fishing rounds Area 4 is the simplest to understand where two strategies are employed: gill netting and crab potting or trawling and crab potting. They go on to note that this simple strategy may signify few choices for fishermen in this area in the case of environmental or regulatory change (Johnson and Orbach 1997). Possible fishing communities within Area 4 might be: Vandemere and Oriental.

Table 11. Population and Economic Information for Counties included in Area 4. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 4				
County		**1993**	**1994**	**1995**
Craven				
	Population	83,595	83,851	85,163
	Personal Income (Thousands of $)	1,450,296	1,508,353	1,626,657
	Per Capita Pers Income ($)	17,349	17,988	19,101
	Personal Income Fishing (Thousands of $)	386	405	- - - -
Pamlico				
	Population	11,772	11,948	12,064
	Personal Income (Thousands of $)	179,384	186,131	199,576
	Per Capita Pers Income ($)	15,238	15,578	16,543
	Personal Income Fishing (Thousands of $)	2,714	2,851	3,211
Beaufort				
	Population	43,446	43,815	43,998
	Personal Income (Thousands of $)	674,788	711,961	756,048
	Per Capita Pers Income ($)	15,532	16,249	17,184
	Personal Income Fishing (Thousands of $)	1,339	1,406	1,580
Hyde				
	Population	5,374	5,339	5,362
	Personal Income (Thousands of $)	80,982	90,101	80,300
	Per Capita Pers Income ($)	15,069	16,876	14,976
	Personal Income Fishing (Thousands of $)	1,860	1,973	2,215

Pamlico county had the highest personal income from fishing for Area 4 from 1993 to 1995 with a steady increase over those three years (Table 11). Hyde county followed with Beaufort next; both showing an increase over time. For most counties in Area 4 (Table 12) the general trend seems to be an increase from 1970 to 1980 and then a decrease from 1980 to 1990 within these occupation and industry categories. Beaufort County shows an overall decrease from 1970-1990.

Table 12. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for North Carolina Coastal Counties included in Area 4 for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	Occupation/Industry	1970	1980	1990
Craven County	Farm/Fish/Forest	873	1136	832
	Agri.,Fishing,Mining	1129	1222	860
Pamlico County	Farm/Fish/Forest	245	498	442
	Agri.,Fishing,Mining	502	662	477
Beaufort County	Farm/Fish/Forest	1452	1393	1024
	Agri.,Fishing,Mining	2169	2123	1190
Hyde County	Farm/Fish/Forest	295	509	454
	Agri.,Fishing,Mining	442	579	511

Area 5: Carteret County

In Area 5 Johnson and Orbach (1997) found that commercial fishermen had three primary gear types, gill nets, trawls and hand harvest of shell fish. In terms of annual fishing rounds Area 5 did not show the clear gear stratification found in other areas. Shrimp trawling is the most central fishery, but pound netting, crab potting, and mechanized clamming also occur with shrimp trawling. (Johnson and Orbach 1997). Possible fishing communities within Area 5: Morehead City and Beaufort.

Table 13. Population and Economic Information for Counties included in Area 5. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

Area 5				
County		1993	1994	1995
Carteret				
	Population	55,747	56,381	57,690
	Personal Income (Thousands of $)	935,032	985,484	1,076,753
	Per Capita Pers Income ($)	16,773	17,479	18,664
	Personal Income Fishing (Thousands of $)	2,783	2,871	3,207

Among North Carolina's coastal counties, Carteret county was second to Dare county (Table 13) in terms of personal income from fishing. In addition, Carteret County (Table 14) shows an marked increase from 1970 to 1980, then a decrease from 1980 to 1990, within the occupations of Farm/Fish/Forest and an overall increase in the number of Agriculture, Fishing and Mining industries.

Table 14. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for Carteret County (Area 5) for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database.

County	Occupation/Industry	1970	1980	1990
Carteret County	Farm/Fish/Forest	225	1200	1158
	Agri.,Fishing,Mining	731	1234	1260

In a recent report on the importance of commercial fishing in Carteret county, Diaby (1997) found that Carteret county ranked first in poundage (96,652,314 lb) and second in dockside value ($20,618,486) in terms of commercial landings for North Carolina coastal counties. Finfish represented the 91% of total landings and 46% of total ex-vessel value. The most important species of finfish were: menhaden, flounder, croaker, weakfish and spot. Shellfish and crustaceans accounted for only 9% of all commercial landings but, represented over half of the value of landings during the period from 1974-1994. Employment by the commercial fishing industry, both full and part time for Carteret county was estimated to be 3,232 people for 1994 (Diaby, 1997). This number varies from those reported in the census data and emphasizes the problems in comparing these types of data. Since 1981 there have been about 105 to 140 licensed seafood dealers in Carteret county. The value of processed seafood peaked for the county in 1981 when scallops accounted for almost half of the value with a total value of $19,737,126. Since that time there has been a general decline in total value of processed seafood attributable to a decline in scallop landings. Menhaden was the most important single processed product over a fifteen year period from 1980 to 1994 (Diaby, 1997).

In estimating the economic impact of Carteret county commercial harvesting sector Diaby (1997) estimated $27 million in sales of goods and services and $11.66 million in value added. Total employment from commercial harvesting activities was estimated to be 3,371.

Sales of goods and services for the wholesaling and processing sector were estimated at $19 million, with $11 million n value added. There were an estimated 1,563 full and part time jobs created earning $6.55 million in wages (Diaby, 1997).

Overall, the activities of the commercial fishing industry created $46 million in sales of goods and services and $24 million in value added. There were 4,934 full and part time jobs which earned $14 million in wages (Diaby, 1997).

The recreational fishery spent approximately $70 million on fishing trips in Carteret county with $25.23 million in employ compensation and $47.61 in value added. There were 1,821 full and part time jobs associated with the recreational fishing industry in Carteret County.

The total impact of the coastal fishing industry on the economy of Carteret County was estimated to be $120.74 million with $71.32 million in value added. The total number of full and part time jobs was estimated at 6,755 with earnings of $38.94 (Diaby, 1997).

Snapper Grouper Fishing

The Morehead City/Beaufort area is located approximately 50 miles south of Ocracoke in Carteret County. This area is known for its sportfishing activity including several major tournaments each year. There is a small population of full time commercial reef fishermen in Morehead, however the majority of fishermen holding commercial permits are primarily part timers. Many of these fishermen divide their time between charter fishing during the peak tourist season (April through September) and commercial fishing in the winter months. Full time fishermen in this area reported fishing approximately 50 miles straight offshore and fishing from Hatteras to as far south as the South Carolina/Georgia line. Trip lengths vary with the size of the vessel, but the average trip length is 7 days and the larger boats carried up to 3 crew members (Iverson, 1997).

King Mackerel Fishery

The king mackerel fishery in North Carolina has grown steadily since 1980 and has leveled with catches repeatedly around one million pounds in recent years. From 1986 to 1990 the number of permits for Atlantic group king mackerel issued in North Carolina ranged from a

low of 325 in 1987/88 to a high of 533 in 1989/90. Again, the majority of those permits were granted to hook and line fishermen. Present data indicates there were 448 commercial vessels permitted for king and Spanish mackerel in North Carolina (Vondruska, 1997).

4.3.3.1.3 South Carolina

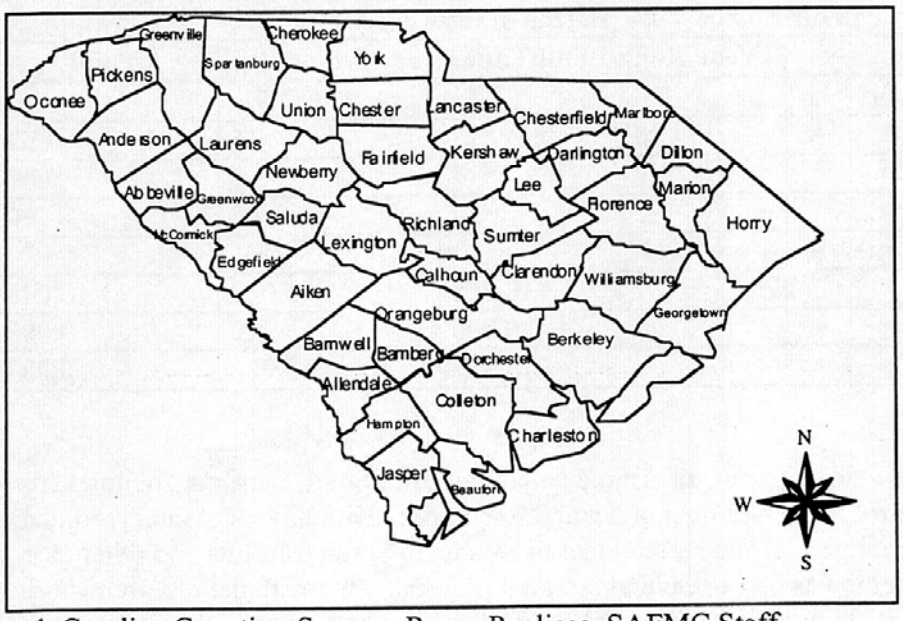

Figure 3. South Carolina Counties Source: Roger Pugliese, SAFMC Staff.

The 1990 Census of Population and Housing provides the following information for South Carolina regarding individuals who reported their occupation as fisher in Table 15. A total of 401 individuals claimed Fisher as their occupational title with less than half indicating it was a year round full time employment. There were few females who indicated such and they had a far lower mean annual income than males in this occupation.

Table 15. Number of Fishers and Mean Annual Income for South Carolina Fishers in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of fishers			
Male	188	193	381
Female	6	14	20
Total	194	207	401
Mean Annual Income ($)			
Male	28,842	14,489	18,946
Female	750	5,000	2,403
Total	23,710	14,269	18,390

There were a total of 69 individuals who indicated their occupation as captain of a fishing vessel in the 1990 census of population and housing. and 7 of them were female according to Table 16 Again, females had a much lower mean annual income when compared to males.

Table 16. Number of Captains of Fishing Vessels and other officers and Mean Annual Income for South Carolina in 1990. Source: U.S. Bureau of the Census

	Year Round/Full Time	Other	Total
Number of Captains			
Male	17	45	62
Female	7	0	7
Total	24	45	69
Mean Annual Income ($)			
Male	18,765	15,022	16,048
Female	9,000	0	9,000
Total	15,917	15,022	15,333

Horry County

The following descriptions for fishing communities in South Carolina are notes from Kim Iverson of South Carolina Department of Natural Resources. Kim has spent many months interviewing both commercial and recreational fishermen in South Carolina and other parts of the South Atlantic region as part of several research projects. Although the research was not intended to identify fishing communities, her notes represent the best available information on fishing communities for South Carolina.

Little River has a long history of fishing activity, both commercial and recreationally. The headboat operations date back to the 1940's. As of 1996, there were headboats operating in Little River. There are approximately 4 vessels that actively run charters and also commercial fish. Several full time snapper/grouper vessels operate out of the area. Little River also hosts an annual Blue Crab Festival each spring (Kim Iverson, SCDNR pers. comm., 1998).

Murrells Inlet has a large fleet of charter and headboats, with one marina hosting one of the Governor's Cup Billfishing Tournaments. There are several smaller fishing tournaments held in the area. There are fish houses in the community that deal primarily with finfish. There are no shrimp dealers. This area is also noted for it's large number of seafood restaurants that target the tourist market from Myrtle Beach (Kim Iverson, SCDNR pers. comm., 1998).

Major fishing tournaments held in Murrells Inlet are: March of Dimes Annual Flounder Tournament - Voyagers View Marina. Registration was by angler with approximately 200 anglers participating. Local tournament with many family participants. Primarily smaller boats < 25' participating. Tournament date May 17.; and the Marlin Quay Governor's Cup Billfish Tournament - Marlin Quay Marina. The last in the series of SC Gov. Cup. Total of 31 boats registered. July 23-26 (Kim Iverson, SCDNR pers. comm., 1998).

