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Description and Preliminary Evaluation of a Statewide Estuarine Trawl Survey in North Carolina

by

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ABSTRACT

The North Carolina Division of Marine Fisheries established a long term, statewide, estuarine trawl survey in 1978 to monitor annual recruitment of economically important species such as brown shrimp (*Penaeus aztecus*), blue crab (*Callinectes sapidus*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), weakfish (*Cynoscion regalis*), and southern flounder (*Paralichthys lethostigma*). A total of 119 fixed stations from Pamlico Sound to Cape Fear River were sampled monthly March-November during 1979-1984. Seventy-nine of the stations are located in the shallow (0.6-1.2 m) upper reaches of dead-end creeks or bays and are sampled with a two-seam trawl with a 3.2 m headrope, 6.4 mm bar mesh body, and 3.2 mm cod end. The remaining 40 stations are located in the lower and/or deeper portions of creeks and bays and are sampled with a two-seam trawl with a 6.1 m headrope, 19 mm bar mesh body, and 6.4 mm cod end. A total of 128 species were collected, with spot and croaker being the most and second most abundant species in both trawls. Except for paralichthid flounders, most of the fish caught were young-of-the year (YOY) less than 200 mm. Mean monthly YOY catch-per-unit-effort (C/f) peaked in April for blue crab, spot, and southern flounder, May for croaker, and June for brown shrimp. Minimum variability in C/f occurred during May, June, or July. Mean annual YOY C/f varied greatly for brown shrimp, spot, and croaker, with maximum annual increases of 85, 203, and 149% and maximum declines of 59, 62, and 52%, respectively. $\log_e$ mean annual brown shrimp C/f was highly correlated with Pamlico Sound landings ($r^2 = 0.987$, $p = 0.0001$). Regressions of YOY croaker C/f on northern Pamlico Sound long haul seine landings three years later yielded r^2's of 0.978-0.993 with probabilities of 0.0533-0.0943.

INTRODUCTION

The North Carolina Division of Marine Fisheries (DMF) is charged with stewardship of the state's marine and estuarine resources, utilized by a very large recreational fishery and commercial fisheries with a dockside value of $57 million in 1984. Over 90% of the commercial landings are comprised of estuarine-dependent species (Ross and Epperly in press). During 1971-1975, the DMF, realizing the importance of identifying and protecting the most sensitive portions of the estuarine habitats utilized as nursery areas by so many of the state's economically-important fishes and crustaceans, initiated extensive one-two year trawl surveys throughout the state (Spitsbergen and Wolff, 1974; Purvis, 1976; Wolff, 1976). These surveys identified primary nursery areas which were then officially designated by the state and are protected from any bottom-disturbing fishing activity and most dredging and filling activities.

In 1978 the DMF established a long term, statewide, estuarine trawl survey. The primary objective of this survey is to monitor annual recruitment and create a long term data base on those economically important species, such as brown shrimp (Penaeus aztecus), blue crab (Callinectes sapidus), spot (Leiostomus xanthurus), Atlantic croaker (Micropogonias undulatus), weakfish (Cynoscion regalis), and southern flounder (Paralichthys lethostigma), which inhabit primary nursery areas. Other objectives of the survey include determining and monitoring species distributions by season and by area, providing age and growth and movement data on young-of-the-year (YOY), and providing information for use in environmental impact questions.

Ross and Epperly (in press) presented findings on the sizes, distribution, and seasonality of nekton in Pamlico Sound nursery areas, as well as the relationships of several abiotic factors to their distribution, using 1981-82 DMF survey data. Epperly (1984) incorporated DMF survey data in a report on the distribution and ecology of fishes in northwestern Pamlico and Albermarle sounds. Other reports (Carpenter and Ross, 1979; Ross and Carpenter, 1980, 1983; Hawkins, 1982) presented annual summaries of species composition, length frequency, and relative abundance data from the survey.

The DMF plans to use the recruitment indices to monitor changes in relative stock size and, through correlation analyses with environmental and biological parameters, determine some of the factors affecting year class strength. Rickhus et al. (1980) used 21 years of juvenile C/f data to correlate white perch (Morone saxatilis), and American shad (Alosa sapidissima) to landings data. They were able to explain 87% of the variance in the Potomac River white perch catch using juvenile C/f data from 9 years earlier. For American shad they were able to obtain significant correlations by lagging the C/f data four to six years, which fit biologically. On a smaller scale, these recruitment indices provide information on the relative productivity of different drainages and, to a lesser extent, on the effects of any significant environmental changes or alterations--valuable data when making decisions concerning estuarine use or modification.

This paper describes the methods and geographical coverage of the DMF trawl survey, presents total length frequency, species composition, and monthly and annual C/f data from 1979 through 1984, and examines relationships between mean annual C/f for brown shrimp, blue crab, spot, and Atlantic croaker and commercial landings data.

MATERIALS AND METHODS

Description of the Survey

Two different two-seam otter trawls are used in the DMF survey. One net has a 3.2 m headrope, 6.4 mm bar mesh wings and body, and 3.2 mm bar mesh cod end. The other net has a 6.1 m headrope, 19 mm bar mesh in the wings and body, and 6.4 mm bar mesh cod end (19 mm prior to 1981). Both nets have tickler chains, are towed with 46 cm x 76 cm doors by outboard boats, and are set and retrieved by hand. The 3.2 m net is towed for one min at a speed (about 1.1 m/sec) designed to cover 68.6 m. The 6.1 m trawl is towed for 5 min and 342.9 m. A few stations are marked at both beginning and ending points so that engine speed can be easily and frequently calibrated. The 3.2 m trawl stations are located primarily in the shallow (0.6-1.2 m) upper reaches of dead-end creeks or bays with highly organic, coarse silt bottoms (DMF, unpublished data). The 6.1 m trawl stations are typically located in the lower and/or deeper (2-5 m) portions of creeks and bays over sand or sandy-mud bottom.

One tow is made at each station during daylight hours at about 30 d intervals during March-November with one of the two trawls, although some 3.2 m trawl stations were only sampled through August after 1982 because of manpower limitations. No sampling occurs during December-February because the initial survey showed that extremely few, if any, of the target species were captured in the nursery areas during these months. Because lunar tides are negligible in Pamlico Sound (Roelofs and Bumpus 1953) and less than 1 m south to New River, tide stage is not considered when sampling north of New River. South of New River, where tides are one to two m, sampling is done on early to mid-ebb tide.

The DMF survey utilizes fixed stations in estuaries from the northern end of Pamlico Sound south to the Cape Fear region near the South Carolina border (Figures 1 and 2). The total number of stations sampled each year during 1979-1984 were 141, 145, 152, 172, 187, and 192. Of these, 119 stations (79 3.2 m and 40 6.1 m) were sampled each of the six years and only data from these core sets of stations will be presented herein. Eighty-three (70%) of the 119 stations (56 3.2 m and 27 6.1 m stations) are located in tributaries of Pamlico Sound, the dominant feature of North Carolina's estuarine system and the largest embayment formed behind barrier beaches along the U.S. Atlantic coast (Roelofs and Bumpus 1953).

Catch handling, and measuring procedures in particular, have changed several times since 1979, but all species of fish and marketable crustaceans have always been counted and identified. During 1979 and 1980, at most stations, all fish were identified to species, visually assigned to size groups, counted, and their modal size recorded. Blue crabs and penaeid shrimp were measured to the nearest cm carapace width (CW) and total length (TL), respectively. At the remaining stations, all specimens of spot, croaker, weakfish, southern flounder, blue crab, and penaeid shrimp were measured to nearest mm (median length for fish) to provide length frequency information.

Beginning in 1981, all specimens of blue crabs and all species of fish, if there were obviously less than 30-60 in the catch, were measured to the nearest mm at all stations. Large collections (>30-60 individuals) of a species were subsampled by thoroughly mixing the separated pile of that species, randomly selecting (as a group) and measuring 30-60 individuals, then counting the remainder and expanding the length frequency of the subsample to represent the entire catch (Gulland 1966). When only a few individuals of an obviously different size or age class were present in a large collection, size groups were separated and counted and measured independently to ensure correct representation in the length frequency,. By having a range for subsample size and selecting it as a unit, the bias that would have been introduced by counting out and handling individually a specific-sized subsample was eliminated. Bay anchovies (<u>Anchoa mitchilli</u>) were no longer measured after 1981, and beginning in 1984, all penaeids were measured to the nearest mm and only species of fish with commercial or recreational value were measured. In addition to biological data, surface and bottom temperatures and salinities were recorded for each tow.

Because both trawls are quite inefficient in capturing the small, schooling, pelagic bay anchovy, especially newly-recruited YOY, abundance data on this very abundant species is suspect at best and was not included in these analyses. In addition, all invertebrates except blue crabs and the three penaeid shrimps were excluded because their treatment in the survey has varied greatly.

Data Analyses

Only YOY data from the 3.2 m stations were used in the calculations of C/f. For spot, croaker, and southern flounder, YOY were identified by examining total monthly length frequencies for each year, determining a maximum size for each month overall, then eliminating all individuals larger than that size. In most instances it was very easy to distinguish year classes, especially during the peak recruitment months of March-June, and overall, few one year olds were collected.

Separate spring and fall C/f values for blue crabs were based on fairly distinct modal groups ranging up to 50 mm CW during March-May and 30 mm CW during September-November. These two recruitment peaks likely result from two spawning peaks during the extended March-October spawning season (Van Engel 1958; Williams 1971). It was not possible to distinguish one year's recruits from the previous year's in the length frequencies from June through August. All data for the brown shrimp, basically an annual species, was included when calculating C/f.

Monthly arithmetic mean C/f was calculated after pooling all collections in a given month over all years (1979-1984). Annual arithmetic mean C/f was calculated after pooling all collections from the two or three peak recruitment months in a given year. Peak recruitment months-May and June for brown shrimp and April-June for spot and croaker-were determined using monthly mean C/f values.

Annual mean C/f was calculated for all 79 of the 3.2 m stations as a group and for just the 56 stations in the Pamlico Sound system. This was done because Pamlico Sound is hydrologically quite different from those estuaries south of it, spans a major zoogeographical boundary at Cape Hatteras, is the most simple system to deal with, and much of the landings data used in the C/f-landings regressions came solely from there. When calculating mean annual Pamlico Sound C/f for brown shrimp, 10 of the 56 stations which historically have never produced more than trace catches of the species were deleted.

These were eliminated because stations which seldom, if ever, yield this species cannot be expected to give C/f values showing any relationship to landings.

Standard linear regression techniques were used to examine relationships between mean annual C/f and commercial landings for brown shrimp, blue crab, spot and croaker. Both untransformed and $\log_e$ transformed C/f values were used in the regressions. Many different combinations of landings data besides total annual state landings were used (Table 1). For brown shrimp, total state and total Pamlico and Core Sound landings from the same year were used.

The almost continuous recruitment of blue crab with spring and fall peaks and the inability to identify different year classes in length frequencies necessitated trying many combinations. These included total state and total Pamlico Sound (including Neuse and Pamlico Rivers) landings the following year, all possible consecutive 12 mo totals from Pamlico Sound beginning with August of the same year through July of the next, and ending with July of the next year through June of the second year after recruitment, and the October (same year) through September (next year) landings from the entire state.

Landings from the estuarine long haul seine fishery were used for spot and croaker. This spring through fall fishery, restricted mainly to Pamlico and Core Sounds, is the state's largest producer of spot and croaker, is seldom restricted by weather, and has maintained a fairly stable level of annual effort since 1979. For both species C/f was regressed against landings one, two and three years after recruitment, as well as the combined landings one and two years and one, two and three years later. In addition, the same data with October and November landings excluded was also used for spot. October is usually the peak landings month for this species, but fishing success seems most variable and most dependent on weather then. Because unpublished DMF data shows distinct differences in the size and quantity of croaker caught in northern versus southern Pamlico Sound, long haul landings from those two areas were also used for that species.

RESULTS

Species and Size Composition

Spot, a sciaenid, is the most abundant species taken in the DMF survey, comprising 63.4 and 58.6% of all individuals collected and occurring in 87.6 and 89.6% of all collections at the 3.2 m and 6.1 m trawl stations, respectively, during 1979-1984 (Tables 2 and 3). Atlantic croaker, another sciaenid, was second most abundant, occurring in 74.7 and 83.4% of all 3.2 and 6.1 m collections and comprising 15.6 and 26.4% of all individuals taken in those respective gears. Annually, spot comprised from 48.2 to 75.0% of the total 3.2 m catch during 1979-1984, while croaker ranged from 4.1 to 28.1% (Table 4). The five most abundant species in the 3.2 m collections, in order of abundance, were spot, croaker, menhaden, brown shrimp, and blue crab.

A total of 128 species were collected during 1979-1984, 108 in the 3.2 m trawl and 99 in the 6.1 m trawl (Tables 2 and 3). Seventy-nine species were common to both trawls, while 29 and 20 species were unique to the 3.2 and 6.1 m net, respectively. Despite the large number of species overall, the top ten species each year in the 3.2 m trawl comprised 97.5 to 98.4% of the total number of individuals caught (Table 4). Seven species--spot, croaker, menhaden, brown shrimp, blue crab, southern flounder, and silver perch (Bairdiella chrysoura)--were among the ten most abundant each year in the 3.2 m collections.

Total length frequencies of 11 of the more economically important species collected in the survey are presented in Figure 3. These length frequencies clearly show that, except for paralichthid flounders, the two trawls catch primarily fish <200 mm, which are YOY for most species. The length frequencies also show that for most species, the 6.1 m trawl tends to catch the larger individuals.

Catch Effort Analysis

Mean monthly YOY C/f peaked in April for blue crab, spot and southern flounder, May for Atlantic croaker, and June for brown shrimp (Table 5, Figure 4). Except for blue crab, mean C/f dropped sharply soon after peaking, with decreases of 60 to 88% by July and 83 to 94% by August. Maximum monthly C/f was lower in Pamlico Sound than overall for brown shrimp, spot, and southern flounder, and higher for blue crab and Atlantic croaker.

Minimum variability in the catches of brown shrimp, blue crab, spot, croaker, and southern flounder, as evidenced by the coefficient of variation (CV), occurred during May, June or July (Table 5). Maximum variability for all but blue crab catches occurred early and late in the sampling season. The minimum monthly CV for each of the five species was 2.7-19.1% lower in Pamlico Sound than overall.

Annual mean C/f (Table 6, Figure 5) varied greatly for brown shrimp, spot and Atlantic croaker, with maximum annual increases of 85, 203, and 149% and maximum declines of 59, 62, and 52% for these respective species. Spring-recruited blue crab values were less variable with a maximum increase and decline of 36 and 28%, while fall recruit values were quite variable, at least between 1979 and 1980, when C/f increased 464%. Mean annual C/f values for spot were at least one and sometimes two or three orders of magnitude greater than those of brown shrimp, blue crab, and croaker, except in 1983 when croaker C/f were at a six yr high.

Simple six yr means of the CV's of the annual mean C/f showed considerable variability among species and between different recruitment groups within species, ranging from 157 for spot to 507 for fall-recruited blue crab (Table 6). When only Pamlico Sound stations were considered, excluding May brown shrimp values, all mean CV's declined, with brown shrimp, fall-recruited blue crab, and spot declining 32, 36, and 23%. Mean CV's for spring blue crab and croaker declined only 0.5 and 7%. The May brown shrimp value increased 1.5%, while the June brown shrimp mean CV decreased 36%.

Regressions of annual mean C/f on landings for brown shrimp yielded highly significant relationships (Table 7, Figure 6). Log_e mean annual C/f from June yielded an r^2 of 0.987 ($p = 0.0001$) when regressed on Pamlico Sound landings and an r^2 of 0.968 ($p = 0.0004$) when regressed on total state landings. Fifteen other combinations of brown shrimp data yielded statistically significant relationships with r^2's ranging from 0.737 to 0.986 and with 12 of the 15 at probability levels less than 0.01.

Regressions of Atlantic croaker C/f data on northern Pamlico Sound long haul seine croaker landings three years later yielded r^2's of 0.978-0.993, but because of the few degrees of freedom (2), probabilities ranged from 0.0533 to 0.0943 (Table 7, Figure 7). Pamlico Sound C/f showed the closest relationship to landings with an r^2 of 0.993 and a probability of 0.0533.

No statistically significant positive correlations were found between either blue crab or spot C/f data and landings.

DISCUSSION

The DMF trawl survey is very successful in collecting many demersal species of significant economic interest to the state of North Carolina. The five most abundant species in the 3.2 m trawl collections (Table 2) support major commercial fisheries which had a combined ex-vessel value in 1984 of $25,711,000, 45% of the total value of North Carolina's fisheries that year. Each year during 1979-1984, only one of the ten most abundant species in the

3.2 m collections (Trinectes maculatus) was not commercially and/or recreationally important.

Weakfish and summer flounder (Paralichthys dentatus), demersal species which support the state's two most valuable foodfish fisheries, were not adequately sampled in the 3.2 m trawl nor, for the latter species, in the 6.1 m trawl. Newly-recruited YOY weakfish were much more abundant at the 6.1 m stations, where they ranked fifth in abundance, comprising 2.59%, than at the 3.2 m stations, where they ranked twelfth at 0.21% (Tables 2 and 3, Figure 3). Because only four years of data were available for the 6.1 m collections, weakfish data were not analyzed for relationships to landings data. The scarcity of summer flounder in either gear reflects their distribution. Powell and Schwartz (1977) found summer flounder were most abundant in the eastern and central parts of Pamlico Sound and around inlets, areas not sampled in the DMF survey. The trawls are very inadequate at sampling bluefish (Pomatomus saltatrix), a common, pelagic, and commercially and recreationally important species.