Major tournaments in North Myrtle Beach: Dock Holidays Governor's Cup Billfish Tournament - Dock Holiday's Marina. The first tournament in a series of 6 for the SC Governor's Cup. April 30 - May 3. Total of 25 boats entered; Frantic Atlantic King Mackerel Tournaments - North Myrtle Beach - Blue Marlin Yacht & Fishing Club. A two tournament series consisting of the Spring and Fall Classics. Total purse of $250,000 for the series. Total of 392 paid boat entries with an average of 4.09 anglers per boat. Tournament dates May 9-11, September 26-28; Evinrude Outboard King Mackerel Tournament - Oct. 11-12, Weigh-in

stations at Dock Holidays Marina, Marlin Quay Marina and Georgetown Landing. 147 boats were registered; Yamaha Contender King Mackerel Classic - Weigh in stations at Dock Holidays Marina, Marlin Quay Marina and Georgetown Landing. 125 boats registered; Fall Pier King Tournament - September 19-21 (Kim Iverson, SCDNR pers. comm., 1998).

One of the largest concentration of snapper grouper vessels is located in Murrells Inlet, SC. Most of the reef fishermen in this area are full time commercial fishermen and consider bandit reels to be the most effective way of catching snapper grouper. There is a wide variety of snapper grouper species off of Murrells Inlet, with gag grouper, scamp grouper and vermilion snapper being highly targeted. The average trip length is 5 days with some of the larger boats (>40 ft.) fishing up to 10 days. A few smaller bandit boats may stay out for 2-3- days. The Gulf Stream is approximately 62 miles offshore from Murrells Inlet. Most bandit boats fish between the 20-50 fathom line, concentrating on the 25 fathom curve. Winter weather dictates that fishermen fish shallow, in waters 60-90' deep. Several fishermen switch to sea bass trapping during the winter months (Iverson, 1997).

Horry County has shown a small increase in personal income from fishing that follows the general increase in personal income overall (Table 17).

Table 17. Population and Economic Information for Horry County, South Carolina. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Horry				
	Population	148,385	152,435	157,834
	Personal Income (Thousands of $)	2,543,793	2,744,260	3,013,059
	Per Capita Pers Income ($)	17,143	18,177	19,220
	Personal Income Fishing (Thousands of $)	81	129	169

Vessels in Murrells Inlet will fish an area from Frying Pan Shoals off southern NC, south to Savannah. The average boat has two crew members. It is interesting to note that fishermen stated a crew of 3 plus the captain was ideal for this area, but decreasing catches and increased costs have made it necessary to cut back on crew members (Iverson, 1997).

Georgetown County

The community of Georgetown has shrimp dealers who also deal in finfish and shellfish. Georgetown is host to the one of the SC Governor's Cup Billfish Tournaments along with several other smaller fishing tournaments. There are no headboats operating from the area and charter activity is limited. Georgetown is known for it's historic waterfront district (Kim Iverson, SCDNR pers. comm., 1998).

Major fishing tournaments in Georgetown County: Georgetown Landing Governor's Cup Billfishing Tournament - May 21-24, Georgetown Landing Marina. The oldest of the series tournaments with 45 boats participating.

Georgetown County shows an increasing personal income from fishing like Horry County in Table 18 but, personal income from fishing tends to be a larger percentage of overall personal income than in Horry County.

Table 18. Population and Economic Information for Georgetown County, South Carolina. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Georgetown				
	Population	49,371	49,966	50,835
	Personal Income (Thousands of $)	822,317	885,024	946,898
	Per Capita Pers Income ($)	16,656	17,713	18,627
	Personal Income Fishing (Thousands of $)	246	388	399

Charleston County

McClellanville is a small community with a long history of commercial shrimping. McClellanville has a large shrimp fleet. At any given time (dependent upon the season) there can be as many as 20 shrimp boats at the docks. Shrimp wholesale dealers are also present within the community. McClellanville hosts an annual Blessing of the Fleet Festival each spring. Shem Creek (Mt. Pleasant) hosts a mixture of commercial and recreational fishing activity along with a number of seafood restaurants, a retail seafood market and a waterfront hotel. There are also headboats operating out of Shem Creek along with charter operations. There is a large permanent shrimp fleet and many shrimp boats visit seasonally. At any give time there are an average of 30 shrimp boats along the creek. Shrimp dealers along the creek also buy and sell finfish from the trawlers. There are several offshore fishing boats including longline and snapper/grouper boats. Several shellfishermen and crabbers do business along the creek. Each spring, Mt. Pleasant hosts an Annual Blessing of the Fleet for the shrimp boats.

In Folly Beach there is a concentration of commercial fishing vessels and several fish houses who handle offshore finfish, shellfish, shrimp and crabs. Rockville is a historical small community located at the south end of Wadmalaw Island. There are commercial dealers who handle shrimp, inshore fish, offshore finfish and some shellfish. On Edisto Island there are several commercial seafood dealers. There are approximately 10 shrimp boats that operate there, fluctuating with the season. The dealers handle primarily shrimp and in-shore species along with shellfish and blue crabs. There is also a large "harvest" of horseshoe crabs. These crabs are "bled" for their blood that is used in cancer research and returned to the water. Edisto Island is also host to the annual SC Governor's Cup Billfish Tournament. Charter activity here is limited. Bennett's Point is a small community south of Edisto with shrimping operations in the community. There are 10-15 small boat shrimpers that live in Walterboro and fish out of Bennett's Point (Kim Iverson, SCDNR pers. comm., 1998).

Table 19. Population and Economic Information for Charleston County, South Carolina. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Charleston	Population	297,888	287,139	281,068
	Personal Income (Thousands of $)	5,653,489	5,879,506	6,083,636
	Per Capita Pers Income ($)	18,979	20,476	21,645
	Personal Income Fishing (Thousands of $)	3,188	3,809	----

Charleston County (Table 19) has a higher personal income from fishing than the previous two counties, but has a much larger overall dollar value for personal income overall.

Major fishing tournaments in the Charleston County area: SCSSA (South Carolina Saltwater Sportfishing Assoc.) Early Bird - Ashley Marina. Approximately 25 registered boats. April 19. Multi-species tournament; James Island King Mackerel Tournament - James Island

Yacht Club, May 24; Wild Dunes Governor's Cup Billfish - June 11-14. Total of 46 registered boats; Bohicket Invitational Governor's Cup Billfish - June 25-28. Total of 48 registered boats. Bohicket Marina on John's Island; Lowcountry Angler's Inshore Tournament - June 28. Multi-species tournament held at the East Cooper Outboard Motor Club on Gold Bug Island in Mt. Pleasant. Registration by angler, with approximately 200 anglers registered; SCSSA Sailfish XV - Ashley Marina in Charleston. Club sponsored tournament with approximately 25 boats registered. Sailfish, tuna, dolphin & wahoo. August 8-10; Fishing For Miracles King Mackerel Tournament - Ripley's Light Marina. Large King tournament with over 200 boats entered. August 14-16; Alison Oswald, Sr. Memorial Tournament - James Island Yacht Club. Local tournament with approximately 75 boats participating. Multi-species. Aug. 23; Edisto Marina Governor's Cup Billfish Tournament - July 16-19. One of the oldest and largest of the Billfish Series. 46 Boats registered. Edisto Island (Kim Iverson, SCDNR pers. comm., 1998).

Beaufort County

In Frogmore there are 8 commercial dealers which are home to over 50 shrimpers. This does not include the many individuals with shrimp boats in their back yards. The dealers primarily handle shrimp but others may also handle crabs and shellfish. There is a large blue crab industry on nearby Lady's Island. There are several commercial seafood dealers in the Port Royal area with over 30 shrimp boats. There are also commercial crabbers, shad fishermen and offshore finfishermen here. There are a small number of charter vessels operating out of this area also. Hilton Head Island primarily caters to the tourist trade. There are several headboats operating on Hilton Head. These boats make half-day trips and night trips for shark fishing. There are four major marinas that offer charter fishing. Commercially, Hilton Head had 4 seafood dealers and approximately 12-15 shrimp boats (Kim Iverson, SCDNR pers. comm., 1998).

Data on personal income from fishing in Table 20 for Beaufort County may have been excluded due to confidentiality issues.

Table 20. Population and Economic Information for Beaufort County, South Carolina. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Beaufort				
	Population	94,375	97,293	100,017
	Personal Income (Thousands of $)	2,057,250	2,194,774	2,373,921
	Per Capita Pers Income ($)	21,799	22,558	23,774
	Personal Income Fishing (Thousands of $)	----	----	----

Major fishing tournaments in Beaufort County: 42nd Annual Beaufort County Water Festival Fishing Tournament - June 28. Held in conjunction with the annual Beaufort Water Festival; Hilton Head Kingfish Classic - Schillings Marina, Hilton Head Island. July 10-12. Registration by angler with a total of 49 registered; Dottie Dunbar Women's Tournament - Palmetto Bay Marina, Hilton Head. Women's only multi-species inshore tournament. Total of 49 anglers registered. October 4 (Kim Iverson, SCDNR pers. comm., 1998).

Possible fishing communities in South Carolina: Charleston, Mt. Pleasant, Hilton Head, Port Royal, Frogmore (St. Helena), Bennett's Point, Edisto Beach, Rockville, Folly Beach, Shem Creek, McClellanville, Georgetown Waterfront, Murrell's Inlet, Little River (most of these locations are designated ports of landing)

Counties in South Carolina have seen a general increase in these occupations and industries over the past three decades (Table 21), with the exception of Horry County which has seen a slight decreasing trend.

Table 21. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for South Carolina Coastal Counties for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	**Occupation/Industry**	**1970**	**1980**	**1990**
Horry County	Farm/Fish/Forest	2627	2542	2310
	Agri.,Fishing,Mining	2843	2653	2110
Georgetown County	Farm/Fish/Forest	403	558	597
	Agri.,Fishing,Mining	552	856	690
Charleston County	Farm/Fish/Forest	810	1697	2056
	Agri.,Fishing,Mining	1256	1938	2316
Beaufort County	Farm/Fish/Forest	436	938	966
	Agri.,Fishing,Mining	698	1087	1111
Colleton County	Farm/Fish/Forest	532	614	730
	Agri.,Fishing,Mining	787	705	782

For the Charleston, South Carolina MSA (Table 22) there are 113 individuals who indicated fishing as their year round occupation . Another 102 individuals indicated that it is a part time or seasonal occupation for them. This represents over half of those individuals in South Carolina who indicated the occupation as fishing from Table 15. The Charleston, SC MSA includes Berkely, Charleston and Dorchester counties.

Table 22. Number of Individuals in Occupation of Fishing By Work Status and Gender for the Charleston, SC MSA in 1989. Source: 1990 Census Of Population And Housing.

	Year Round Full Time	Other	Total
Male	102	102	204
Female	11	0	11
Total	113	102	215

4.3.3.1.4 Georgia

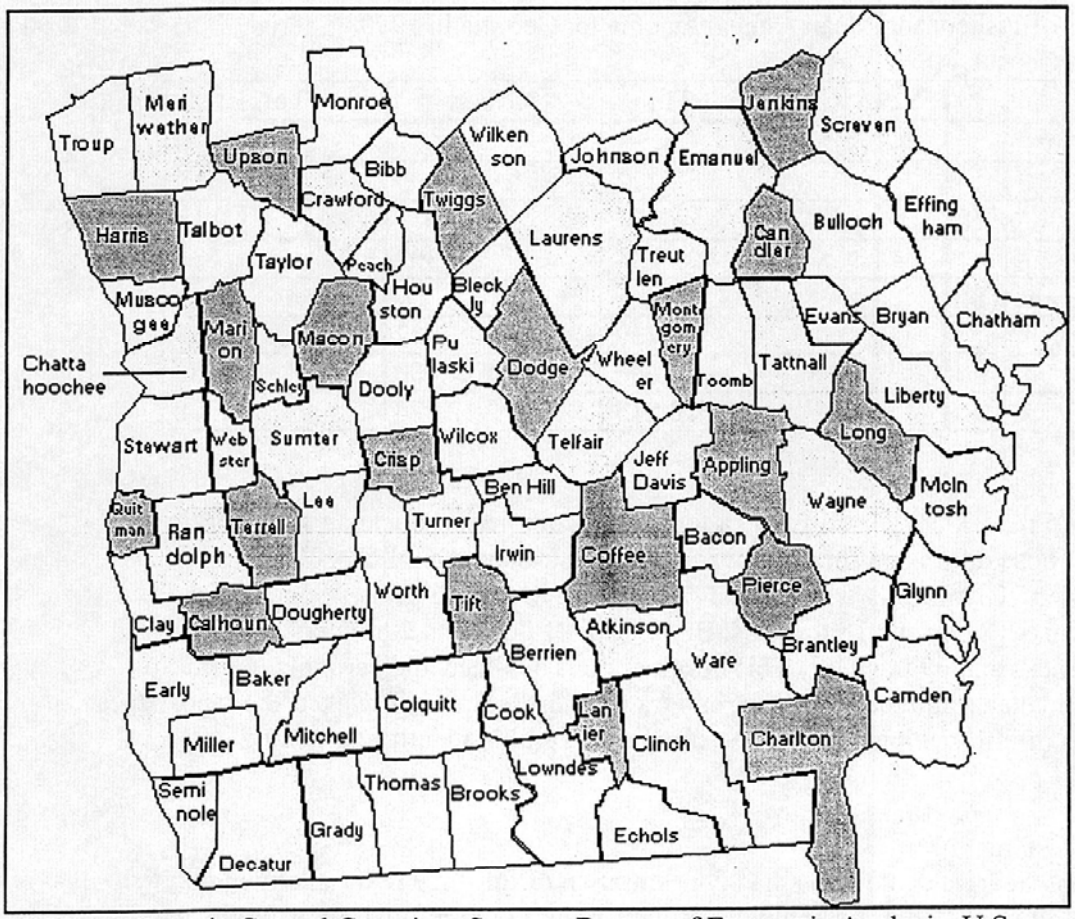

Figure 4. Georgia Coastal Counties. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

The 1990 Census of Population and Housing provides the following information for Georgia regarding individuals who reported their occupation as fisher in Table 23. A total of 536 individuals claimed Fisher as their occupational title with less than half indicating it was a year round full time employment. There were few females who indicated such and they had a far lower mean annual income than males who indicated it was a full time occupation. However, females who indicated it was other than full time had a much higher mean income than any other category. This may be due to a low sample size, however.