The 3.2 and 6.1 m trawls are well-suited to catching YOY of most of the demersal species of interest to the state of North Carolina, and because the catch is primarily YOY, the separation of year classes in data analyses requires only cursory examination of total monthly length frequencies. Few fish larger than 200 mm are caught, which is primarily a function of net selectivity, although station locations and tow speed and duration are also contributing factors. Many species move towards deeper, more open waters as they grow, as evidenced by the catch of larger individuals at the downstream 6.1 m trawl stations, although net selectivity does play a role.

The maximum variability in C/f seen in March and the fall for all but blue crab catches occurred during seasons when environmental conditions were most variable and individuals were either still recruiting (March) or already emigrating to deeper water and/or offshore (fall). The finding of lower minimum monthly CV's and mean annual CV's for Pamlico Sound than overall is likely related to the absence of lunar tides there, which would tend to minimize regular short-term shifts in species distributions and abundance resulting from tidal currents and water level changes. The very large fluctuations in mean annual C/f of brown shrimp, spot, and croaker indicate annual recruitment of YOY of these species to the estuaries is highly variable.

The extremely high correlation between brown shrimp C/f and landings data the same year with only six data points indicates the DMF survey data is a good index of the relative year class strength of that species. Studies in the Gulf of Mexico have also found significant relationships between postlarval or juvenile brown shrimp C/f and landings or adult C/f (Baxter 1963; Berry and Baxter 1969; Caillouet and Baxter 1973; Sutter and Christmas, 1982). Caillouet and Baxter (1973), using average weekly catch/hr in Galveston Bay, Texas, accounted for 72% of the variation in the Texas offshore brown shrimp catch. Sutter and Christmas 1982 could explain 84% of the variability in Mississippi brown shrimp harvests with a multilinear regression using a postlarval recruitment index and temperature and salinity data.

Several factors probably contribute to the high correlation between brown shrimp C/f and landings. One of the more important is the species' short (1-1.5 yr) life span, which results in individuals recruiting to the fishery only a few months after showing up in survey catches, eliminating the need to distinguish year classes in either the juvenile or landings data. Another important factor is that Pamlico Sound brown shrimp landings result solely from larvae recruited there, and except for some possible mixing with individuals from South Carolina offshore south of Cape Fear, all the state's landings probably represent in-state recruits. Other factors likely contributing to the high correlation are (1) juvenile brown shrimp occur primarily in those areas where most of the 3.2 m trawl stations are located, and (2) effort in the fishery is generally proportional to the total crop available, so that survival is probably similar across years and landings should be representative of relative stock size.

The almost significant relationship between Pamlico Sound Atlantic croaker C/f and northern Pamlico Sound long haul landings three years later ($r^2 = 0.993$, $p = 0.0533$), suggests that the fishery was primarily dependent on three year old fish during 1982-1984. Unpublished DMF data indicates that numerically, one and two year olds are more abundant in the catches, but it is quite likely, especially for northern Pamlico Sound, that in terms of weight three year olds are important components. With only three data points in the regressions, any conclusions concerning the reliability of the croaker C/f data are tentative at best.

The absence of a positive correlation between spot C/f data and long haul landings probably resulted because those landings did not reflect relative stock size and/or the presence of two or three age classes in the landings confounded the results.

The failure to find a positive correlation between landings and blue crab C/f data may have resulted from using the wrong size groups and months to calculate mean C/f. The extended recruitment period and bimodal spawning peaks confound length frequency analysis and identification of specific year classes. Because of their short two-three life span (Van Engel 1958) and the strictly estuarine fishery, it seems highly likely that with the right combination of C/f and landings data, significant relationships could be found.

Dudley and Judy (1973) attempted to correlate mean catch/min of juvenile blue crabs from June through May of the following year with catch during the same months one year later. They did not use regression analyses but used their first year's C/f value as an index of 1, then divided subsequent annual means into the base year's to calculate a raising factor to apply to the base year's landings. Predictions for the first year were 21% low and for the second year were 15% high.

After establishing that the survey C/f value for a given species is an accurate index of year class strength, (1) managers have a reliable fishery independent estimate of relative stock size for use in decision making, (2) the search for relationships of environmental and biological factors on year class strength can begin and (3) the effects of some management measures can be evaluated. For example, requiring use of a trawling efficiency device (TED) in the shrimp fishery could significantly reduce fishing mortality on juvenile spot, croaker, and weakfish, which might result in changes in the relationships between juvenile C/f values and landings. A management measure which changed the age distribution or recruitment age of a species in a fishery might nullify one relationship and create a new one with a different lag period between the C/f and landings data.

There are many other possible combinations of DMF C/f and landings data to examine for relationships. The relationship between mean C/f from a single month, all months, or different combinations of months, and landings data from different fisheries should be examined. In the future DMF plans to apply commercial fisheries' age composition data, collected in North Carolina since 1982, to the landings data to examine the relationship of the juvenile C/f data with specific year classes.

Mean monthly C/f values and their associated CV's can be used to evaluate sampling schedules and efficiency, and hopefully optimize sampling time and streamline the survey. In the DMF survey, mean monthly C/f's peaked in April, May, or June and dropped sharply thereafter, and variability (CV) was at or near maximum in March and minimum during May, June, or July. Limiting the survey to April through June or July would probably produce the best C/f data for the least cost.

Future plans for the DMF survey include consideration of changing to stratified random sampling by habitat or by station groups identified by cluster analysis in Ross and Epperly (in press) and addition of 6.1 m trawl stations to improve data on weakfish and summer flounder. Further analyses will include examining relationships between 3.2 m and 6.1 m trawl data.

In conclusion, a long term, estuarine trawl survey such as DMF's, utilizing small outboard-type boats, is an efficient, effective, and fairly inexpensive method for acquiring abundance indices on estuarine dependent YOY with localized fisheries, especially short-lived species such as brown shrimp. In addition, these surveys provide much additional life history and ecological information useful for fisheries management and environmental impact assessment and monitoring.

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Table 1. Preliminary North Carolina commercial landings data (kg) used to examine relationships between recruitment indices and landings.

Species	Landings	Year 79	80	81	82	83	84
Brown shrimp	Total state	886,144	2,220,023	516,440	1,483,016	853,927	1,031,907
	Pamlico Sound [1]	385,170	1,403,155	280,156	804,101	435,063	327,280
Blue crab	Total state		15,568,622	17,203,658	17,330,098	15,734,872	14,737,565
	Oct-Sep [2]	15,060,593	16,379,914	17,584,604	15,674,441	14,822,597	
	Pamlico Sound [3]		12,319,264	13,133,856	11,902,643	10,867,006	11,330,061
	Aug-Jul [2]	10,498,978	13,366,027	11,634,800	10,592,308	11,283,998	
	Sep-Aug [2]	11,060,246	13,200,533	11,584,988	10,849,932	11,418,530	
	Oct-Sep [2]	11,803,988	12,667,499	11,900,410	10,954,318	11,275,438	
	Nov-Oct [2]	12,022,984	12,654,312	12,265,315	10,782,337	11,398,901	
	Dec-Nov [2]	12,212,397	12,986,918	11,919,324	10,926,561	11,411,691	
	Feb-Jan [2]		12,121,171	13,199,250	12,001,447	10,691,861	11,337,762
	Mar-Feb [2]		12,073,778	13,330,926	11,778,965	10,717,881	11,212,792
	Apr-Mar [2]		12,380,801	13,322,667	11,291,046	10,598,702	11,339,631
	May-Apr [2]		12,716,950	12,673,038	10,779,488	10,585,999	11,656,878
	Jun-May [2]		12,799,455	12,420,323	10,727,558	10,730,025	11,623,405
	Jul-Jun [2]		13,222,131	11,995,198	10,385,537	11,141,238	
Spot	Long Haul		1,985,969	967,920	1,599,543	880,087	
	Long Haul exclud. Oct-Nov		1,242,342	777,448	1,090,665	494,129	704,875
Croaker	Long Haul		3,675,504	2,460,256	2,170,674	1,941,735	1,483,152
	N. Pamlico Sound Long Haul		2,996,932	2,052,200	1,879,695	1,744,598	1,082,266
	S. Pamlico Sound Long Haul		677,964	408,055	290,979	197,137	296,179

[1]Includes Neuse River and Core Sound landings.
[2]Listed under year of beginning month.
[3]Includes Neuse River and Pamlico River landings.

Table 2. Total species composition and % frequency of occurrence of 3,943 3.2 m trawl collections from 79 fixed stations in North Carolina estuaries from Pamlico Sound to Cape Fear River during March-November, 1979-1984.

Species	n	%	% Freq. Occur.	Species	n	%	% Freq. Occur.
Leiostomus xanthurus	448,125	63.396	87.57	Prionotus evolans	41	0.006	0.81
Micropogonias undulatus	110,466	15.628	74.66	Diapterus auratus	40	0.006	0.41
Brevoortia tyrannus	49,662	7.026	33.38	Gobionellus hastatus	38	0.005	0.79
Penaeus aztecus	35,263	4.989	34.49	Peprilus alepidotus	31	0.004	0.48
Callinectes sapidus	18,844	2.666	71.92	Chaetodipterus faber	29	0.004	0.66
Bairdiella chrysoura	9,661	1.367	12.86	Syngnathus louisianae	27	0.004	0.46
Paralichthys lethostigma	7,439	1.052	41.49	Selene vomer	26	0.004	0.51
Lagodon rhomboides	7,250	1.026	14.43	Urophycis regia	23	0.003	0.28
Penaeus duorarum	3,200	0.453	18.36	Citharichthys macrops	22	0.003	0.10
Trinectes maculatus	2,421	0.343	24.58	Ictalurus nebulosus	22	0.003	0.30
Penaeus setiferus	2,400	0.340	7.84	Gobionellus boleosoma	21	0.003	0.33
Cynoscion regalis	1,477	0.209	8.06	Ictalurus natalis	20	0.003	0.41
Microgobius thalassinus	1,381	0.195	14.05	Archosargus probatocephalus	19	0.003	0.46
Gobiosoma bosci	1,131	0.160	9.54	Lepomis macrochirus	17	0.002	0.25
Mugil cephalus	855	0.121	5.48	Syngnathus sp.	16	0.002	0.15
Anguilla rostrata	564	0.080	6.67	Centropristis striata	14	0.002	0.03
Anchoa hepsetus	506	0.072	1.34	Gobiidae	13	0.002	0.10
Alosa sapidissima	492	0.070	0.10	Lutjanus griseus	13	0.002	0.28
Lucania parva	423	0.060	1.39	Lepisosteus osseus	13	0.002	0.13
Citharichthys spilopterus	410	0.058	4.97	Mugil sp.	12	0.002	0.10
Orthopristis chrysoptera	389	0.055	2.03	Menidia menidia	12	0.002	0.23
Menidia beryllina	358	0.051	1.85	Myrophis punctatus	11	0.002	0.28
Eucinostomus gula	335	0.047	2.05	Chasmodes bosquianus	10	0.001	0.23
Elops saurus	321	0.045	2.00	Prionotus tribulus	9	0.001	0.23
Alosa aestivalis	278	0.039	0.96	Etrumeus teres	9	0.001	0.08
Caranx hippos	276	0.039	3.53	Mycteroperca microlepis	8	0.001	0.18
Symphurus plagiusa	266	0.038	3.40	Fundulus heteroclitus	7	0.001	0.13
Cynoscion nebulosus	254	0.036	2.94	Trichiurus lepturus	6	0.001	0.15
Cynoscion sp.	218	0.031	0.68	Stellifer lanceolatus	6	0.001	0.03
Morone americana	180	0.025	1.42	Fundulus sp.	6	0.001	0.10
Paralichthys dentatus	156	0.022	2.28	Peprilus triacanthus	5	0.001	0.10
Lepomis gibbosus	154	0.022	1.75	Mugil curema	5	0.001	0.10
Eucinostomus argenteus	104	0.015	0.96	Chloroscombrus chrysurus	5	0.001	0.10
Synodus foetens	101	0.014	1.55	Morone saxatilis	5	0.001	0.10
Sciaenops ocellatus	94	0.013	1.47	Gobiesox strumosus	5	0.001	0.10
Gobionellus shufeldti	93	0.013	0.63	Unknown fish	5	0.001	0.13
Pomatomus saltatrix	88	0.012	1.85	Monacanthus hispidus	4	0.001	0.10
Paralichthys sp.	80	0.011	0.25	Scophthalmus aquosus	4	0.001	0.08
Perca flavescens	68	0.010	0.91	Paralichthys albigutta	4	0.001	0.10
Alosa pseudoharengus	68	0.010	0.74	Abudefduf saxatilis	4	0.001	0.05
Ictalurus catus	63	0.009	0.71	Membras martinica	4	0.001	0.10
Pomoxis nigromaculatus	60	0.008	0.43	Notropis sp.	4	0.001	0.05
Opsanus tau	51	0.007	0.99	Dorosoma petenense	4	0.001	0.10
Dorosoma cepedianum	51	0.007	0.71	Lutjanus analis	3	*	0.08
Syngnathus fuscus	45	0.006	0.68	Enneacanthus gloriosus	3	*	0.05
Etropus crossotus	44	0.006	0.58	Syngnathus floridae	3	*	0.08
Gerreidae	43	0.006	0.28	Cyprinus carpio	3	*	0.08
Alosa mediocris	3	*	0.08	Bothidae	1	*	0.03
Mustelus canis	2	*	0.05	Scomberomorus maculatus	1	*	0.03
Sphoeroides maculatus	2	*	0.05	Hypsoblennius hentzi	1	*	0.03
Spheroides sp.	2	*	0.03	Pogonias cromis	1	*	0.03
Blennidae	2	*	0.05	Menticirrhus americanus	1	*	0.03
Menticirrhus saxatilis	2	*	0.05	Rachycentron canadum	1	*	0.03
Lutjanus synagris	2	*	0.05	Etheostoma olmstedi	1	*	0.03
Caranx crysos	2	*	0.03	Micropterus salmoides	1	*	0.03
Lepomis sp.	2	*	0.05	Prionotus carolinus	1	*	0.03
Hippocampus erectus	2	*	0.05	Priontus sp.	1	*	0.03
Gambusia affinis	2	*	0.03	Cyprinodon variegatus	1	*	0.03
Dasyatis sabina	1	*	0.03	Cyprinodontidae	1	*	0.03
Carcharhinus plumbeus	1	*	0.03	Strongylura marina	1	*	0.03
Ancylopsetta quadrocellata	1	*	0.03	Ictaluridae	1	*	0.03
Citharichthys sp.	1	*	0.03	Esox sp.	1	*	0.03

Table 3. Total species composition and % frequency of occurrence of 1,323 6.1 m trawl collections from 40 fixed stations in North Carolina estuaries from Pamlico Sound to Cape Fear River during March-November, 1979-1984.