Table 23. Number of Fishers and Mean Annual Income for Georgia in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of fishers			
Male	222	295	518
Female	11	7	18
Total	234	302	536
Mean Annual Income ($)			
Male	19,139	11,082	15,058
Female	8,600	25,000	20,080
Total	18,813	12,024	15,308

Shrimping

In their 1975 report, Nix et. al., found a total of 32 commercial docks in six Georgia coastal counties. Those docks and shrimp trawlers were distributed as follows: Camden Co. - 5 docks and 33 trawlers; Glynn Co. - 5 docks and 74 trawlers; McIntosh Co. - 12 docks and 111 trawlers; Liberty Co. - 1 dock and 18 trawlers; Bryan Co. - 1 dock and 2 trawlers; and finally Chatham Co. - 8 docks and 69 trawlers. This information is outdated and certainly does not represent the current status and location of shrimp trawlers in Georgia. However, the report does represent the kinds of information that can be extremely helpful in identifying fishing communities.

Snapper Grouper Fishing

The coast of Georgia contains a small concentration of full-time reef fishermen that fish primarily with bandit reels. Their fishing patterns are similar to those found in SC with vessels fishing from northern Florida north to the SC/NC line (Iverson, 1997).

Possible fishing communities in Georgia: Savannah, Brunswick, St. Marys, Jekyll Island, and Darien.

Table 24. Number of Captains of Fishing Vessels and other officers and Mean Annual Income for Georgia in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of Captains			
Male	17	21	38
Female	0	0	0
Total	17	21	38
Mean Annual Income ($)			
Male	25,706	1,976	12,592
Female	0	0	0
Total	25,706	1,976	12,592

Table 25. Population and Economic Information for Chatham County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Chatham	Population (number of persons)	224,050	225,779	226,554
	Personal income (thousands of dollar	4,569,113	4,810,530	5,087,638
	Per capita personal income (dollars)	20,393	21,306	22,457
	Personal Income Fishing (Thousands of $)	650	(D)	25

Table 26. Population and Economic Information for Bryan County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Bryan				
	Population	18,827	20,008	21,212
	Personal Income (Thousands of $)	274,738	307,258	342,128
	Per Capita Pers Income ($)	14,593	15,357	16,129
	Personal Income Fishing (Thousands of $)	251	359	----

Table 27. Population and Economic Information for Liberty County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Liberty				
	Population	56,625	58,827	58,571
	Personal Income (Thousands of $)	636,042	669,454	709,468
	Per Capita Pers Income ($)	11,233	11,380	12,113
	Personal Income Fishing (Thousands of $)	----	90	97

Table 28. Population and Economic Information for McIntosh County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
McIntosh				
	Population	8,985	9,153	9,372
	Personal Income (Thousands of $)	110,187	116,171	125,645
	Per Capita Pers Income ($)	12,263	12,692	13,406
	Personal Income Fishing (Thousands of $)	3,619	4,486	----

Table 29. Population and Economic Information for Glynn County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Glynn				
	Population	64,759	64,956	65,450
	Personal Income (Thousands of $)	1,322,745	1,400,544	1,505,337
	Per Capita Pers Income ($)	20,426	21,558	23,000
	Personal Income Fishing (Thousands of $)	328	343	351

Table 30. Population and Economic Information for Camden County, Georgia. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Camden				
	Population	39,712	41,262	40,819
	Personal Income (Thousands of $)	502,639	542,385	556,622
	Per Capita Pers Income ($)	12,657	13,145	13,636
	Personal Income Fishing (Thousands of $)	1,889	2,431	2,484

Georgia coastal counties have seen a general increase in these occupations and industries with the exception of Liberty County which has shown a decrease from 1970-1990.

Table 31. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for Georgia Coastal Counties for 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	Occupation/Industry	1970	1980	1990
Bryan County	Agri.,Fishing,Mining	161	100	200
	Farm/Fish/Forest	121	135	136
Chatham County	Agri.,Fishing,Mining	558	686	1103
	Farm/Fish/Forest	228	704	1062
Liberty County	Agri.,Fishing,Mining	332	146	152
	Farm/Fish/Forest	242	205	157
McIntosh County	Agri.,Fishing,Mining	233	266	169
	Farm/Fish/Forest	27	260	193
Glynn County	Agri.,Fishing,Mining	261	482	593
	Farm/Fish/Forest	84	581	712
Camden County	Agri.,Fishing,Mining	209	126	176
	Farm/Fish/Forest	106	110	205

4.3.3.1.5 Florida

Florida's eastern coastline is made up largely of metropolitan counties. This is primarily due to the increases in population for Florida's coastal counties over the past 50 years. Florida's coastline has become a very popular retirement destination and tourist attraction. Because they are largely metropolitan, fishing communities here may be subsumed into these larger metropolitan areas and difficult to identify. Data presented from the most recent Census will also show that in relation to the larger economy, fishing will contribute very little at the county level for most coastal counties. Over the years, with the demographic changes following the inmigration of retirees and tourists and the subsequent economic transition, few fishing communities will have survived as distinct communities.

The data presented in Table 32 shows Florida as having almost 6,000 individuals claiming fisher as their occupation in the 1990 census; 381 of those individuals were female. Mean annual income is highest for those reporting fishing as a full time occupation with women reporting a lower mean annual income in all categories.

Table 32. Number of Fishers and Mean Annual Income for Florida in 1990. Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of fishers			
Male	2,698	2,844	5,544
Female	111	270	381
Total	2,809	3,116	5,925
Mean Annual Income ($)			
Male	23,288	11,794	17,388
Female	17,285	11,511	13,193
Total	23,051	11,770	17,118

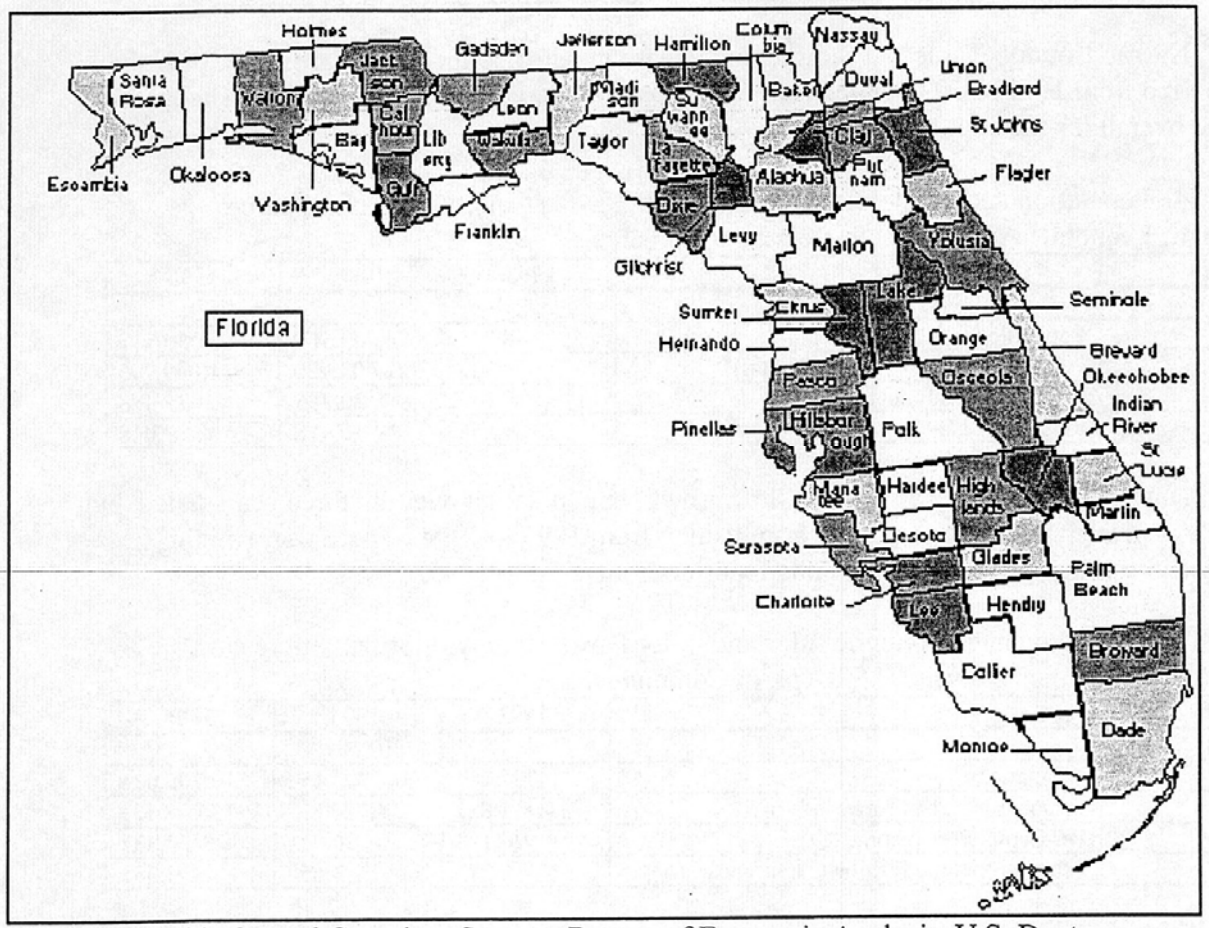

Figure 5. Florida Coastal Counties. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

There were over 1100 individuals from Florida who reported their occupation as captain of a fishing vessel during the 1990 census, with 51 of them being female (Table 33). Again, mean annual income was highest for full time workers and females reported lower mean annual income for both full time and other work.

Table 33. Number of Captains of Fishing Vessels and other officers and Mean Annual Income for Florida in 1990 Source: U.S. Bureau of the Census.

	Year Round/Full Time	Other	Total
Number of Captains			
Male	430	633	1,063
Female	26	25	51
Total	456	658	1,114
Mean Annual Income ($)			
Male	25,993	21,274	23,183
Female	8,487	15,420	11,885
Total	24,995	21,052	22,666

Nassau County (Table 34) showed an increase in personal income from fishing over the time period from 1993 to 1995 which reflects the general increase in population and personal income overall for the county.

Table 34. Population and Economic Information for Nassau County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Nassau				
	Population	48,355	49,565	50,717
	Personal Income (Thousands of $)	954,342	1,003,920	1,089,793
	Per Capita Pers Income ($)	19,736	20,255	21,488
	Personal Income Fishing (Thousands of $)	1,540	1,918	2,068

Duval County (Table 35) shows slow growth in population over the three years listed, but does show growth in personal income from fishing from 1993 to 1994. There was a slight decrease in personal income from fishing reported from 1994 to 1995.

Table 35. Population and Economic Information for Duval County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Duval				
	Population	701,267	703,152	705,014
	Personal Income (Thousands of $)	14,111,822	14,724,897	15,748,121
	Per Capita Pers Income ($)	20,123	20,941	22,337
	Personal Income Fishing (Thousands of $)	2,272	3,658	3,335

St John's County (Table 36) had some growth in personal income from fishing from 1993 to 1994 but no data were available for 1995 to indicate whether that trend continued.

Table 36. Population and Economic Information for St. John's County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
St. Johns				
	Population	94,480	98,377	101,966
	Personal Income (Thousands of $)	2,394,764	2,612,557	2,869,300
	Per Capita Pers Income ($)	25,347	26,557	28,140

	Personal Income Fishing (Thousands of $)	432	502	----

According to Table 37, Flagler County had no individuals reporting personal income from fishing for the time period 1993 to 1995. Volusia County also has no personal income from fishing listed in Table 38, but data were not included due to confidentiality issues.

Table 37. Population and Economic Information for Flagler County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Flagler				
	Population	35,868	37,894	40,260
	Personal Income (Thousands of $)	571,528	631,959	692,269
	Per Capita Pers Income ($)	15,934	16,677	17,195
	Personal Income Fishing (Thousands of $)	0	0	0

Table 38. Population and Economic Information for Volusia County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Volusia				
	Population	397,372	405,515	410,115
	Personal Income (Thousands of $)	6,845,402	7,235,060	7,772,063
	Per Capita Pers Income ($)	17,227	17,842	18,951
	Personal Income Fishing (Thousands of $)	----	----	----

Indian River County saw an increase in personal income from fishing from 1993 to 1994 according to Table 39, but saw a decrease from 1994 to 1995. St. Lucie County (Table 40) may have had a similar trend although data from 1993 are missing and the trend is not clear.

Table 39. Population and Economic Information for Indian River County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Indian River				
	Population	94,184	95,374	96,263
	Personal Income (Thousands of $)	2,686,514	2,827,427	3,065,533
	Per Capita Pers Income ($)	28,524	29,646	31,845
	Personal Income Fishing (Thousands of $)	1,340	1,826	1,707

Table 40. Population and Economic Information for St. Lucie County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
St. Lucie				
	Population	165,120	169,284	171,914
	Personal Income (Thousands of $)	2,719,602	2,840,752	3,051,018
	Per Capita Pers Income ($)	16,470	16,781	17,747
	Personal Income Fishing (Thousands of $)	----	1,855	1,303

Table 41. Population and Economic Information for Broward County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce

County		1993	1994	1995
Broward				
	Population	1,353,279	1,358,585	1,412,942
	Personal Income (Thousands of $)	32,716,045	34,273,950	37,007,667
	Per Capita Pers Income ($)	24,175	24,736	26,192
	Personal Income Fishing (Thousands of $)	658	816	- - - -

The trend in personal income from fishing for Broward County is not clear as data from 1995 are missing from Table 41 because of confidentiality. Brevard County (Table 42) shows a decrease in personal income from fishing during 1994 to 1995, but overall shows a much larger percentage of personal income coming from fishing than most counties previous.

Table 42. Population and Economic Information for Brevard County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Brevard				
	Population	435,546	443,337	450,238
	Personal Income (Thousands of $)	8,564,204	8,938,218	9,341,030
	Per Capita Pers Income ($)	19,663	20,161	20,747
	Personal Income Fishing (Thousands of $)	3,600	4,690	3,797

Martin County has one of the highest per capita incomes reported over the three year period according to Table 43. There was also a significant increase in personal income from fishing from 1993 to 1994 which decreased in 1995. Palm Beach County, with an even higher per capita income, showed an increase in personal income from fishing from 1993 to 1994 with no data available for 1995 (Table 44).

Table 43. Population and Economic Information for Martin County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Martin				
	Population	107,238	109,194	110,495
	Personal Income (Thousands of $)	3,406,064	3,521,665	3,815,294
	Per Capita Pers Income ($)	31,762	32,251	34,529
	Personal Income Fishing (Thousands of $)	270	1,658	819

Table 44. Population and Economic Information for Palm Beach County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Palm Beach				
	Population	933,644	957,522	976,358
	Personal Income (Thousands of $)	30,994,531	32,423,719	35,204,121
	Per Capita Pers Income ($)	33,197	33,862	36,057
	Personal Income Fishing (Thousands of $)	1,464	1,902	- - - -

Dade County shows a steady growth in personal income from fishing for the time period listed in Table 45. Monroe County shows, by far, the highest personal income from fishing for any Florida county and most likely any county in the South Atlantic according to Table 46.

Table 45. Population and Economic Information for Dade County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Dade				
	Population	1,985,373	2,011,571	2,046,078
	Personal Income (Thousands of $)	39,110,301	40,344,476	43,087,320
	Per Capita Pers Income ($)	19,699	20,056	21,058
	Personal Income Fishing (Thousands of $)	1,247	1,479	1,897

Table 46. Population and Economic Information for Monroe County, Florida. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce.

County		1993	1994	1995
Monroe				
	Population	81,737	81,461	81,152
	Personal Income (Thousands of $)	1,982,209	2,054,326	2,208,152
	Per Capita Pers Income ($)	24,251	25,219	27,210
	Personal Income Fishing (Thousands of $)	13,506	15,558	16,723

Recently, data were compiled from the last three census and placed into a user friendly interface through a MARFIN grant by the Louisiana Population Data Center, Louisiana State University (C. M. Tolbert, et al. 1998). Those data provide a time series of information from the last three census with the ability to compare several variables at the state,. county and place level. Census places are incorporated and Census designated places of 2500 or more persons. The tables presented below incorporate the data included in the MARFIN SocioDemographic Database for the coastal counties outlined above with a focus on the occupational classification of Farm/Fish/Forest and the industry classification of Agriculture, Fishing, and Mining. These classifications are inclusive of those within the occupation and industry of fishing, but not exclusive of others, therefore it is difficult to know the exact number of individuals who have indicated their occupation or business is fishing. We can only assume that whatever trend appears over the time corresponds to the occupation of fishing as well as the others.

Data covering Metropolitan Statistical Areas are provided because it includes a more detailed occupational breakdown, but unfortunately geographic boundaries expand as most MSAs encompass more than one county. In some cases, MSAs were not used because the area covered did not correspond with the coastal areas within the South Atlantic region. As mentioned earlier, these data are what is currently available. Further analysis is constrained by variety of issues relating to data computability and availability at each place level of analysis. As mentioned before more research on fishing communities will be required before a more complete definition and identification can be accomplished.

Examining census data at the level of Metropolitan Statistical area reveals greater detail for occupation, but the scale changes as MSAs often times encompass more than one county. Metropolitan area (MA) is a large population nucleus, together with adjacent communities that have a high degree of economic and social integration with that nucleus. Metropolitan Areas must contain either a place with a minimum population of 50,000 or a Census Bureau-defined

urbanized area and a total MA population of at least 100,000. An MA comprises one or more central counties and also may include one or more outlying counties that have close economic and social relationships with the central county. Metropolitan statistical areas (MSA's) are relatively freestanding MA's and are not closely associated with other MA's. These areas typically are surrounded by nonmetropolitan counties. See Appendix ?? for details on the parameters for the coastal MSAs included in this discussion.

When you look at the occupations of farming, fishing and forestry for Florida coastal counties in Table 47, over the past 20 years there is, in general, a steady increase in the number of individuals within these occupations and industries.

Table 47. Number within Farm/Fish/Forest Occupation and Agriculture, Fishing, Mining Industry for East Florida Coastal Counties from 1970, 1980, and 1990 Census. Source: MARFIN Sociodemographic Database

County	Occupation/Industry	1970	1980	1990
Nassau County	Farm/Fish/Forest	371	427	559
	Agri.,Fishing,Mining	501	462	606
Duval County	Farm/Fish/Forest	1237	2782	3729
	Agri.,Fishing,Mining	2536	2959	4324
St.Johns County	Farm/Fish/Forest	794	813	1002
	Agri.,Fishing,Mining	1012	883	976
Flagler County	Farm/Fish/Forest	145	314	408
	Agri.,Fishing,Mining	186	298	403
Volusia County	Farm/Fish/Forest	1308	3150	4917
	Agri.,Fishing,Mining	2511	3407	5606
Indian River County	Farm/Fish/Forest	991	1907	2042
	Agri.,Fishing,Mining	1454	2361	2217
St. Lucie County	Farm/Fish/Forest	2602	2710	3147
	Agri.,Fishing,Mining	3253	3252	3342
Broward County	Farm/Fish/Forest	1982	7358	9425
	Agri.,Fishing,Mining	5354	7756	10317
Brevard County	Farm/Fish/Forest	764	1772	3369
	Agri.,Fishing,Mining	1394	2279	3585
Martin County	Farm/Fish/Forest	964	1838	1983
	Agri.,Fishing,Mining	1268	2032	2086
Palm Beach County	Farm/Fish/Forest	6552	9676	13261
	Agri.,Fishing,Mining	9791	11780	15155
Dade County	Farm/Fish/Forest	4804	11257	14894
	Agri.,Fishing,Mining	9682	13708	16926
Monroe County	Farm/Fish/Forest	163	1769	1729
	Agri.,Fishing,Mining	920	1932	1860

The following table includes only those individuals who reported their occupation as fishing for the following Metropolitan Statistical Areas (MSA) within Florida.

Table 48. Number of Individuals in Occupation of Fishing By Work Status and Gender for Florida MSA in 1989. Source: 1990 Census Of Population And Housing.

Jacksonville		Year Round Full Time	Other	Total
	Male	151	210	361
	Female	15	49	64
	Total	166	259	425
West Palm Beach		Year Round Full Time	Other	Total
	Male	94	47	141
	Female	0	0	0
	Total	94	47	141
Miami		Year Round Full Time	Other	Total
	Male	254	254	508
	Female	0	30	0
	Total	254	284	538

Snapper Grouper Fishery Profile

Concentrations of reef fishermen can be found in the communities of Mayport, Port Orange and New Smyrna, north of Cape Canaveral. Bandit reels are the primary gear used for reef fishing in these areas, although a few bottom longline vessels are present. In northern Florida, bandit fishermen report trips lasting 5-6 days and fish 30-50 miles offshore. They average between 2 to 3 crew members depending on vessel size and gear. Vessels from the Mayport area reported fishing from the Georgia line south to the Daytona area. The larger longline vessels are required by regulations to fish past the 50 fathom line and reported trip lengths of up to 10 days, fishing as far as 100 miles from shore. These bottom long line vessels fish for deep water species such as tilefish in water 600 - 900' deep (Iverson, 1997).

King Mackerel Fishery Profile

McKenna (1994) identified the number of fishermen in Florida reporting landings of king mackerel (based on Saltwater Products Licenses) from 1987 to 1993 as varying from 1,500 to 2,222. From 1986 to 1990 the number of commercial permits for Atlantic migratory group king mackerel ranged from a high of 888 in 1989/90 fishing season to low of 785 in the 1987/88 fishing year. The percentage of those permits which were hook and line fishermen for those years ranged from 89% in 86/87 to 78% in 1990. There were 1654 vessels permitted for commercial king mackerel and Spanish mackerel in Florida for the 1993-94 fishing year. The number of permitted vessels was divided with 846 and 808 allocated to the East and West coasts respectively. How many of those vessels landed king mackerel is unknown at this time. Catch per unit of effort data seems fairly consistent for the southeastern region of the Atlantic group king mackerel with an average CPUE of between 200-300 lbs/trip (McKenna, 1994). Most of the commercial landings of Atlantic group king mackerel are made by hook and line fishermen. In addition, because most landings of Atlantic group king mackerel are in Florida and the most

information that exists is on the Florida fishery, the following description will focus primarily on the Florida fishery unless noted otherwise.

King Mackerel Hook and Line Fleet

There were approximately 203 full and part time vessels in the hook and line mackerel fleet in 1980. Vessel size ranged from 22-44 feet in length. Today, the Florida South Atlantic troll fishery is composed of about 100 full-time and 100 part-time operations, about 150 of them are dependent upon king mackerel. Full-time fishermen operate primarily out of Jupiter, Port Salerno, Fort Pierce, Sebastian, and Rivera Beach. Normally, there is one fisherman to a boat. Part-time fishermen operate mostly out of Palm Beach, frequently two or three fishermen per boat. Approximately 40 percent of the full time trollers switch to bottom fishing for various reef fish after the Gulf king mackerel season. The remainder of these full time trollers tie up their boats when the Gulf king mackerel season ends. Some engage in various non-fishing jobs, while the majority reportedly wait for the opening of the Atlantic king mackerel season (GMFMC & SAFMC, 1994).