Species	n	%	% Freq. Occur.	Species	n	%	% Freq. Occur.
Leiostomus xanthurus	245,353	58.628	89.64	Sciaenops ocellatus	17	0.004	0.45
Micropogonias undulatus	110,413	26.383	83.37	Archosargus probatocephalus	17	0.004	1.06
Penaeus aztecus	12,743	3.042	29.02	Ophidion marginatum	16	0.004	0.76
Callinectes sapidus	11,721	2.801	75.36	Urophycis sp.	14	0.003	0.30
Cynoscion regalis	10,850	2.593	32.43	Scomberomorus maculatus	13	0.003	0.83
Brevoortia tyrannus	7,588	1.813	37.79	Centropristis philadelphica	13	0.003	0.68
Bairdiella chrysoura	4,355	1.041	26.46	Paralichthys sp.	12	0.003	0.08
Lagodon rhomboides	3,507	0.838	17.69	Morone americana	11	0.003	0.45
Anchoa hepsetus	1,761	0.421	7.26	Alosa aestivalis	10	0.002	0.76
Trinectes maculatus	1,681	0.402	20.94	Alosa pseudoharengus	8	0.002	0.60
Penaeus duorarum	1,415	0.338	15.42	Dorosoma petenense	7	0.002	0.23
Paralichthys lethostigma	1,137	0.272	31.14	Gobiosoma bosci	6	0.001	0.45
Urophycis regia	837	0.200	4.31	Prionotus carolinus	6	0.001	0.15
Penaeus setiferus	597	0.143	10.36	Syngnathus fuscus	6	0.001	0.38
Alosa sapidissima	549	0.131	0.30	Urophycis floridana	5	0.001	0.08
Symphurus plagiusa	408	0.097	7.63	Myrophis punctatus	5	0.001	0.38
Peprilus alepidotus	366	0.087	7.18	Elops saurus	5	0.001	0.23
Trichiurus lepturus	358	0.086	3.25	Paralichthys oblongus	4	0.001	0.15
Cynoscion sp.	293	0.070	1.66	Microgobius thalassinus	4	0.001	0.15
Mugil cephalus	225	0.054	3.31	Dasyatis sabina	3	0.001	0.23
Anguilla rostrata	186	0.044	6.05	Dasyatis americana	3	0.001	0.23
Etropus crossotus	171	0.041	4.01	Rhizoprionodon terraenovae	3	0.001	0.23
Paralichthys dentatus	148	0.035	7.33	Sphoeroides maculatus	3	0.001	0.23
Caranx hippos	143	0.034	3.93	Mugil sp.	3	0.001	0.15
Citharichthys spilopterus	134	0.032	4.84	Centropristis striata	3	0.001	0.23
Orthopristis chrysoptera	113	0.027	3.17	Prionotus scitulus	3	0.001	0.15
Synodus foetens	104	0.025	4.01	Gobiesox strumosus	3	0.001	0.23
Pomatomus saltatrix	94	0.022	5.44	Ictalurus natalis	3	0.001	0.15
Prionotus evolans	92	0.022	2.57	Lepisosteus osseus	3	0.001	0.15
Peprilus triacanthus	90	0.022	1.89	Chilomycterus schoepfi	2	*	0.15
Menticirrhus saxatilis	88	0.021	1.36	Aluterus schoepfi	2	*	0.15
Menticirrhus americanus	85	0.020	1.06	Paralichthys albigutta	2	*	0.08
Chaetodipterus faber	76	0.018	2.95	Citharichthys sp.	2	*	0.15
Eucinostomus argenteus	73	0.017	1.36	Astroscopus y-graecum	2	*	0.08
Opsanus tau	66	0.016	3.40	Mugil curema	2	*	0.08
Monacanthus hispidus	61	0.015	1.89	Syngnathus sp.	2	*	0.08
Selene vomer	57	0.014	2.42	Arius felis	2	*	0.15
Stellifer lanceolatus	49	0.012	0.83	Alosa mediocris	2	*	0.08
Prionotus tribulus	46	0.011	1.28	Ophichthus gomesi	2	*	0.15
Ictalurus catus	43	0.010	0.91	Rhinoptera bonasus	1	*	0.08
Chloroscombrus chrysurus	33	0.008	1.21	Dasyatis sayi	1	*	0.08
Scophthalmus aquosus	32	0.008	1.28	Citharichthys macrops	1	*	0.08
Cynoscion nebulosus	26	0.006	1.21	Cobiosoma ginsburgi	1	*	0.08
Dorosoma cepedianum	25	0.006	1.13	Gobionellus boleosoma	1	*	0.08
Ancylopsetta quadrocellata	21	0.005	1.28	Hypsoblennius hentzi	1	*	0.08
Eucinostomus gula	21	0.005	0.68	Astroscopus sp.	1	*	0.08
Syngnathus louisianae	18	0.004	0.91	Sphyraena barracuda	1	*	0.08
Sphyraena quachancho	1	*	0.08	Lepomis gibbosus	1	*	0.08
Pogonias cromis	1	*	0.08	Lepomis macrochirus	1	*	0.08
Menticirrhus sp.	1	*	0.08	Mycteroperca microlepis	1	*	0.08
Diapterus auratus	1	*	0.08	Prionotus sp.	1	*	0.08
Gerreidae	1	*	0.08	Fundulus majalis	1	*	0.08
Lutjanus synagris	1	*	0.08	Porichthys plectrodon	1	*	0.08
Lutjanus analis	1	*	0.08	Conger oceanicus	1	*	0.08
Rachycentron canadum	1	*	0.08	Unidentified fish	1	*	0.08

Table 4. Annual species composition of the ten most abundant species (excluding *Anchoa mitchilli*) from the 3.2 m trawl stations 1979-1984.

	Year					
	79		80		81	
Rank	Species	%	Species	%	Species	%
1	Leiostomus xanthurus	69.41	L. xanthurus	48.24	L. xanthurus	75.01
2	Micropogonias undulatus	12.16	M. undulatus	22.29	B. tyrannus	5.75
3	Brevoortia tyrannus	7.88	P. aztecus	13.92	M. undulatus	4.09
4	Penaeus aztecus	4.53	B. tyrannus	4.24	B. chrysoura	4.01
5	Callinectes sapidus	1.48	C. sapidus	4.01	C. sapidus	2.89
6	Paralichthys lethostigma	0.95	P. lethostigma	1.31	P. aztecus	2.71
7	Lagodon rhomboides	0.86	Penaeus setiferus	1.28	L. rhomboides	2.17
8	Bairdiella chrysoura	0.47	P. duorarum	1.10	P. lethostigma	0.85
9	Penaeus duorarum	0.41	Trinectes maculatus	0.66	P. duorarum	0.48
10	Mugil cephalus	0.30	B. chrysoura	0.47	C. regalis	0.34
	Total	98.44	Total	97.51	Total	98.32
	Year					
	82		83		84	
1	L. xanthurus	66.57	L. xanthurus	50.82	L. xanthurus	61.32
2	M. undulatus	14.05	M. undulatus	28.12	M. undulatus	18.43
3	B. tyrannus	6.47	B. tyrannus	10.74	B. tyrannus	5.92
4	P. aztecus	4.71	P. aztecus	3.30	P. aztecus	4.84
5	C. sapidus	2.76	C. sapidus	2.26	C. sapidus	3.27
6	P. lethostigma	1.52	P. lethostigma	0.75	L. rhomboides	1.60
7	B. chrysoura	1.36	L. rhomboides	0.65	P. lethostigma	1.06
8	T. maculatus	0.34	P. setiferus	0.60	B. chrysoura	0.54
9	P. duorarum	0.30	B. chrysoura	0.42	P. duorarum	0.42
10	L. rhomboides	0.22	Alosa sapidissima	0.39	T. maculatus	0.41
	Total	98.31	Total	98.05	Total	97.81

Table 5. Monthly mean C/f, standard error of the mean (SE), and coefficient of variation (CV) for YOY brown shrimp, blue crab, spot, Atlantic croaker, and southern flounder from 79 3.2 m trawl stations, 1979-1984. Pamlico Sound values were based on data from 56 stations north of Core Sound.

		Mean C/f		SE		CV	
Species	Month	All Stations	Pamlico Sound	All Stations	Pamlico Sound	All Stations	Pamlico Sound
Brown shrimp	3	0.04	0	0.03	0	1,328	
	4	0.90	0	0.31	0	740	
	5	21.81	10.85	3.25	2.18	319	366
	6	34.77	25.01	3.16	2.13	196	156
	7	13.96	10.50	1.09	0.84	169	146
	8	3.51	2.97	0.41	0.35	251	214
	9	0.76	0.70	0.11	0.13	292	305
	10	0.24	0.21	0.04	0.04	366	367
	11	0.09	0.008	0.05	0.008	916	1,603
Blue crab	3	4.76	5.53	0.52	0.68	232	221
	4	5.09	5.29	0.56	0.69	234	235
	5	4.71	5.34	0.41	0.54	188	183
	9	0.60	0.74	0.12	0.17	413	338
	10	0.88	1.05	0.15	0.20	352	341
	11	2.02	2.40	0.32	0.41	292	276
Spot	3	82.2	52.5	13.48	9.53	346	324
	4	420.2	364.7	29.45	25.05	150	121
	5	228.8	257.2	10.66	11.63	100	89
	6	112.3	132.1	6.01	6.98	115	101
	7	49.7	57.9	2.46	3.05	107	99
	8	26.9	33.2	1.96	2.59	156	145
	9	13.9	17.6	1.02	1.40	149	138
	10	10.8	13.3	0.78	1.00	148	133
	11	3.5	3.0	0.43	0.43	228	225
Atlantic croaker	3	11.8	11.2	2.03	2.33	364	371
	4	63.0	74.9	8.97	11.76	305	286
	5	68.8	81.6	5.09	6.19	158	139
	6	44.0	52.2	2.43	2.90	119	102
	7	20.2	23.9	1.08	1.21	115	93
	8	7.4	9.5	0.44	0.55	129	106
	9	4.3	5.8	0.30	0.38	142	115
	10	1.9	2.4	0.14	0.18	156	133
	11	0.2	0.2	0.04	0.04	343	375
Southern flounder	3	2.69	1.48	0.64	0.61	506	737
	4	4.54	3.78	0.47	0.48	220	231
	5	3.29	3.57	0.28	0.33	182	169
	6	1.85	2.21	0.14	0.18	161	146
	7	1.30	1.71	0.13	0.18	217	187
	8	0.78	0.99	0.08	0.10	213	188
	9	0.48	0.62	0.06	0.08	247	216
	10	0.44	0.57	0.04	0.05	190	164
	11	0.30	0.35	0.04	0.05	247	236

Table 6. Mean annual C/f, standard error of the mean (SE), and coefficient of variation (CV) for newly recruited brown shrimp, blue crab, and YOY spot and Atlantic croaker, 1979-1984. C/f was based on 3.2 m trawl data from May and June for brown shrimp, March-June and September-November for blue crab, and April-June for spot and croaker.