During the peak season about 75 to 100 troll vessels and 16 to 20 net vessels target king mackerel in the Keys. Net vessels usually start fishing late December, although some of these vessels troll for mackerel before net fishing becomes more practicable. Most king mackerel fishermen in the Keys target other species such as stone crab, spiny lobster, and reef fish throughout the year.

King Mackerel Net Fishing Fleet

There were approximately 89 large gill net vessels in Florida including full and part time in 1980. The vessels ranged in size from 30-65 feet. These vessels fished Spanish and king mackerel during the winter, but also targeted lobster, swordfish and bait fish during other times of the year. Vessels over 40 feet usually employed a power roller to haul nets. The large gill net fleet was primarily located from Florida's central east coast in Ft. Pierce, throughout the Florida Keys to the central west coast as far north as Cortez. There were also a few large boats in the Panhandle area of Port St. Joseph (Centaur Associates, 1981).

Approximately 87% of captains in the large gill net fleet at that time depended entirely upon fishing for their income. Net fishermen, then as they do today, have the options of participating in the Spanish mackerel fishery, trolling for king mackerel, and fishing with nets or hook and line for Atlantic group king mackerel after March (Centaur Associates 1981).

Today, there are twelve large net boats located in the Keys that may fish Atlantic group king mackerel occasionally. These vessels have a capacity of up to 40,000 pounds per trip and have had large catches of king mackerel in the past. There does not seem to be a small gill net boat sector for Atlantic king mackerel. In Monroe County there are 16 to 20 large net boats currently participating in the king mackerel fishery, some with capacity to land up to 50,000 pounds. There are another 6 to 12 small net boats in south-west Florida ready to enter the fishery when the opportunity arises. These vessels are 30 to 40 feet in length with capacities of 5,000 to 10,000 pounds.

There has been a general decline in net catches along the Florida east coast. This may be attributed to regulations like the prohibition of drift nets and purse seines, but also stems from the recent net ban in Florida state waters.

King Mackerel Dealers

McKenna (1994) identified over 200 dealers in Florida who had handled king mackerel since 1987. In 1992 there were 240 who reported landings of king mackerel. Most of those dealers purchased king mackerel ten or fewer times per season and handled less than 5000 pounds. There were over twenty dealers who handled 100,000 pounds or more during the 1992 season (McKenna, 1994) .

Possible fishing communities in Florida: Mayport, Port Orange, New Smyrna, Sebastian, Port Salerno, Rivera Beach, Ft. Pierce, Jupiter, West Palm Beach, Boyton Beaches, The Keys -- Upper Keys: Key Largo, Tavernier; Middle Keys - Islamorada, Marathon; Lower Keys; and Key West.

4.3.3.1.6 Other Community related Analysis

In a recent survey of snapper grouper fishermen in the South Atlantic questions were posed concerning a fishermen's tenure within a community and attitudes towards community change. The results in Table 49 show that the majority of fishermen feel their community has stayed the same or has changed for the better. A larger percentage of inactive than active snapper grouper fishermen feel that their community has changed for the worse. Well over half of fishermen interviewed had been in their present community for twenty years or more. Over sixty percent of inactive fishermen have lived in their community for twenty years or more, while over fifty percent of active fishermen have lived in their communities for 19 years or less. The mean number of years a fishermen had resided in their present community was twenty years or more for North Carolina, South Carolina and Florida. In comparison Georgia snapper grouper fishermen had an average tenure in their communities of 6.5 years. This may be an artifact of the small sample size in Georgia as only seven fishermen from that state were interviewed, but could also be reflective of the nature of snapper grouper fishing in Georgia (Rhodes et al., 1997).

Table 49. Snapper Grouper Fishermen's Tenure and Attitude toward Change in their Present Community. Source: Socio-demographic Assessment of Commercial Reef Fishermen in the South Atlantic Region. 1997.

	Active (%)	Inactive (%)
Feel Your Community has changed?	(N=201)	(N=26)
For the better	41.8	30.8
For the worse	32.1	46.2
Stayed the same	25.9	23.1
	Active (Yrs)	Inactive (Yrs)
Number of Years in Present Community?	(N=201)	(N=26)
2-12	27.6	25.9
13-19	32.0	11.1
20-35	19.5	33.4
36 <	20.9	29.6

These perspectives on an individual's feelings toward a community become important when that person must face significant changes regarding his/her occupation, as is often the case when limited entry or some other form of fisheries management is implemented. An individual's commitment toward their community and sense of belonging will influence decisions on whether to stay in fishing or within a particular community. The impacts become important for

the community if many individuals face the same decision. When active fishermen were asked what is the likelihood of moving to a new town in the next 2-3 years most responded that it is was unlikely, however, over 27% indicated they were not sure or it was likely. When both inactive and active fishermen were asked the likelihood of leaving commercial fishing altogether 46% of inactive fishermen said it was likely or very likely, while only 11% of active fishermen indicated such a likelihood. (Rhodes et al., 1997). These type of data at the community level would contribute much to the understanding of possible impacts of future fisheries management.

4.3.3.1.7 Data Needs

As mentioned earlier, the data presented here is what is currently available and readily accessible. It is very limiting and does not provide a sufficient amount of detail needed to define and identify fishing communities. Therefore, the likelihood of realistic impact assessment of future fishing regulations on fishing communities is not good.

At the present the NMFS does not collect data on fishing communities. Therefore, it is impossible to realistically identify fishing communities in this amendment. There is a tremendous need for research to be conducted on a continuous basis to collect this information. Both state and federal government agencies have access to current information which can inform the process of identifying fishing communities. Permit databases for fishing licenses, wholesale and retail licenses, boat registrations, marina permits, boat landing locations, and many others exist now. Putting that information into one database is a monumental task, but should be undertaken soon. Geographic Information System software is now available and being used to compile much of the data regarding habitat. The same type of databases need to be created regarding fishing communities. Spatial analysis of the variables that help identify and define fishing communities can give useful insight into the changes that affect these coastal communities.

It is unlikely that Council Staff would be able to gather these data. Council staff have in the past, with the cooperation of industry, been able to gather important information about a particular fishery, but were criticized for not following OMB guidelines. The difficulty with following OMB guidelines is that approval of data gathering tools is too time consuming. Councils are often on a timeline to develop FMPs which does not allow for a lengthy approval process. The South Atlantic Council staff has sufficient expertise with this type of data collection that design, implementation and analysis can often take place during an extremely short time period with little burden upon the public. In fact, industry is often eager to provide these type of data for consideration during development of an FMP, but don't have the expertise to offer data a form that can be used by Council staff.

Data collection is critical to the future of impact assessment of fishing communities. Standards must be set and data need to be collected. At present, the ACCSP is attempting to set those standards and has included social and economic data in that program. The ACCSP Technical Source Document IV contains detailed social and economic data needs and draft survey instruments. Social and economic data collection projects should at least collect the minimum data elements. Support of ACCSP can be an important step in meeting the future needs of the councils with regard to fishing communities. In addition, another guideline for the types of data needed can be found in the Southeast Social and Cultural Data Analysis Plan (NMFS, 1994). The plan was designed to address many of the current social and cultural information needs for the three councils in the Southeast."

Appendix N. Results of Literature Search

Note: The References section (6.0) of this document contains additional titles pertaining to calico scallops.

TI: Title
South Carolina's first calico scallop fishery
AU: Author
Anderson,W.D.; Lacey,W.
AF: Author Affiliation
Mar. Res. Cent., Charleston, SC 29412, USA
CF: Conference
Presented at: 70. Annual Meeting of the National Shellfisheries Assocation, New Orleans, LA (USA), 19 Jan 1978
SO: Source
Proc. Natl. Shellfish. Assoc., Md., 69, 201, (1979)
NT: Notes
Summary only.
ER: Environmental Regime
Marine
AB: Abstract
In 1977, high densities of Argopecten gibbus were found 60 miles offshore of the South Carolina-Georgia border. Monthly growth measurements in conjunction with a resource assessment to determine the extent of the scallop community showed exponential shell growth. Meat yield was commercially favorable and the scallops shucked out to approximately 960 meats per gallon. In Jan 1978 seven Florida scallop trawlers began harvesting the bed and meat yields ranged from 1200 to 650 per gallon. By March, approximately 45 vessels from Florida, North and South Carolina were actively harvesting scallops and an average meat yield of 504 meats per gallon was recorded. The scallops were processed and marketed in Florida and North Carolina. At the end of March, over dollar 800,000 in ex-vessel scallop revenues had been landed in South Carolina.

TI: Title
Biological aspects of the calico scallop, Argopecten gibbus , determined by spat monitoring
AU: Author
Allen,D.M.
AF: Author Affiliation
NOAA, Natl. Mar. Fish. Serv., Southeast Fish. Cent., Miami, FL 33149, USA
SO: Source
Nautilus, 93(4), 107-119, (1979)
ER: Environmental Regime
Marine

AB: Abstract
Biological information on A. gibbus was collected using spat traps as monitoring devices on the Cape Canaveral grounds off the Florida east coast from March 1970 to October 1971. The shells of spat differ in shape and colour from those of adults. Spat and, by deduction, the larval scallops, occurred at five sampling locations off Cape Canaveral in depths of 9 to 24 m; spat were most abundant at the 18 m site. There was no evidence that scallop larvae survived in estuarine waters in the Cape Canaveral area. Based on spat distribution, larvae were apparently distributed throughout the water column but were least abundant near the surface. Seasonally, spat were most abundant in the spring. Growth estimates show that young scallops can reach 1.5 mm shell height in 1 month from spawning, 17.0 mm in 2 months, and 28.0 mm in 3 months. Setting apparently occurred at a minimum size of 0.25 mm shell height and spat showed strong byssal attachment up to at least 5.0 or 6.0 mm shell height. Spat may utilize filamentous host organisms, such as hydroids, for setting, perhaps before attachment to shell. Numerous invertebrates were associated with calico scallops in the traps, but calico scallops were generally dominant. Based on spat abundance, spawning of adults occurred during all seasons, but intensity was highest in spring (March through May) when bottom water temperatures associated with spawning scallops were probably about 18 C. Recommendations for future spat monitoring are discussed.

TI: Title
Occurrence levels of the adductor muscle parasite Sulcascaris sulcata Rudolphi in the calico scallop Argopecten gibbus Linne.
AU: Author
Blake, NJ; Barber, BJ; Rodrick, GE
AF: Author Affiliation
Dep. Mar. Sci., Univ. South Florida, St. Petersburg, FL 33701, USA
CF: Conference
Annu. Meet. National Shellfisheries Association, Hilton Head Island, SC (USA), 6 Jun 1983
SO: Source
Journal of Shellfish Research [J. SHELLFISH RES.], vol. 4, no. 1, p. 82, 1984
IS: ISSN
0077-5711
NT: Notes
Summary only. Rec'd. May 1987.
AB: Abstract
In late 1981 and 1982 the value of the fishery for the calico scallop Argopecten gibbus centered off the east coast of Florida was endangered as a result of the occurrence and recognition of parasites, presumably Sulcascaris sulcata , in the adductor

muscle. In order to determine the geographic distribution and seasonal occurrence of the parasite along the southeastern coast of the United States, scallops were collected in June 1982 from 16 stations ranging from Savannah, GA, to Fort Pierce, FL. Additional collections were made at 6 of those stations off Cape Canaveral, FL, in December 1982. Occurrence of at least one parasite per muscle ranged from 28 to 68%. The internal number of parasites closely followed the number of parasites on the surface of the muscle. A latitudinal pattern of parasite occurrence was not observed; however, levels of parasite occurrence appeared to be related to scallop size and age.

TI: Title
Mitochondrial DNA variation in the bay scallop, Argopecten irradians, and the calico scallop, Argopecten gibbus
AU: Author
Blake, SG
AF: Author Affiliation
Sch. Mar. Sci., Virginia Inst. Mar. Sci., Coll. William and Mary, Gloucester Point, VA 23062, USA
CF: Conference
1994 Annu. Meet. of the National Shellfisheries Assoc., Charleston, SC (USA), 24-28 Apr 1994
SO: Source
Journal of Shellfish Research [J. SHELLFISH RES.], vol. 13, no. 1, p. 277, 1994
IS: ISSN
0077-5711
NT: Notes
Abstract only.
AB: Abstract
The subspecies of the bay scallop, Argopecten irradians, have long been distinguished on the basis of shell morphology, with diagnostic features including rib count, valve color and valve inflation. There is a significant degree of overlap in these characters, however, and there are no clear geographic boundaries delineating the ranges of the subspecies. Variation in the mitochondrial DNA of four geographically separate populations was examined in order to clarify current taxonomic designations and published geographic ranges. The hypothesis, that the sampled populations share a common gene pool, was tested. A concurrent study was conducted for two populations of the calico scallop, Argopecten gibbus.

TI: Title
Mitochondrial DNA variation in the bay scallop, Argopecten irradians (Lamarck, 1819), and the Atlantic calico scallop,

Argopecten gibbus (Linnaeus, 1758)
AU: Author
Blake, SG; Graves, JE
AF: Author Affiliation
Sch. Mar. Sci., Virginia Inst. Mar. Sci., Coll. William Mary, Gloucester Point, VA 23062, USA
SO: Source
Journal of Shellfish Research [J. SHELLFISH RES.], vol. 14, no. 1, pp. 79-85, 1995
IS: ISSN
0077-5711
AB: Abstract
Restriction site variation of the mitochondrial DNA of Argopecten irradians ssp. was surveyed within four populations from the U.S. Atlantic coast and the Gulf of Mexico. A population from North Carolina was resampled one year after the first collection to provide a measure of temporal variation within a population. Haplotype diversity was high, with 49 haplotypes revealed among a total of 135 bay scallops screened with 8 restriction endonucleases. Nucleotide sequence divergences corrected for within-sample variation among populations ranged from 0.00%, between the temporal samples, to 0.33% between geographically distant populations. Tests for heterogeneity indicated that no two of the geographically separated populations shared a common gene pool. UPGMA cluster analysis based on nucleotide sequence divergences suggested that bay scallops in North Carolina waters are more closely related to those from New England than to those from the Florida Gulf, though only slightly. Two populations of the calico scallop, Argopecten gibbus Dall, from the Atlantic and Gulf coasts of Florida, were sampled and analyzed similarly. In these, haplotype diversity was high, with 6 restriction endonucleases revealing 19 different haplotypes among 51 individuals. Nucleotide sequence divergence between the geographically distant populations was low, however, and a test for heterogeneity was consistent with the null hypothesis of a shared, common gene pool for the two populations. No restriction fragment patterns were common to the bay and calico scallop, reinforcing their classification as separate species.

TI: Title
Synopsis of biological data on scallops (Chlamys (Aequipecten) opercularis (Linnaeus), Argopecten irradians (Lamarck), Argopecten gibbus (Linnaeus))
AU: Author
Broom, M.J.
AF: Author Affiliation
Mar. Resour. Res. Unit, Portsmouth Polytech., Portsmouth, England, UK

SO: Source
Publ.by: FAO, Rome (Italy), 1976, 44p., FAO Fish. Synop., (no.114)
PB: Publisher
Publ.by: FAO, Rome (Italy)
ER: Environmental Regime
Marine
AB: Abstract
A synopsis of information on 3 species of scallops is presented. This covers identity, distribution, bionomics and life history, population parameters, exploitation, protection and management.

TI: Title
Carbonate skeletal remains in beach-to-offshore sediments. Pensacola, Florida.
AU: Author
Frey, RW; Doerjes, J
AF: Author Affiliation
Dep. Geol., Univ. Georgia, Athens, GA 30602, USA
SO: Source
Senckenbergiana maritima. Frankfurt/Main [SENCKENB. MARIT.], vol. 20, no. 1-2, pp. 31-57, 1988
IS: ISSN
0080-889X
NT: Notes
Bibliogr.: 73 ref.
AB: Abstract
Distributions of carbonate skeletal components were studied along two beach-to-offshore transects near Pensacola, Florida. Beaches are typified by assemblages of low diversity but moderate abundance of specimens, especially the bivalve Donax variabilis . Shoreface assemblages exhibit intermediate levels of diversity and abundance and are characterized particularly by the bivalves D. variabilis, Strigilla mirabilis, Anadara transversa, Chione intapurpurea , and Macrocallista nimbosa , and the gastropod Olivella pusilla . Offshore accumulations exhibit relatively high levels of diversity and total abundance; the single most characteristic species is the bryozoan Discoporella umbellata . The upper offshore is typified further by the bivalves Argopecten gibbus, Anadara transversa, Anomia simplex , and Varicorbula operculata ; the lower offshore, although needing additional study, seems to be characterized further by the bivalve Laevicardium pictum and the scaphopod Cadulus quadridentatus .

TI: Title
Fatty acids from larval Sulcascaris sp. (Nematoda) as possible indicators of infection of calico scallops (Argopecten gibbus).
AU: Author

Hoskin, G; Bier, JW
AF: Author Affiliation
Div. Microbiol., Food and Drug Adm., Washington, DC 20204, USA
SO: Source
Journal of Food Safety [J. FOOD SAF.], vol. 5, no. 2, pp. 73-78, 1983
AB: Abstract
Fatty acid profiles of larval nematodes (stage-4 Sulcascaris sp.), of tissue from their intermediate host (calico scallops, Argopecten gibbus), and of the host capsule that surrounds the larvae were prepared in an attempt to identify infected scallops. Nematode tissue showed lower ratios of C sub(14:0)/C sub(14:1), C sub(16:0)/C sub(16:1) and C sub(18:0)/C sub(18:1) than did scallop tissue. The nematodes contained relatively less C sub(16:0) and more C sub(18:2) than did scallops. Fatty acids shorter than C sub(14:0) were found in small amounts in both organisms. Fatty acid profiles of capsules differed little from those of normal scallop tissue.

TI: Title
Morphological and genetic variation among three populations of calico scallops, Argopecten gibbus
AU: Author
Krause, MK; Arnold, WS; Ambrose, WG Jr
AF: Author Affiliation
Nat. Sci. Div., Southampton Coll., LIU, Southampton, NY 11968-4198, USA
SO: Source
Journal of Shellfish Research [J. SHELLFISH RES.], vol. 13, no. 2, pp. 529-537, 1994
IS: ISSN
0077-5711
AB: Abstract
We surveyed morphological and genetic variation among three populations of Argopecten gibbus from the Marquesas Keys, Florida; Cape Canaveral, Florida; and Cape Lookout, North Carolina; in order to determine the extent of the genetic isolation of these populations and to examine the hypothesis for larval transport between populations. Burnaby size-adjusted principal component analysis of 14 morphological characters revealed significant differences among sites for the third principle component, which explained 6% of the total variation. Analyses of electrophoretic loci showed significant allele frequency heterogeneity among sites for one of seven polymorphic loci. The magnitude of the morphological and genetic differences between the Marquesas Keys sample and both of the Atlantic coast samples was generally greater than between the geographically more distant Cape

Canaveral and Cape Lookout samples, although overall levels of variation among sites were small. Estimates of gene flow suggest that relatively frequent migration, sufficient for panmixia in the absence of historical divergence, may occur between populations. Our results suggest that oceanographic processes play a critical role in the transport of A. gibbus larvae between populations. We recommend that management of the A. gibbus fishery should include consideration of these processes.

TI: Title
Cd/Ca ratios and stable isotopes in mollusc shells: Potential tracers of circulation on the continental shelf.
AU: Author
Kronick, A; Williams, DF
AF: Author Affiliation
Univ. South Carolina, Columbia, SC, USA
CF: Conference
8. Biennial International Estuarine Research Conf., Durham, NH (USA), 28 Jul 1985
SO: Source
Estuaries, vol. 8, no. 2B, p. 128A, 1985
IS: ISSN
0160-8347
NT: Notes
Abstract only.
AB: Abstract
The Cd/Ca and stable isotope ratios of super(18)O/ super(16)O and super(13)C/ super(12)C in biogenic carbonate are important indicators of paleocirculation and paleoproductivity in the deep ocean. Cd/Ca and super(13)C/ super(12)C ratios in certain species of benthic foraminifera show a consistant relationship with the bottom water chemistry and carbon transfer. These concepts have been applied to the continental shelf using shells of the scallop Argopecten gibbus . Isotopic and Cd/Ca profiles were determined in shells sampled sequentially from margin to umbo. The use of these ratios may have important applications in determining circulation and productivity changes on the continental shelf.

TI: Title
Larval anisakid (Sulcascaris) nematodes from Atlantic molluscs with marine turtles as definitive hosts
AU: Author
Lichtenfels, J.R.; Bier, J.W.; Madden, P.A.
AF: Author Affiliation
US Dep. Agric., Anim. Parasit. Inst., Sci. and Education Admin., Beltsville, MD 20705, USA
SO: Source

Trans. Am. Microsc Soc, 97(2), 199-207, (1978)
ER: Environmental Regime
Marine
AB: Abstract
Anisakid nematode larvae identified to the genus Sulcascaris Hartwich, 1957 have been collected from several marine molluscs: surf clam Spisula solidissima, calico scallop Argopecten gibbus, Atlantic bay scallop Argopecten irradians, moon sail Lunatia heros, and whelk Busycon canaliculata. As an adult, the only known species of this nematode genus (Sulcascaris sulcata) parasitizes the stomach and intestine of the green (Chelonia mydas) and loggerhead (Caretta caretta) turtle. Parasitized turtles occur in the areas where the larvae parasitize the molluscs. The excretory system of S.sulcata includes an excretory pore at the base of the ventral interlabium, a large ventral ribbon-like gland cell with a nucleus posterior to the level of the ventriculus, and an excretory canal in the right lateral chord that extends posteriorly about half the length of the body. Third- and fourth-stage larvae from molluscs are described and compared with fourth-stage larvae and adults from marine turtles. Comparative data for fourth-stage Sulcascaris from Australian turtles and a scallop are also presented.

TI: Title
New hosts for larval Sulcascaris sp. (Nematoda, Anisakidae) and prevalence in the calico scallop (Argopecten gibbus)
AU: Author
Lichtenfels,J.R.; Sawyer,T.K.; Miller,G.C.
AF: Author Affiliation
US Dep. Agric., Animal Parasitol. Inst., Beltsville, MD 20705, USA
SO: Source
Trans. Am. Microsc. Soc., 99(4), 448-451, (1980)
AB: Abstract
Fourth-stage larval nematodes indistinguishable from Sulcascaris sulcata were found in 38% of A. gibbus collected in marine waters off Cape Canaveral, Florida, in 1970 and 1976. The same nematode was found in Hunter's banded tulip shell (Fasciolaria lilium hunteria) and the Florida horse conch (Pleuroploca gigantea) . A list of 12 species of marine molluscan hosts is given for the larval nematode that matures in sea turtles.