		Mean C/f		SE		CV	
Species	Year	All Stations	Pamlico Sound	All Stations	Pamlico Sound	All Stations	Pamlico Sound
Brown shrimp	79	26.7	24.4	4.1	3.7	187	143
	80	49.4	52.8	7.5	8.6	186	156
	81	20.5	13.9	4.0	2.4	242	164
	82	28.6	31.6	4.6	5.5	199	168
	83	20.5	11.2	6.9	2.5	423	215
	84	24.4	19.3	5.0	3.5	255	176
	Unweighted Mean	28.4	25.5			249	170
Brown shrimp (May)	79	23.5	15.6	7.0	5.6	255	236
	80	41.3	36.8	11.7	12.2	246	225
	81	15.5	3.7	6.5	2.1	367	378
	82	19.2	15.5	6.5	6.4	296	278
	83	11.2	2.1	5.2	2.1	413	664
	84	20.3	5.3	8.9	1.7	388	219
	Unweighted Mean	21.8	13.2			328	333
Brown Shrimp (June)	79	29.8	32.9	4.3	4.7	125	94
	80	57.5	68.7	9.3	11.7	141	116
	81	25.3	24.0	4.7	3.7	161	105
	82	37.8	47.7	6.3	8.5	148	120
	83	29.8	20.0	12.8	4.2	380	141
	84	28.5	33.2	4.6	6.2	143	128
	Unweighted Mean	34.8	37.8			183	117
Blue crab (spring)	79	3.3	3.3	0.52	0.65	235	251
	80	4.5	4.4	0.83	0.98	279	292
	81	5.6	6.9	0.85	1.16	229	215
	82	6.1	7.6	0.70	0.92	173	156
	83	5.4	5.7	0.70	0.83	197	189
	84	3.9	4.2	0.51	0.65	197	199
	Unweighted Mean	4.8	5.4			218	217
Blue crab (fall)	79	0.11	0.18	0.03	0.06	518	449
	80	0.62	1.60	0.13	0.34	438	270
	81	0.83	2.02	0.16	0.41	414	268
	82	0.44	1.24	0.10	0.29	484	281
	83	0.56	1.90	0.22	0.73	759	407
	84	0.50	1.16	0.11	0.30	431	271
	Unweighted Mean	0.51	1.35			507	324
Atlantic croaker	79	51.9	65.7	4.8	6.2	139	120
	80	51.1	61.5	4.0	5.0	118	106
	81	14.9	15.3	1.9	2.4	192	200
	82	49.5	60.1	4.9	6.4	151	138
	83	123.4	151.9	16.9	21.4	209	186
	84	59.5	58.6	7.9	8.7	204	193
	Unweighted Mean	58.4	68.9			169	157
Spot	79	318	294	35.3	21.5	166	93
	80	122	104	14.9	11.4	186	141
	81	370	342	37.3	23.6	152	95
	82	300	333	22.4	25.2	114	105
	83	202	229	24.7	27.5	186	170
	84	210	187	19.1	17.0	139	122
	Unweighted Mean	254	248			157	121

Table 7. Statistically significant linear relationships of mean annual YOY C/f on North Carolina commercial landings data for brown shrimp and croaker, 1979-1984. Croaker relationships were significant at the 0.10 level. Slope and intercept values predict landings in pounds. PS = Pamlico Sound. See text for further descriptions of independent and dependent variables.

Species	Independent Variable[1] Annual Mean C/f	Dependent Variable (Landings Data)	r^2	Prob.	Slope	Intercept
Brown shrimp	May-June	Total[2]	0.888	0.0049	116,150	-723,938
	May-June	Pamlico Sound[3]	0.900	0.0039	83,681	-1,036,736
	Log May-June	Total	0.905	0.0035	3,893,172	-10,261,324
	Log May-June	Pamlico Sound	0.878	0.0058	2,745,595	-7702,710
	PS May-June	Total	0.906	0.0034	83,244	443,414
	PS May-June	Pamlico Sound	0.893	0.0044	59,171	-175,231
	Log PS May-June	Total	0.811	0.0144	2,127,080	-4,032,886
	Log PS May-June	Pamlico Sound	0.737	0.0285	1,452,495	-3,172,493
	PS May	Pamlico Sound	0.851	0.0088	67,751	443,554
	June	Total	0.944	0.0012	109,108	-1,226,207
	June	Pamlico Sound	0.986	0.0001	79,829	-1,441,114
	Log June	Total	0.968	0.0004	4,426,955	-12,965,133
	Log June	Pamlico Sound	0.987	0.0001	3,200,632	-9,895,314
	PS June	Total	0.930	0.0019	71,710	-138,141
	PS June	Pamlico Sound	0.886	0.0051	50,124	-556,569
	Log PS June	Total	0.849	0.0090	2,729,627	-7,105,100
	Log PS June	Pamlico Sound	0.755	0.0247	1,842,709	-5,195,103
Atlantic croaker	April-June	N. Pamlico Sd. + 3 yr[4]	0.981	0.0891	44,082	1,726,291
	Log April-June	N. Pamlico Sd. + 3 yr	0.978	0.0943	1,299,574	-1,126,370
	PS April-June	N. Pamlico Sd. + 3 yr	0.983	0.0533	33,527	1,866,198
	Log PS April-June	N. Pamlico Sd. + 3 yr	0.986	0.0756	1,135,266	-716,019

1 Months listed are those included in C/f calculations.
2 All brown shrimp landings were heads off.
3 Pamlico Sound = Pamlico Sound, Core Sound, and Neuse River
4 Long haul landings 3 yr later.

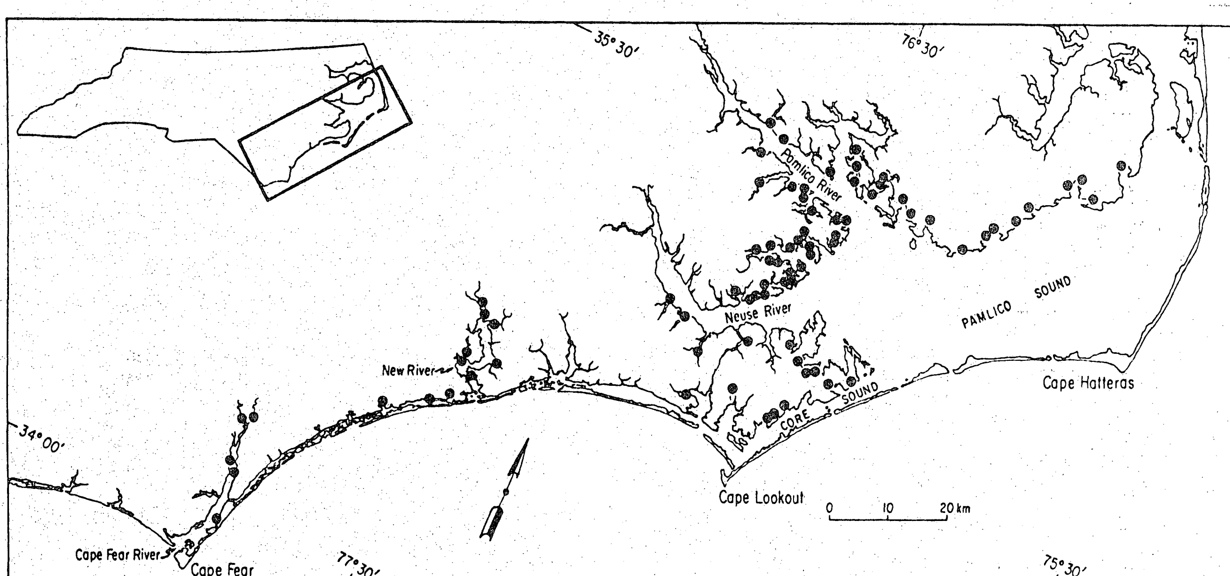

Figure 1. DMF estuarine survey 3.2 m trawl stations sampled each year, 1979-1984.

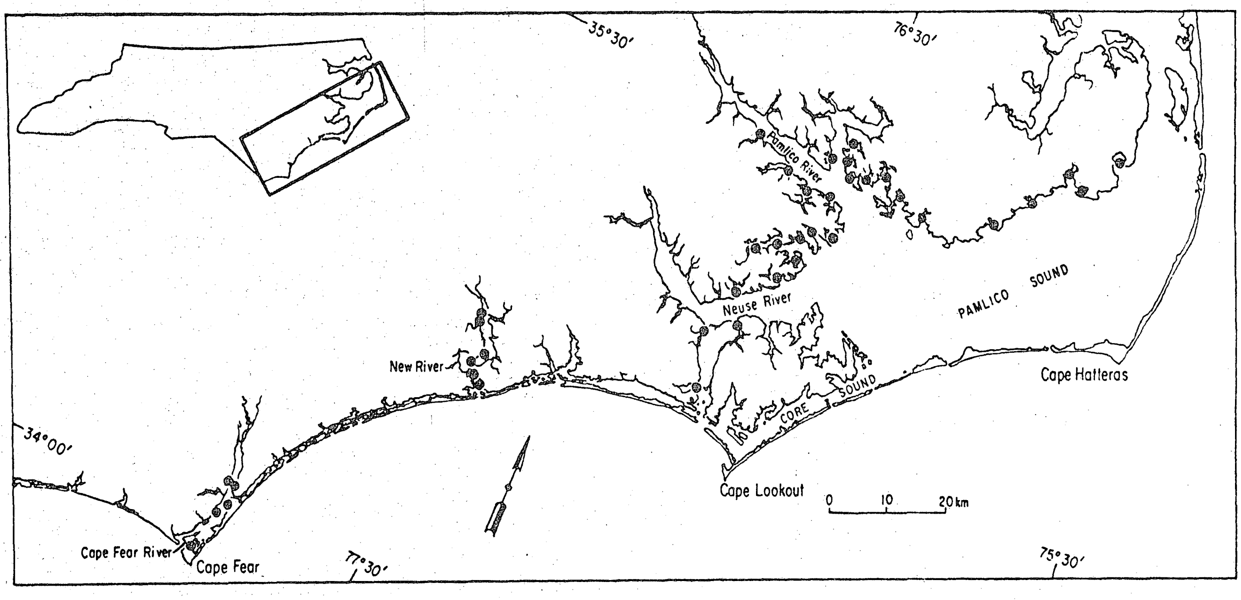

Figure 2. DMF estuarine survey 6.1 m trawl stations sampled each year, 1979-1984.

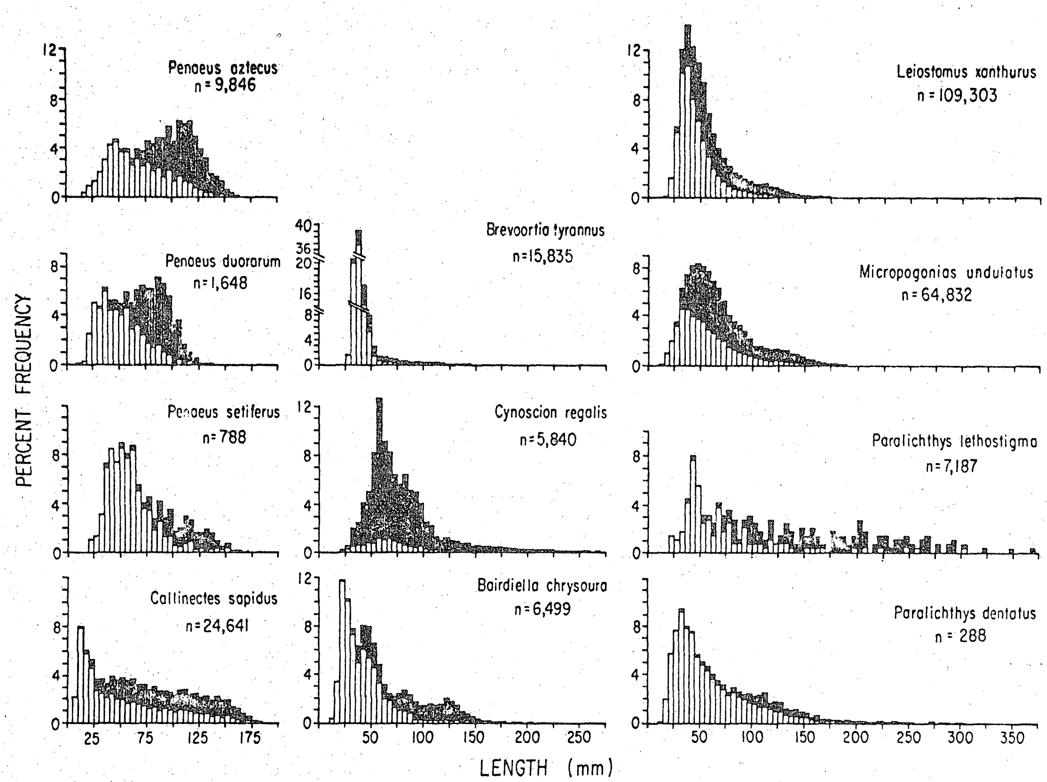

Figure 3. Total length frequencies for eleven commercially or recreationally important species collected in the 3.2 m (open bars) and 6.1 m (solid bars) trawls during 1979-1984.

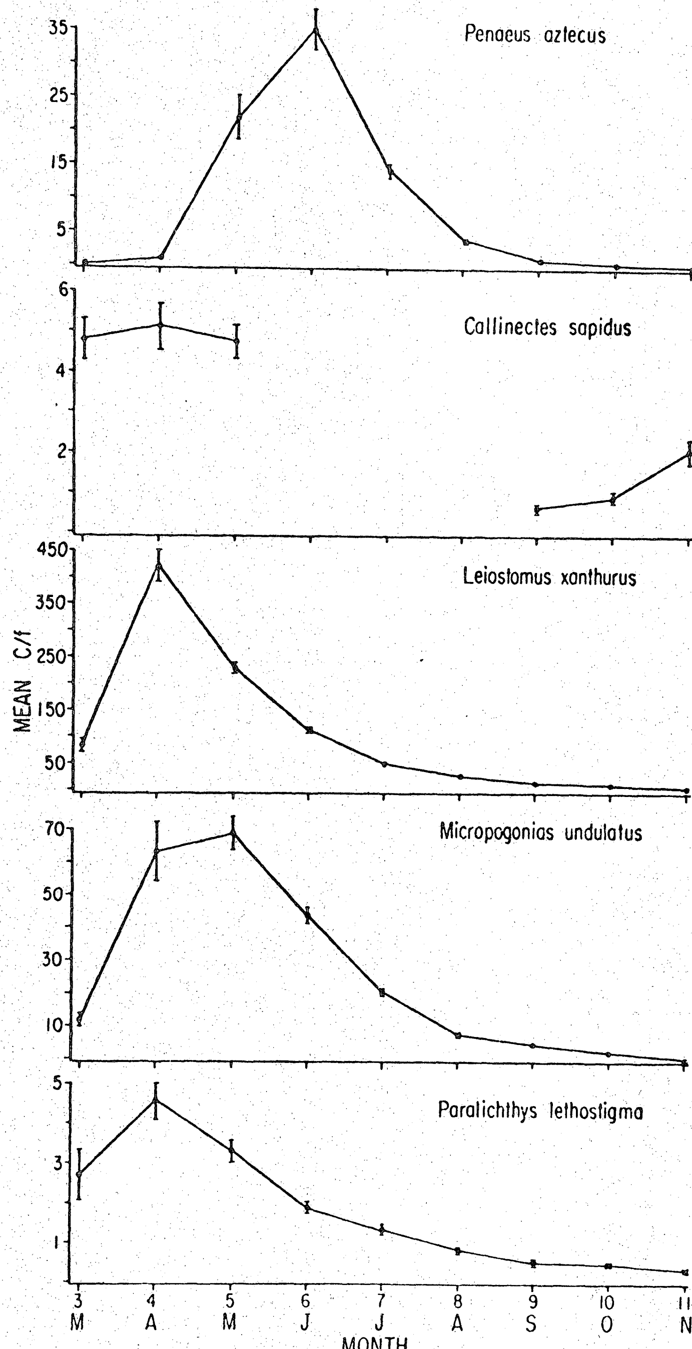

Figure 4. Mean monthly YOY C/f (circle) ± one standard error of the mean (bars) for brown shrimp (P. aztecus), blue crab (C. sapidus), spot (L. xanthurus), croaker (M. undulatus), and southern flounder (P. lethostigma) in the 3.2 m trawl collections, 1979-1984.