TI: Title
Growth and survival of the tropical scallop Nodypecten (Lyropecten) nodosus in suspended culture at three different depths
AU: Author
Lodeiros, C; Himmelman, J; Rangel, J; Freite, L; Morales, F; Velez, A

AF: Author Affiliation
Dep. Biol. GIROQ (Groupe Interuniversitaire de Recherches Oceanographiques de Quebec), Universite Laval, Quebec, Canada G1K 7P4

CF: Conference
Aquaculture 95', San Diego, California (USA), 1-4 Feb 1995

SO: Source
TRIENNIAL MEETING OF FISH CULTURE SECTION OF AMERICAN FISHERIES SOCIETY WORLD AQUACULTURE SOCIETY NATION SHELLFISHERIES ASSOCIATION., 1995, p. 270, Journal of Shellfish Research [J. SHELLFISH RES.], vol. 14, no. 1

IS: ISSN
0077-5711

AB: Abstract
As part of an evaluation of the aquaculture potential of various Caribbean bivalves, we examined the growth and survival of Nodypecten (Lyropecten) nodosus which were placed in December 1.993 in pearl nets at 3 depths at Turpialito in the Golfo de Cariaco, Venezuela. The initial size was at 9.4 mm (SD = 1.3) in shell height. For each depth, temperature was recorded continuously using thermographs and seston, chlorophyll a and salinity were measured at weekly intervals. The data up to April 1993 show an almost linear increase in shell height, but the rate decreased with depth (10.0, 8.5 and 5.0 mm monn super(-1) at 8, 21 and 34 m in depth, respectively). Those at 8 m attained 51.6 mm (SD = 4.7) in April, after 4 mon of culture. The rates of increase in the muscle and remaining tissues, and in shell mass, were slow during the first month but increased markedly thereafter. The rates of increase of these mass parameters were greatest at 8 m and least at 34 m. The wet mass of the muscle attained 3.4 g in April at 8 m, equivalent to the commercial muscle size for Argopecten gibbus. Gonadal development was most advanced at 8 m, where 90% of the scallops had gonads in February and 100% in March. Gonads were absent for scallops at 34 m in April. Monthly survival rates were consistently >80%, except at 34 m in January (63%). Mortality decreased with depth. Mean chlorophyll a concentrations decreased from 4.8 mg L super(-1) at 8 m to 0.7 mg L super(-1) at 34 m, whereas mean temperatures were similar over the depth gradient studied. This suggests that the accelerated growth at the shallower depths is more likely related to food availability than temperature. (DBO)

TI: Title
Composting calico scallop processing residues, an alternative disposal option

AU: Author
Mahan, WT Jr

AF: Author Affiliation
Univ. Florida/Franklin County Extension Prog., 33 Market St., Suite 305, Apalachicola, FL 32320-2310, USA
CF: Conference
89. Annual Meeting of the National Shellfisheries Association, Fort Walton Beach, FL (USA), 20-24 Apr 1997
SO: Source
Journal of Shellfish Research, vol. 16, no. 1, pp. 347-348, Jun 1997
IS: ISSN
0077-5711
NT: Notes
Summary only.
AB: Abstract
During the initial development (1970) of the calico scallop (Aequipecten gibbus) industry in Florida, production was limited and waste disposal was not an issue. However, development of a mechanical shucking process in 1974, resulted in increased scallop production. By 1984, statewide production peaked at 26.3 million pounds of meats and the Department of Environmental Regulation became concerned about odor and pollution problems associated with inshore and nearshore disposal of the processing wastes. To alleviate this concern, some processors began sending processing residues to landfills. Then in 1988, the Florida Legislature passed the Solid Waste Management Act (SWMA) which mandated major changes in solid waste management practices. Brevard and Franklin were two of the five counties specifically identified in the Act as having major seafood processing waste disposal problems. In fact, the problem got so bad in Franklin County that in May 1990, the Board of County Commissioners passed a resolution prohibiting the disposal of seafood processing wastes at their new landfill, leaving the industry with limited legal disposal options, ocean dumping and trucking the waste out of county. To help these counties and the scallop industry solve their waste problems, the University of Florida's Sea Grant Program worked cooperatively with county officials and seafood processors (Brevard 1991 & Franklin 1993) to develop scallop viscera compost operations as a solution to their landfill problems.

TI: Title
Composting calico scallop processing residues, an alternative disposal option
AU: Author
Mahan, WT Jr
AF: Author Affiliation
Univ. Florida/Franklin County Extension Prog., 33 Market St., Suite 305, Apalachicola, FL 32320-2310, USA

CF: Conference
89. Annual Meeting of the National Shellfisheries Association, Fort Walton Beach, FL (USA), 20-24 Apr 1997
SO: Source
Journal of Shellfish Research, vol. 16, no. 1, pp. 347-348, Jun 1997
IS: ISSN
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NT: Notes
Summary only.
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During the initial development (1970) of the calico scallop (Aequipecten gibbus) industry in Florida, production was limited and waste disposal was not an issue. However, development of a mechanical shucking process in 1974, resulted in increased scallop production. By 1984, statewide production peaked at 26.3 million pounds of meats and the Department of Environmental Regulation became concerned about odor and pollution problems associated with inshore and nearshore disposal of the processing wastes. To alleviate this concern, some processors began sending processing residues to landfills. Then in 1988, the Florida Legislature passed the Solid Waste Management Act (SWMA) which mandated major changes in solid waste management practices. Brevard and Franklin were two of the five counties specifically identified in the Act as having major seafood processing waste disposal problems. In fact, the problem got so bad in Franklin County that in May 1990, the Board of County Commissioners passed a resolution prohibiting the disposal of seafood processing wastes at their new landfill, leaving the industry with limited legal disposal options, ocean dumping and trucking the waste out of county. To help these counties and the scallop industry solve their waste problems, the University of Florida's Sea Grant Program worked cooperatively with county officials and seafood processors (Brevard 1991 & Franklin 1993) to develop scallop viscera compost operations as a solution to their landfill problems.

TI: Title
Maturation of the calico scallop, Argopecten gibbus , determined by ovarian color changes.
AU: Author
Miller, GC; Allen, DM; Costello, TJ; Hudson, JH
AF: Author Affiliation
Southeast Fish. Cent., NMFS, NOAA, 75 Virginia Beach Drive, Miami, FL 33149, USA
SO: Source
NORTHEAST GULF SCI., vol. 3, no. 2, pp. 96-103, 1979
IS: ISSN

: 0148-9836
AB: Abstract
Ovarian color was described for the calico scallop, A. gibbus , by sizes and seasons from May 1970 to October 1971 on the Cape Canaveral grounds, Floria. Seven stages of ovarian development were recognized primarily by color and sequence of development and graded from immature to ripe to spent. Scallops as small as 20 mm shell height can be ripe. There were distinct changes in developmental stage by season. Most scallops were ripe from January to May; in August, large scallops were spent or developing and small scallops were immature. Based on seasonal occurrence of ripe and partially spawned scallops, spawning extended primarily from about November to July and was intense from January to May. There was no spawning in August. Variations occurred in the spawning pattern between years.

TI: Title
Spawning of the calico scallop Argopecten gibbus in relation to season and temperature.
AU: Author
Miller, GC; Allen, DM; Costello, TJ
AF: Author Affiliation
Southeast Fish. Cent., NMFS, NOAA, 75 Virgina Beach Dr., Miami, FL 33149, USA
SO: Source
Journal of Shellfish Research [J. SHELLFISH RES.], vol. 1, no. 1, pp. 17-21, 1981
IS: ISSN
0077-5711
AB: Abstract
Analysis of previous research demonstrated that most spawning of the calico scallop A. gibbus off Cape Canaveral, Florida, occurred between November and June. In 1970 and 1971, spawning intensity was highest from January and May when bottom water temperatures were below 22.5 degree C, and lowest from June to October when temperatures were usually above 22.5 degree C. Major spawning occurred when bottom water temperatures ranged from about 15.0 to 22.5 degree C at depths from 18 to 55 m (the zone of calico scallop concentrations). Off Cape Canaveral, bottom water temperatures in the calico scallop zone are strongly influenced by seasonal atmospheric temperatures and by intrusions onto the Florida-Hatteras Shelf of deep, cold water. Movement of cold water from inshore or offshore into the scallop zone apparently initiates spawning. Calico scallops are most abundant near Cape Canaveral and Cape San Blas, Florida, and Cape Lookout, North Carolina.

TI: Title
Semiannual reproduction in the calico scallop, Argopecten gibbus .
AU: Author
Mover, MA; Blake, NJ
AF: Author Affiliation
Dep. Mar. Sci., Univ. South Florida, 140 7th Ave. S., St. Petersburg, FL 33701-5016, USA
CF: Conference
1990 Annu. Meet. of the National Shellfisheries Association, Williamsburg, VA (USA), 1-5 Apr 1990
SO: Source
Journal of Shellfish Research [J. SHELLFISH RES.], vol. 8, no. 2, p. 434, 1989
IS: ISSN
0077-5711
NT: Notes
Summary only.
AB: Abstract
Extensive commercial fishing for the calico scallop (Argopecten gibbus) occurs off the east coast of Florida centered around Cape Canaveral. Periodic fluctuations in the population level of the calico scallop leads to financial difficulties for the scallop industry. Since October, 1983 the reproductive biology and growth rate of the calico scallop has been studied along with various environmental factors to determine what factors cause the fluctuations in the population level in order to develop methods of predicting periods of decreased productivity. The research has shown that the calico scallop normally spawns semiannually. The primary spawn occurs in the late spring while a secondary spawning event occurs in the fall or early winter. The effects of environmental factors upon spawning and population level is discussed.

TI: Title
Fluctuations in calico scallop production (Argopecten gibbus).
AU: Author
Moyer, MA; Blake, NJ
AF: Author Affiliation
Dep. Mar. Sci., Univ. South Florida, St. Petersburg, FL 33701, USA
CF: Conference
11. Annu. Tropical and Subtropical Fisheries Technological Conf. of the Americas, Tampa, FL (USA), 13-16 Jan 1986
ED: Editor
Otwell, WS; Koburger, JA (eds)
SO: Source
ELEVENTH ANNUAL TROPICAL AND SUBTROPICAL FISHERIES TECHNOLOGICAL

CONFERENCE OF THE AMERICAS., 1986, p. 3, TECH. PAP. FLA. SEA GRANT PROGRAM., no. 45

NT: Notes
Summary only.

NU: Other Numbers
FSG-TP-45

AB: Abstract
During the past year there has been an unexpected and drastic drop in the numbers of scallops located in the calico scallop (Argopecten gibbus) fishing grounds. This has forced a reduction in production by the calico scallop industry. Production data and monthly data on the reproductive state of the calico scallop has been collected since October 1983 from the area north and south of Cape Canaveral, Florida. The data clearly indicates the minimum size for maximizing productivity based upon a constant fishing effort. The relationship between the size of the scallop and the season is examined as well as the seasonal fluctuation in the meat count. The reproductive state of the calico scallops has been determined using wet and dry weight indices of the major components (gonads, digestive gland, adductor muscle and the remaining mantle and gills). Histological examination was performed. These parameters have been correlated with shell morphology.

TI: Title
Mass mortality in the calico scallop Argopecten gibbus caused by Marteilia

AU: Author
Moyer, MA; Blake, NJ; Darden, RL; Arnold, WS

AF: Author Affiliation
Dep. Mar. Sci., Univ. South Florida, 140 7th Ave. South, St. Petersburg, FL 33701, USA

CF: Conference
Fisheries, Biology and Aquaculture of Pectinids. 8. Int. Pectinid Workshop, Cherbourg (France), 22-29 May 1991

ED: Editor
Barret, J; Dao, J-C; Lubet, P (eds)

SO: Source
[FISHERIES, BIOLOGY AND AQUACULTURE OF PECTINIDS: 8TH INTERNATIONAL PECTINID WORKSHOP.] PECHES, BIOLOGIE ET AQUACULTURE DES PECTINIDES: 8E ATELIER INTERNATIONAL SUR LES PECTINIDES, CHERBOURG (FRANCE), 22-29 MAI 1991, INSTITUT FRANCAIS DE RECHERCHE POUR L'EXPLOITATION DE LA MER, DCOM/SE, PLOUZANE (FRANCE), 1995, pp. 41-44, Actes de colloques. Institut Francais de Recherche pour l'Exploitation de la Mer. Brest [ACTES COLLOQ. IFREMER], no. 17

IS: ISSN
0761-3962

IB: ISBN
2-905434-60-0
PB: Publisher
INSTITUT FRANCAIS DE RECHERCHE POUR L'EXPLOITATION DE LA MER, DCOM/SE, PLOUZANE (FRANCE)
AB: Abstract
Mass mortality was observed in the calico scallop, population located on the eastern coast of Florida. Histological examination pointed to the presence of a protozoan in the digestive diverticulum as the probable cause. The protozoan pathogen was later identified as an ascetosporan of the genus Marteilia. This determination was made there was no further evidence of the protozoan in the remaining scallop population. There have been no reported cases of this pathogen in the bivalves of North American waters. The protozoan pathogen reappeared in the Cape Canaveral calico scallop population. The pathogen results in severe pathology in the scallop with massive infestation of the tubules of the digestive diverticulum resulting in mortality due to starvation.

TI: Title
The reproductive biology of the calico scallop, Argopecten gibbus (Linnaeus)
AU: Author
Moyer, MA; Blake, NJ
AF: Author Affiliation
Dep. Mar. Sci., 140 7th Ave., Univ. South Florida, Saint Petersburg, FL 33701, USA
CF: Conference
89. Annual Meeting of the National Shellfisheries Association, Fort Walton Beach, FL (USA), 20-24 Apr 1997
SO: Source
Journal of Shellfish Research, vol. 16, no. 1, p. 348, Jun 1997
IS: ISSN
0077-5711
NT: Notes
Summary only.
AB: Abstract
The calico scallop, Argopecten gibbus (Linnaeus), forms the basis of an important commercial industry on the east coast of Florida. Large fluctuations in annual landings reflect the large variability in the stock availability for this short lived species. These fluctuations are due, at least in part, to spawning success which in turn is influenced by several environmental factors. The lack of sufficient information on the reproductive biology of this animal prompted this research. Field samples were collected over a 12 year period and the reproductive state of the

animals determined. The reproductive cycle as determined through body component indices, body component weights, histological staging and oocyte measurements is presented. This provides a clear picture of the reproductive biology of this animal as well as providing a comparison of the various techniques used to examine the reproductive state of marine bivalves. This information is related to field measurements of various parameters including temperature and phytoplankton concentration. This information is supplemented with laboratory studies on how the reproductive biology of the calico scallop is influenced by temperature and food abundance.