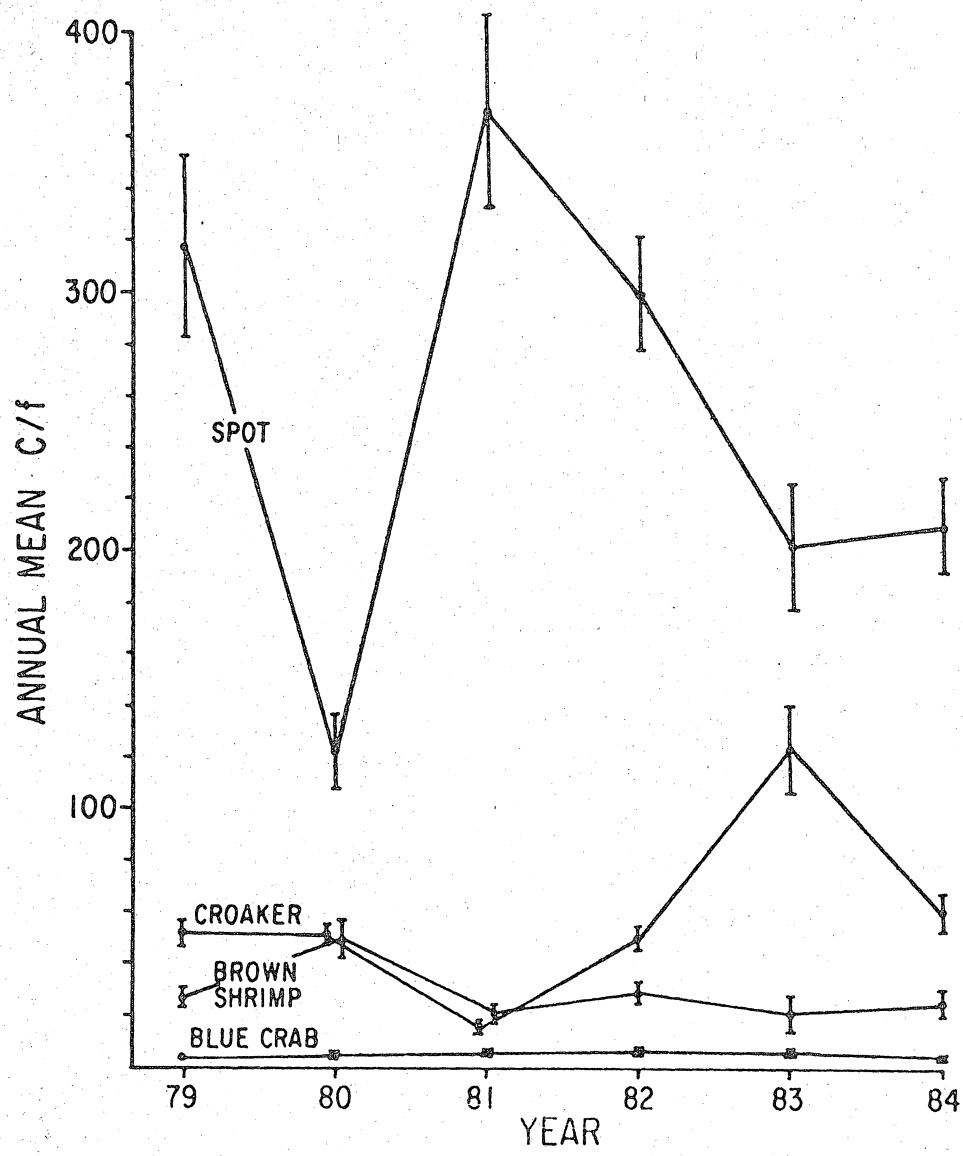

Figure 5. Mean annual YOY C/f (circles) ± one standard error of the mean (bars) for spot (L. xanthurus), croaker (M. undulatus), brown shrimp (P. aztecus), and spring-recruited blue crab (C. sapidus) in the 3.2 m trawl collections, 1979-1984.

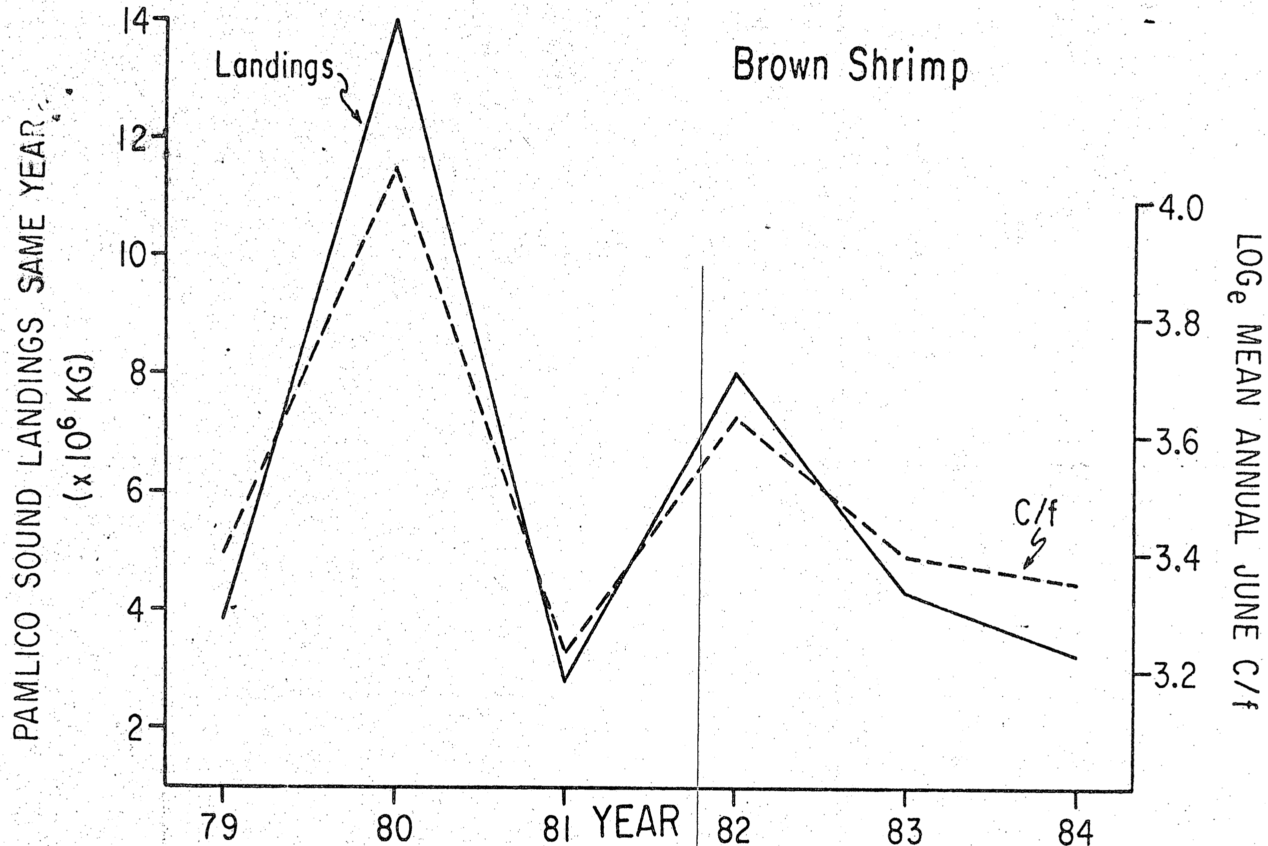

Figure 6. $\mathrm{Log_e}$ mean annual June brown shrimp C/f from the 3.2 m trawl collections and annual landings from Pamlico and Core sounds and Neuse River, 1979-1984.

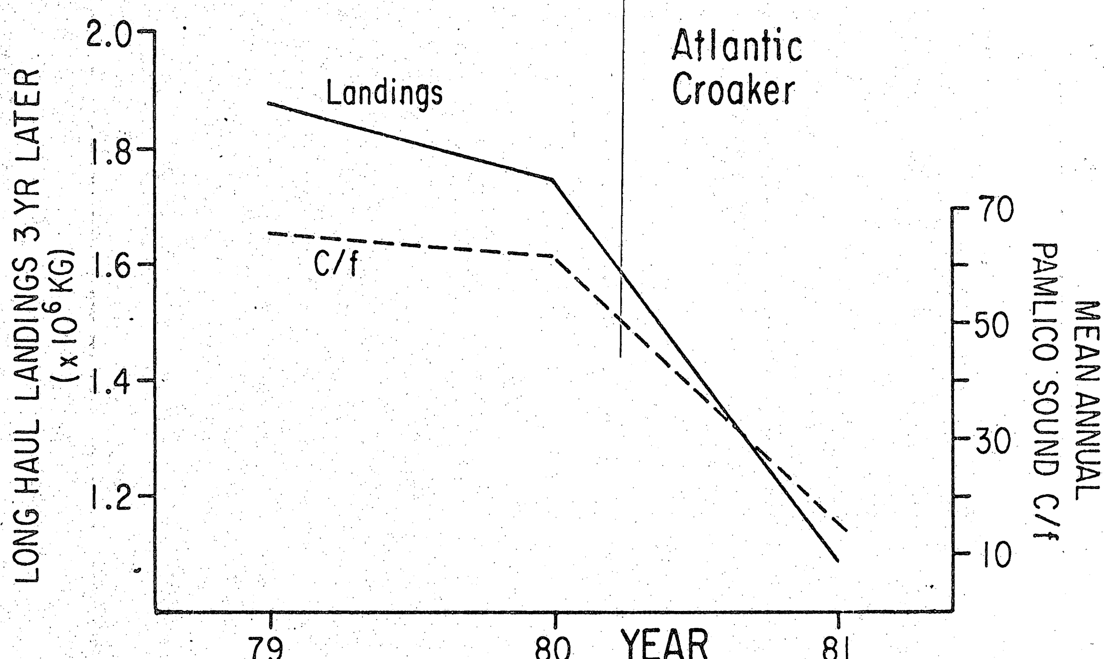

Figure 7. Overall mean annual YOY Atlantic croaker C/f from the 3.2 m trawl collections, 1979-1981, northern Pamlico Sound and long haul seine landings three years later (1982-1984).