TI: Title
An ascetosporan disease causing mass mortality in the Atlantic calico scallop, Argopecten gibbus (Linnaeus, 1758)
AU: Author
Moyer, MA; Blake, NJ; Arnold, WS
AF: Author Affiliation
Dep. Mar. Sci., Univ. South Florida, 140 7th Ave. S., St. Petersburg, FL 33701, USA
SO: Source
Journal of Shellfish Research [J. SHELLFISH RES.], vol. 12, no. 2, pp. 305-310, 1993
IS: ISSN
0077-5711
AB: Abstract
The Atlantic calico scallop, Argopecten gibbus, prior to December 1988, supported a fishery off the east coast of Florida with an annual production varying between 10 and 40 million pounds of adductor muscle meats. In a six week period from December, 1988 through mid-January, 1989 all harvestable stocks over the 2500 square mile fishing area were devastated. Stocks began to reappear in the summer of 1989. In January of 1991, as the population was rebounding and fishing had resumed, massive mortalities were again observed in the calico scallop stock; by February, 1991 the scallop population had again been reduced to negligible numbers. Histopathological examination of the scallops involved implicates an ascetosporan of the genus Marteilia as the primary cause of the observed mortalities.

TI: Title
Preliminary observations on the mechanical extraction of meats from the sea and Iceland scallop.
AU: Author
Naidu, KS
CA: Corporate Author
Department of Fisheries and Oceans, St. John's, Nfld. (Canada)

SO: Source
CAN. MANUSCR. REP. FISH. AQUAT. SCI., no. 2023, 1989, 15 pp
NU: Other Numbers
ISSN 0706-6473
AB: Abstract
Sea scallops (Placopecten magellanicus) and Iceland scallops (Chlamys islandica) were subjected separately to a prototype mechanical shucking device used normally for calico scallops (Argopecten gibbus). Gaping was effected with pressurized steam and separation of viscera from shells was induced mechanically on a perforated vibrator plate. Removal of some of the physical constraints, together with some secondary processing, may well result in the deployment of the shucking machine for Iceland scallops. The mechanical device ought to extract meats more rapidly and cheaply than through labor intensive and tedious manual shucking.

TI: Title
Scallops and their utilization
AU: Author
Peters,J.A.
AF: Author Affiliation
Peters Associates, South Hamilton, MA, USA
SO: Source
Mar. Fish. Rev, 40(11), 1-9, (1978)
NT: Notes
MFR Paper No. 1352
ER: Environmental Regime
Marine
AB: Abstract
Pertinent information on the history, biology, harvesting, and utilization of the various species of scallops of commercial importance in the United States is presented. There are currently four species of scallops of commercial importance in the United States: sea scallops (Placopecten magellanicus), bay scallops (Aequipecten iradians), calico scallops (Argopecten gibbus), and the Pacific sea or weathervane scallop (Patinopecten caurinus). A possible solution to the problems of steadily declining catch of sea scallops and the great fluctuations in landings of bay and calico scallops might be found in the application of aquaculture to these species.

TI: Title
A cooperative management solution to a fishery commons
AU: Author
Pompe, J; Rockwood, CE
AF: Author Affiliation

Sch. Bus., Francis Marion Univ., Florence, SC 29501, USA
SO: Source
Marine Fisheries Review [MAR. FISH. REV.], vol. 55, no. 4, p. 14, 1993
IS: ISSN
0090-1830
AB: Abstract
A common property resource with open access, such as a fishery, will be used to excess when faced with sufficient demand. This will lead to an excessive amount of effort on the part of the fishery, resulting in a depletion of the stock. This paper discusses the development of a property rights regime for the Atlantic calico scallop, Argopecten gibbus, fishery of Florida. The management solution of the Calico Scallop Conservation Association (CSCA) provides an example of the assignment of property rights to a common property resource without resorting to governmental intervention. In this particular fishery, self-regulation limited early harvesting which would be uneconomic; there may be other fisheries in which self-regulation could be economically efficient and biologically appropriate. While this solution may not be applicable to all common property resources, for those cases which may be similar, the example of the CSCA provides valuable information that may be helpful in establishing a more efficient use of the resource. Some types of government facilitation may also be useful.

TI: Title
Seasonal variations in tissue weight and total solids of the calico scallop, Argopecten gibbus (Linne) and their relationship to changes in gonad condition
AU: Author
Porter,H.J.; Schwartz,F.J.
AF: Author Affiliation
Inst. Mar. Sci., Univ. North Carolina, Morehead City, NC, USA
CF: Conference
Presented at : NSA Convention, Maryland (USA), 1975
SO: Source
Proc. Natl. Shellfish. Assoc., Md, 66, 104-105, (1976)
NT: Notes
Summary only
AB: Abstract
Seasonal tissue weight and total-solids data were collected in 1972 as part of an ecological study of the commercial calico scallop, A.gibbus (Linne), beds which existed that year south of Beaufort Inlet, North Carolina, at a depth of 20 to 25 m. Seasonal tissue weights were examined by three methods: (1) wet weight, (2) weight-length ratio, and (3) growth-curve ratio. Because of

significant correlations between wet-tissue weights and weight-length ratios to scallop lengths (gonad tissue data were exceptions), these methods were considered of questionable value as indicators of the life history of calico scallops. No correlation was found between calico scallop shell length and either growth-curve-ratio or total-solids data. Total-solids and growth-curve-ratio data indicated that calico scallops off the North Carolina coast spawned between April and May and possibly the late fall in 1972. With spawning, all tissues exhibited a weight drop followed by gradual weight increase. Total-solids values for muscle and visceral tissue, subsequent to the spring spawning, did not increase or decrease, suggesting possibly that glycogen values or scallop condition remained relatively constant. During early and late summer gonad tissue, tissue-weight and total-solids data contained a number of peaks. It is theorized that one of these may have been an indication of an early September spawning by the calico scallops. The supply of scallops diminished by October to an unprofitable level and commercial fishing was discontinued. Scallop tissue conditions, during this same period, did not suggest that demise of the fishery was caused by dying off of the scallops. Seasonal chlorophyll-a values from the fishing area were not indicative of an upwelling condition and had no tracable relation to tissue values. A late fall bloom may have helped survival of larvae from a possible late fall spawning.

TI: Title
The organic content of shells and soft tissues of selected estuarine gastropods and pelecypods

AU: Author
Price, T.J.; Thayer, G.W.; LaCroix, M.W.; Montgomery, G.P.

AF: Author Affiliation
Natl. Mar. Fish. Serv., Atl. Estuarine Fish. Cent., Beaufort, NC 28516, USA

SO: Source
Proc. Natl. Shellfish. Assoc., Md., 65, 26-31, (1976)

ER: Environmental Regime
Brackish

AB: Abstract
The total organic matter in shells and soft tissues of 3 species of gastropods and 14 species of pelecypods was measured by combustion at 475 5 degree C. The organisms were collected along the eastern coast of the United States during 1970-1972. The percent organic material in the shells of pelecypods ranged from 12 . 2 (Argopecten irradians) to 71 . 9% (Crassostrea virginica); in soft tissues from 25 . 5 (C.virginica) to 84 . 3% (A.irradians); and in pallial fluid from 2 . 6 (C.virginica) to 9 . 1% (Modiolus demissus). For the gastropods (Littorina irrorata, Ilyanassa obsoleta and Urosalpinx cinerea), the average organic material in the shells, 35 . 9, and in the soft

tissues, 63 . 7%, were similar for the 3 species. The percent ash-free dry weight for the shells, soft tissues and pallial fluid of pelecypods averaged 4 . 5, 79 . 5 and 30 . 5%, while that for the shells and soft tissues of gastropods averaged 3 . 1 and 77 . 8%. The percent of ash-free dry weights of pelecypods ranged from 1 . 4 (A.irradians) to 21 . 4% (Solemya velum) for shells; 68 . 1 (Abra aequalis) to 93 . 9% (Rangia cuneata) for soft tissues; and 20 . 0 (C.virginica) to 60 . 2% (R.cuneata) for pallial fluid. The percent ash-free dry weight of gastropod shells ranged from 2 . 7 (L.irrorata) to 3 . 2% (I.obsoleta) and for soft tissues from 67 . 7 (I.obsoleta) to 85 . 1% (U.cinerea). The other species of pelecypods that were analyzed were Argopecten gibbus, Mercenaria mercenaria, Tagelus plebeius, Chione cancellata, Mytilus edulis, Macoma tenta, Tellina versicolor, and Corbula contracta. Since molluscs are important estuarine herbivores and the organic matrix of their shells rarely is assimilated by carnivores or other organisms, the production of shells represents a drain on the productive capacity of an estuary.

TI: Title
Scallop fisheries, culture and enhancement in the United States
AU: Author
Shumway, SE; Castagna, M
AF: Author Affiliation
Nat. Sci. Div., Southampton Coll. LIU, Southampton, NY 11968, USA
SO: Source
Memoirs of the Queensland Museum. Brisbane [MEM. QUEENSL. MUS.], vol. 36, no. 2, pp. 283-298, 1994
IS: ISSN
0079-8835
AB: Abstract
Information is provided on distribution, commercial landings and landed value of: sea scallop, Placopecten magellanicus, bay scallop, Argopecten irradians, calico scallop, Argopecten gibbus, pink scallop Chlamys rubida, spiny scallop, Chlamys hastata and weathervane scallop, Patinopecten caurinus. Where applicable, information is provided on fishing regulations and management plans. Aquaculture of scallop is limited to a few ventures utilizing the bay scallop, A. irradians. Enhancement programs are designed to reinstate populations of A. irradians to areas decimated by the 'brown tide' Aureococcus anophagefferens and regional efforts to provide some stability to local fishing efforts.

TI: Title
Scallop fisheries, culture and enhancement in the United States
AU: Author

Shumway, SE; Castagna, M
AF: Author Affiliation
Southampton Coll. Nat. Sci. Div., Southampton NY 11968, USA
CF: Conference
2. Australasian Scallop Workshop, Triabunna, Tas. (Australia), 23 Mar 1993
SO: Source
Memoirs of the Queensland Museum. Brisbane [MEM. QUEENSL. MUS.], vol. 36, no. 2, pp. 283-298, 1994
IS: ISSN
0079-8835
NT: Notes
Maps, graphs, 6 tables, 43 ref.
AB: Abstract
Information is provided on distribution, commercial landings and landed value of: sea scallop, Placopecten magellanicus; bay scallop Argopecten irradians; calico scallop Argopecten gibbus; pink scallop Chlamys rubida; spiny scallop Chlamys hastata and weather-vane scallop Patinopecten caurinus. Where applicable, information is provided on fishing regulations and management plans. Aquaculture of scallop is limited to a few ventures utilising the bay scallop. Enhancement programmes are designed to reinstate populations of A. irradians to areas decimated by the brown tide, and regional efforts to provide some stability to local fishing efforts.

TI: Title
Occurrence of Echeneibothrium (Platyhelminthes, Cestoda) in the calico scallop Argopecten gibbus from North Carolina.
AU: Author
Singhas, LS; West, TL; Ambrose, WG Jr
AF: Author Affiliation
Dep. Biol., East Carolina Univ., Greenville, NC 27858, USA
SO: Source
Fishery Bulletin [FISH. BULL.], vol. 91, no. 1, pp. 179-181, 1993
IS: ISSN
0090-0656
AB: Abstract
During the course of a study describing gametogenesis and reproductive periodicity in the North Carolina population of A. gibbus , a larval cestode was found in specimens collected in late 1990 and early 1991. The objectives of this report are to identify the cestode, and to describe alterations in intestinal morphology and percent dry weight of the gonadal tissues ("gonadal index") of A. gibbus , which coincided with infection by this cestode.